DEVELOPMENT OF A PERFORMANCE ASSESSMENT TOOL FOR WORKPLACE SUPPORT TO PRODUCTIVITY AND USER SATISFACTION IN SAUDI ARABIA

BY

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To my ***parents***, ***brothers, sisters, and wife***

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I thank God Almighty for granting me the chance to seek the knowledge through completing the master's degree program in this lofty scientific edifice that had expanded my awareness of the philosophy of architectural engineering field toward serving the humanity through employment of science sources in this field into a practical applications toward an effective and sustainable environments in order to contribute in the comprehensive renaissance of workers and the economies associated with their output according to the vision of the Kingdom of Saudi Arabia 2030.

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A/E	Architect/Engineer
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers
EI	Extremely important
FM	Facilities Management
FMs	Facilities Managers
GDP	Gross Domestic Product
HVAC	Heating, ventilation, and Air Conditioning
IEQ	Indoor Environmental Quality
IGR	In group ranking
IR	Importance rating
IT	Information Technology
KPI	Key Performance Index
OR	Overall ranking
PI	Productivity Index
POE	Post-Occupancy Evaluation
RII	Relative Importance Index

SPSS	Statistical Package for Social Science
VI	Very important
WGBC	World Green Building Council
WODI	Work environment diagnostic instrument

THE DEFINITION OF TERMS

Knowledge Worker : The employee that is using knowledge as the main work resource to analyze, learn, and practice.

Performance: The act of working.

A Productive workplace: The workplace designed to get most of its occupant productivity**.**

Productivity : A rate of work produced compared to the input of resources to execute a specific work.

Tool: A series of steps implemented specifically to get the desired result.

User Satisfaction: User comfort and acceptability.

Workplace: A place where people do mental work for their employment or for themselves**.**

ABSTRACT

Full Name : Turky Suliman Almhbash

Thesis Title : Development of a performance assessment tool for workplace support to productivity and user satisfaction in Saudi Arabia

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The design of workplaces is impacting the national economies through its impression on worker productivity. Design professionals and facility managers have to develop a productive workplace where users are satisfied with the built environment. Therfore, the development of a quantification tool to assess the supportive level of a built environment toward productivity and user satisfaction is vital for any organization to accommodate economic development and its required present and future modifications. This research present an assessment tool to rank the workplace environment and evaluate user satisfaction in those environments. The literature was reviewed to identify the factors that affect workplace productivity. Then, the factors were evaluated by 90 local experts to evaluate the importance that each factor has on a given environment in the Kingdom of Saudi Arabia. The study created a checklist composed of the measures that assess the built environment in terms of productivity. The study applied the checklist to three cases studies in the eastern province of Saudi Arabia followed by evaluating user satisfaction in the highest ranked workplace in terms of productivity using post occupancy evaluation (POE) questionnaire survey, filled by 107 workers and the feedback was analyzed and presented

using the mean satisfaction index approach. The results showed that users are strongly satisfied when working in a productive workplace.

ملخص الدراسة

الاسم : تركي سليمان حمد المهباش

عنوان الرسالة : إعداد مقياس لتقييم مدى دعم بيئا ت العمل للإنتاجية ورضا العاملين بها.

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يؤثر تصميم أماكن العمل على الإقتصاديات الوطنية من خلال التأثير على إنتاجية العاملين بتلك البيئات و يتعين على مصممي بيئات العمل المختلفة و مديري مرافقها الأساسية والمساندة ، تطوير بيئات عمل منتجة يشعر العاملون بها بالرضا لزيادة مستوى الإنتاجية لديهم ، لذا بات من الضرورة إيجاد طريقة عملية للقياس الكمي كمؤشرعن مدى دعم بيئات العمل لإنتاجية ورضا العاملين بها واستخدامها كأداة فاعلة لإعطاء مؤشرفعلي للمساعدة في اكتشاف جوانب القصور للعمل على إصلاحها لترقية بيئة العمل من حيث الإنتاجية والرضا استجابة لمتطلبات عجلة التنمية الاقتصادية المتسارعة وذلك من خلال إحلال التعديلات البيئة وفقاً للعوامل البيئية المتعلقة بالانتاجية ورضا الموظف لتلبية الاحتياجات القائمة والاستراتيجية. حيث يهدف هذا البحث إلى تقديم مقياس لفحص بيئات العمل القائمة من حيث الإنتاجية ورضا العاملين بها من خلال العوامل المؤثرة ، حيث تمت مراجعة الأدبيات لبحث تلك العوامل ، ومن ثم تم القيام بتقييمها عبر تعبئة الاستبيان الخاص بذلك بمشاركة ٩٠ خبيرمهني في مجال التصميم و إدارة المرافق بالإضافة إلى مشاركة مستخدمي مباني مكتبية لتقييم تلك العوامل من حيث الأهمية التي تتضمنها للتأثيرعلى إنتاجية الموظف و رضاه في المملكة العربية السعودية. وبذلك استحدثت الدراسة قائمة لفحص وقياس الانتاجية في بيئات العمل تتكون من العوامل الخاصة بها والمندرجة تحت خمسة أقسام رئيسية ، حيث تم تطبيقها على ثلاثة مكاتب عمل بالمنطقة الشرقية بالمملكة العربية السعودية ، بالإضافة إلى تقييم مستوى الرضا للعاملين من خلال تعبئة استبيان خاص بتقييم مابعد الاشغال بمشاركة ١٠٧ موظف في بيئة العمل الحاصلة على أعلى تقييم من حيث الإنتاجية و تحليل الملاحظات وعرضها باستخدام نهج مؤشر الرضا المتوسط حيث أظهرت النتائج أن المستخدمين لبيئة العمل المنتجة هم راضون بشدة عن بيئاتهم وحيث ساهمت عوامل الانتاجية وبشكل ملحوظ في تعزيزمستوى الانتاجية لديهم.

CHAPTER 1

INTRODUCTION

1.1 Background

The global economy transitioned from depending on people working in large factories to workers working in office buildings utilizing computer and technical equipment after WWII. As a result, the transition from depending on manual employees to relying on knowledge workers has begun. (Ramírez & Nembhard, 2004).

Since that time, the number of knowledge workers in workplaces has increased rapidly throughout the world, and in the case of the Kingdom of Saudi Arabia, office workers form around 50% of its labor force, with approximately two million office workers (General Authority of statisctics-Saudi Govt, 2021). Thus, a small development in the worker's productivity level will lead to significant growth in the yield of the national economy.

Many initiatives were undertaken by the Ministry of Human Resources and Social Development in the Kingdom of Saudi Arabia in an attempt to increase the level of work environment to be motivating and productive (Institute of Public Administration-Research and Study Center, 2021). One of these initiatives was the initiation of a recent project that attempted to measure the degree to which employees are engaged to their jobs in different time intervals of the year.

The project identified the necessity of a national scale to measure the degree to which workplaces promote employee productivity to assess productivity development.Therefore, office productivity can only be improved if it can be measured.

Productivity for the office worker will be the biggest challenge of the 21st century due to its fundamental ability to bear economic growth, as per (Harris, 2019b). The physical environment is known to affect human moods and concentration at work. As such, it can help or hinder work in the context of increased productivity, a growing theme in corporate real estate management that is overcoming the quest for real estate cost savings (Palvalin et al., 2017).

Numerous studies in the domain of facilities management have identified different factors affecting workplace productivity around the world. Yet, no studies have been reported on identifying what really constitutes a productive workplace. Furthermore, according to (Harris, 2019), no studies have described workplace productivity in numerical terms and tangible numbers. Considering this gap in the literature, this thesis seeks to present a methodology for developing a performance assessment tool for workplace productivity and user satisfactions. The developed performance assessment tool for the productive workplace will be validated through a post-occupancy evaluation to assess the user satisfaction with the productive workplace environment.

1.2 Statement of the Problem

The workplace environment is considered the main factor toward knowledge creation and transfer (B. Haynes et al., 2017b) through applying the key processes that include receiving input, applying knowledge transformation processes, and producing output (Jan van Ree, 2002), focusing on the employee's performance while keeping in mind that job satisfaction affects the employee's everyday life. (Lottrup et al., 2015).

Numerous studies in the facilities management field have presented diverse factors affecting worker productivity within the workplace environment in several countries and have shown a strong impact on employees' performance levels, job satisfaction, and commitment to the organization (Lottrup et al., 2015). The office environmental aspects provide an immediate impact on the workers, either negatively or positively (Naharuddin, N. M., & Sadegi, 2013). The overall building with its associated services, plan, and environment has an imperative effect on the employees' perception of work (De Been & Beijer, 2014). The office indoor environment has a great influence on employees' attitudes, behavior, satisfaction, work performance, and concentration (Kamarulzaman et al., 2011), and as per (Oseland & Burton , 2012), environmental factors could be responsible for a 5–15 percent increase in productivity.

According to the "World Green Building Council (WGBC)" for production research, better air quality can increase productivity by 8 to 11 percent, cooler and warmer temperatures decrease productivity by 4 and 6 percent, respectively, and employees working near windows spend 46 minutes more sleeping, emphasizing the importance of having control over lighting and office layout (B. Haynes et al., 2017).

The national economy and the GDP rate are indirectly affected by workers productivity (Gupta et al., 2018). Offices are paying billions to the UK economy every year, but billions of pounds are wasted due to the unrewarding design of many offices (Chadburn et al., 2017).

As per (B. P. Haynes.,2008), poorly designed workplaces are wasting up to 135 billion pounds every year. Furthermore, the payroll cost can exceed the cost of energy and building maintenance by forty times, and the capital cost by about 200 times every year. (Gupta et al., 2018).

According to (Stallworth & Kleiner.,1996), the US economy has a workforce of more than 55 percent, which accounts for 70 percent of wages (over 1 trillion US dollars), and knowledge workers are a significant field to be included within organizational strategic plans to improve productivity (Ramrez & Nembhard, 2004).

The absence of clarity on what really establishes productivity in the workplace context has led to diverse methods of productivity measurement (B. P. Haynes, 2007b), and as per (Bortoluzzi et al., 2018), there is a scarcity of research on productivity measurement.

According to current research, the creation of a performance evaluation instrument for workplace efficiency and user satisfaction that identifies and quantifies performance-related components is required. No study has yet been conducted to quantify the impact of the physical workplace environment on employee productivity and diagnose the environment as either supporting or hindering productivity through the implementation of supporting design that include factors of aligning workplace to the highest possible productivity and user satisfaction (Ramrez & Nembhard, 2004). As a result, the purpose of this thesis is to develop a method for developing a performance assessment instrument for workplace efficiency and user satisfactions.

1.3 Research Goal

The goal of this research is to investigate the physical factors that affect the workplace's support for productivity and user satisfaction in any organization and subsequently assess the level of users' satisfaction with an established productive workplace, as a case study.

1.4 Research Objectives

The objectives of the research are as follows:

1. To develop an assessment tool for establishing the workplace support to user productivity.
2. To conduct a post occupancy evaluation to assess user satisfaction with an established productive workplace.

1.5 Research Scope

The scope of this research is as follows:

1. The research will focus on the identification of the physical factors that affect workplace support to productivity and user satisfaction.
2. The assessment of the identified factors will be conducted by three groups of experts, namely A/E, building users and facillities managers.

1.6 Research Limitations

The limitations of this research are as follows:

1. The assessment of the factors will be limited to those practicing in the Eastern Region of the Kingdom of Saudi Arabia.
2. The selected case study for conducting the post occupancy evaluation are located

in the Eastern Region of Saudi Arabia, as it facilitates the generalization of the findings due to the kingdom's nearly identical job standards.

1.7 Research Significance

The research significance stems from the following:

1. The study can support effective design factors to align the workplace to the highest possible user productivity and satisfaction through incorporating aspects that boost productivity into diverse office designs.
2. The study will provide a guide that can be applied to different work environments to improve the employee productivity.
3. The study can offer various stakeholders of workplace renovation projects with the attributes of employee satisfaction, efficiency and effectiveness

1.8 Research Methodology

The research methodology has been designed into two phases to achieve the objectives of the research as follows:

1.8.1 Development of an assessment tool for establishing the workplace support to user productivity, the activities in this phase include:

1. Carrying out a literature review to identify the factors affecting workplace support for user productivity.
2. Developing a checklist that encompasses the identified factors.
3. Assessing the developed checklist, by a group of stakeholders (building users, A/Es, and facilities/space managers) to determine a workplace productivity index

(PI) for each of the identified factors.

4. Conducting a walkthrough in three selected case study workplaces to determine their support to productivity through the use of the developed checklist.
5. Determining the workplace support to productivity for each case study building, based on a devised workplace productivity scale.

1.8.2 Conducting a post occupancy evaluation to assess user satisfaction with an established productive workplace, the activities in this phase include:

1. Selecting the building that has the highest workplace support for productivity to assess the satisfaction of its users.
2. Performing a literature review to identify the technical, functional, and behavioral elements of performance.
3. Developing, pilot test, and administer a user satisfaction survey.
4. Reporting the findings and develop a relevant action plan.

Each phase worked to achieve a millstone of the research. Thus, phase 1 serves to attain the first objective of the research through a group of activities that are mandatory and phase 2 in attaining the second research objectives through a specified activities, as illustrated in Figure 1.1.

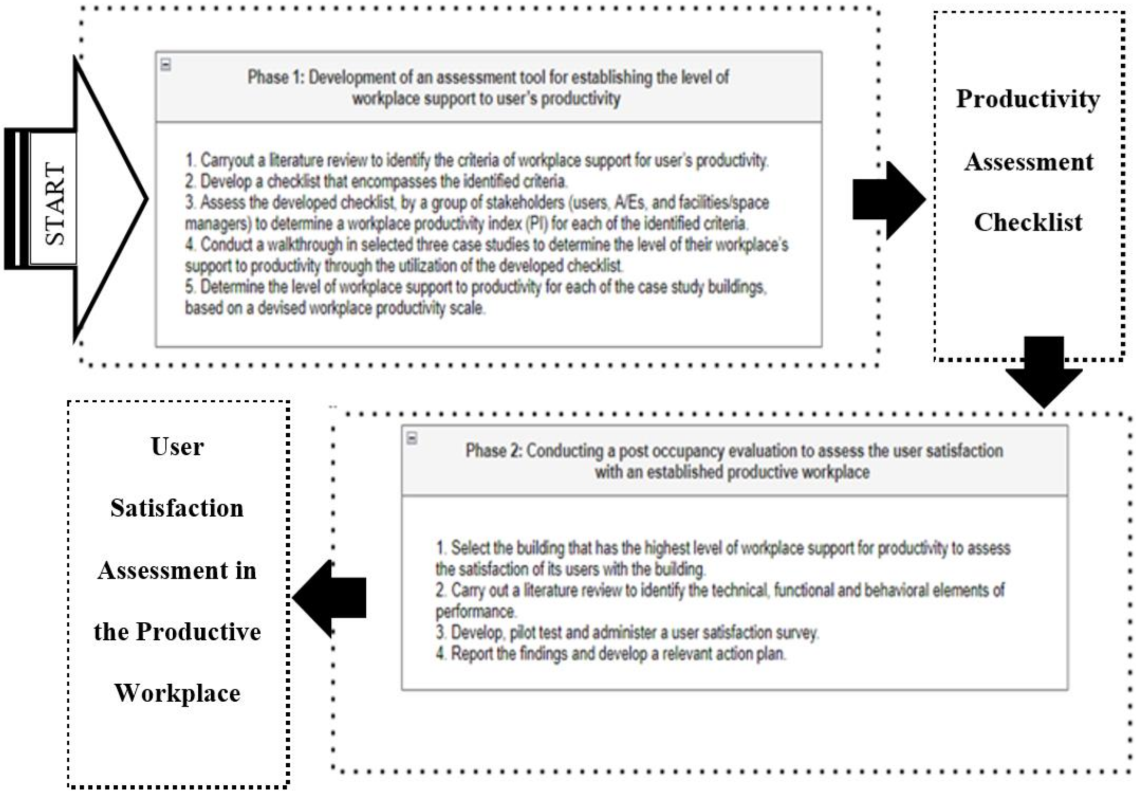

Figure 1.1 The adopted research methodology

1.9 Organization of the Thesis

1.9.1 Chapter one: Introduction

This chapter includes broad related information on office aid in productivity and user satisfaction, followed by headings that clarify the study's scope. Namely they are background, statement of the problem, research goal, research objectives, research scope, research limitations, research significance of the study, research methodology and organization of the thesis.

1.9.2 Chapter Two: Literature Review

This chapter reviews the research on the impact of the office environment on employee productivity and satisfaction, as well as defining elements that contribute to a productive workplace and related attributes.

1.9.3 Chapter Three: Factors Affecting Workplace Productivity

This chapter discusses the elements that contribute to workplace productivity.

1.9.4 Chapter Four: Methodology of Assessing the Identified Factors

This chapter covers the data analysis and survey findings from experts in the Kingdom of Saudi Arabia.

1.9.5 Chapter Five: Case Studies

This chapter describes the creation of an evaluation instrument for measuring workplace productivity.

1.9.6 Chapter Six: Assessment of User Satisfaction in the Productive Workplace

This chapter presents the degree of satisfaction for the highest ranked workplace that promotes productivity.

1.9.7 Chapter Seven: Conclusion and Recommendations

This chapter concludes with suggestions for further research.

CHAPTER 2

LITERATURE REVIEW

2.1 The Workplace

The workplace is referred to as the “decisive link within the production process between humans, equipment and the product of its components” as per (Kern et al., 1995), and (Nappi et al., 2020), described it as “a territory around which the social life of the whole organization is shaped” . Also, it is referred to the place of employment as per (Cowan & Smith, 2004) and it is “ the physical embodiment of the office” as per (Thompson, 2008).

The workplace environment affects human moods and concentration. Hence, it may assist or hinder the role of the workplace function in the context of productivity gain, which has been a rising theme in corporate real estate management (Harris, 2019b).

2.1.1 Workplace and Workers

Over a century ago, Frederick Taylor was worried about the impact of the workplace on individuals and productivity. According to him, facility management must be accommodating and cooperative in order to successfully establish an efficient incentive-based wage system. (Harris, 2019b).

Since then, the concern about worker productivity has been raised by investigating the link between lighting and productivity through the Hawthorne experiment in the period between 1920 and 1930 (Harris, 2019b). The experiment was composed of test group and control group to measure the output of of agiven work by changing the light illumination level (B. P. Haynes, 2007b). The results of the Hawthorne experiment were unexpected as the change in lighting illumination level affected human performance in the working environment (B. P. Haynes, 2007b; Thompson, 2008).

Following that era, Robert Propst began developing the open-layout office in the 1970s to resolve the workplace complexity and keep it efficient, effective, and productive to cope up with the increased number of knowledge workers within a specified place. Following that period was the presence of technology during 1985, which set out the need to integrate the physical office layout with communication tools and equipment in order to raise the level of productivity (Harris, 2019b).

As space occupancy increased in the 1990s and 2000s in response to increased use of technology and computers, as well as a rise in workers in the services industry, there was concern about space efficiency (Harris, 2019b). Recently, the focus has gradually turned toward improving workplace productivity and well-being (Harris, 2019a).

2.1.2 The Workplace Environment

The workplace environment, as per (Nzewi et al., 2018) is "the sum of interrelationships that exist between employees and the environment in which they work". It has an accompanying effect on the quality and quantity of the personal production (B. P. Haynes, 2007b). Conducive workplaces improve workers' well-being, causing their energy to be directed into realizing their maximum potential in job performance (Nzewi et al., 2018). The physical environment is not the sole factor of the work environment. It's also evident in the link between space, work habits, and corporate culture to ensure alignment with business goals (Philip, 2007).

The physical atmosphere of the workplace has an emotional impact on those who work there.: either they create positive dynamics like collaboration and creativity, or negative dynamics like stress among the workers (Nappi et al., 2020). Additionally, the environment has a positive or negative effect on employees, and it can be designed to reduce absenteeism by utilizing office environment tactics such as the machine, setting, and design of facilities (Naharuddin and Sadegi, 2013).

2.1.3 Workplace Environmental Impact on Productivity

The quality and quantity of the work have been directly linked to the workplace environment, as per (Kaplan & Aronoff, 1996). According to a national examination of several corporate sectors in the UK, the office environment contributes 135 billion pounds each year and helps to increase productivity by 20% (Al Horr et al., 2016) and 5% to 15% (Thomas, 2010). Furthermore, according to a survey of 61 office buildings with 7,000 replies, the majority of workers miss 2.5 days per year due to working environmental discomfort (Ali et al., 2015).

Furthermore, one dollar spent in the office environment provides ten dollars in performance-related benefits, and studies have indicated that enhanced workplace design may account for around 32 billion dollars in savings per trillion dollars in industrial costs. Human resources and automation techniques should be linked to attain maximum potential productivity (Kulik and Vischer, 1990).

2.1.4 Spatial Layout of the Workplace

The spatial layout refers to the arrangement configuration in which devices and fittings are arranged, including the dimension and configuration of those items, and it is found to affect the level of fit between workers and their workspaces (Nzewi et al., 2018). It has a great effect on individuals and teams performance and satisfaction (Vischer, 2008), and hence, it forms a major factor in employee productivity (Ali et al., 2015).

The spaces should be spatially related to other spaces at the early design stage and reconfigured to meet the changing needs of the organization (D. J. Clements-Croome, 2018). One of the important attributes to support productivity for workers is the spatial condition to serve different work activities, one for concentration and the other for communication and social interaction (Palvalin et al., 2017). A research of the spatial settings for collaborative provision revealed that two factors influence these settings: the distance between workstations and the availability of gathering areas (Nappi et al., 2020).

Designers have classified the tasks of knowledge workers into four spatial typologies depending on the work type: socialize, focus, collaborate, and learn (Greene & Myerson, 2011). Further office spatial classification is to be made into five types: cell, shared, open plan, flex, and combi offices (Agustin Chevez Bernaldo de Quiros, 2009).

2.2 Workplace Support for Productivity

2.2.1 Productivity

The basis of the productivity concept came from manufacturing and agriculture (Palvalin et al., 2017). The first appearance of the term “productivity” was traced back to the year

1766 in the journal of agriculture Quesnay (Tangen, 2005) to concentrate on the percentage of the output to the resources used and to guide the improvements by increasing the outputs from a given or decreasing resources (Harris, 2019).

Although the most widely used definition of productivity is quantity driven (B. P. Haynes, 2007b), other dimensions have affected its definition to include other dimensions consisting of quality, team, or individual levels (Palvalin et al., 2017), a social view connecting it to organizational change (B. P. Haynes, 2007b), a building performance view linking it to innovation (Duffy, 1990), and further to efficiency (B. P. Haynes, 2007b).

2.2.2 Knowledge Worker Productivity

Knowledge worker is a relatively new term replacing the known term "white collar work," and it refers to "anyone who works for a living at the tasks of developing or using knowledge" (Ramrez & Nembhard, 2004). The productivity of knowledge workers will be a major concern of the 21st century due to its direct connectivity to economic development, and it should be understood through knowing the tasks, personal awareness, innovation, learning continuity, quality of the work, and considering the workers as an asset rather than a cost (Harris, 2019b).

The different targeted goals by different teams and individuals have hindered the application of a generic knowledge worker productivity outlook (Harris, 2019b). Hence, the intangible nature of input and output has led to the division of activities into smaller pieces (Palvalin, 2019).

As an example of dividing productivity into parts, (Koopmans et al., 2011) classified productivity into four components with sub-indicators signs for each component, as illustrated in Figure 2.1: task performance, contextual performance, adaptive performance, and counterproductive work behavior.

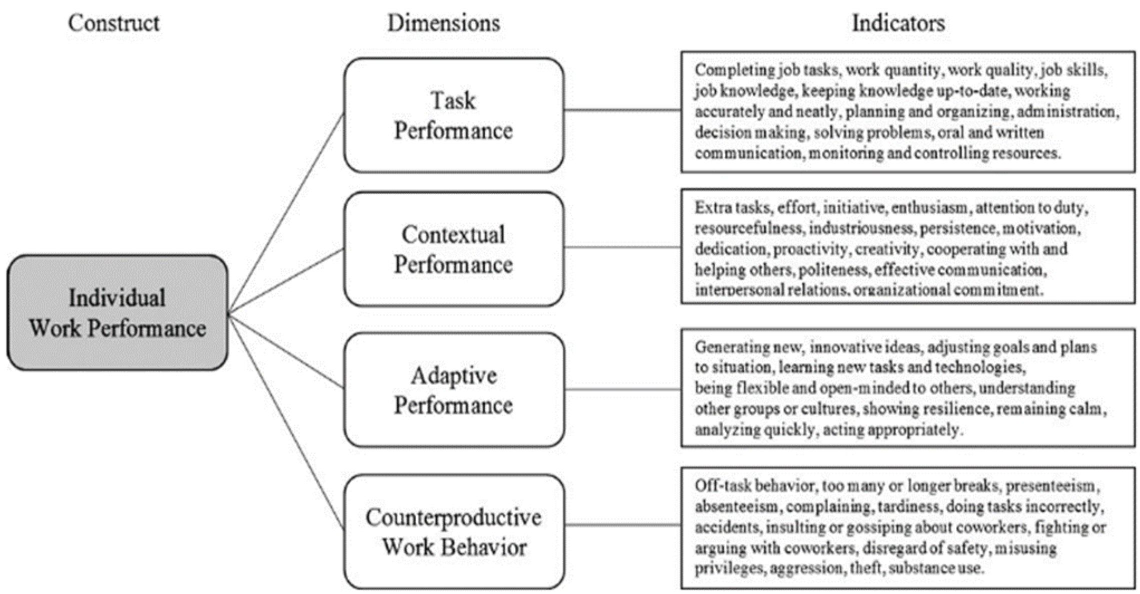

Figure 2.1 Framework of individual performance (Koopmans et al., 2011)

According to (Palvalin, 2019), another classification of knowledge worker productivity that divides productivity into two parts: doing the right thing by following work processes and doing the right thing for output. (Ramírez & Nembhard, 2004) reviewed the literature and found more than twenty methods to look for knowledge productivity in pieces such as project success, autonomy, and quality. Hence, To simplify the assessment of knowledge worker productivity, it should be split into evaluative parts rather than productivity itself (Palvalin, 2019).

2.2.3 Workplace and Productivity

The investment in automation of factories will increase production, but the investment in automation of offices by computers and other technology tools will pay off if they are integrated with workers' ways of working (Stanley Aronoff, 1995). The workplace is a stimulation source that affects the arousal level and hence performance in an inverted U-shaped relationship, as shown in Figure 2.2.

As can be seen in Figure 2.2, the optimum level of performance can be attained by sustaining a workplace away from either a space that exerting a high arousal level, such as stressors, or a space that exerting a low arousal level, such as poor concentration (Margulis, 1984).

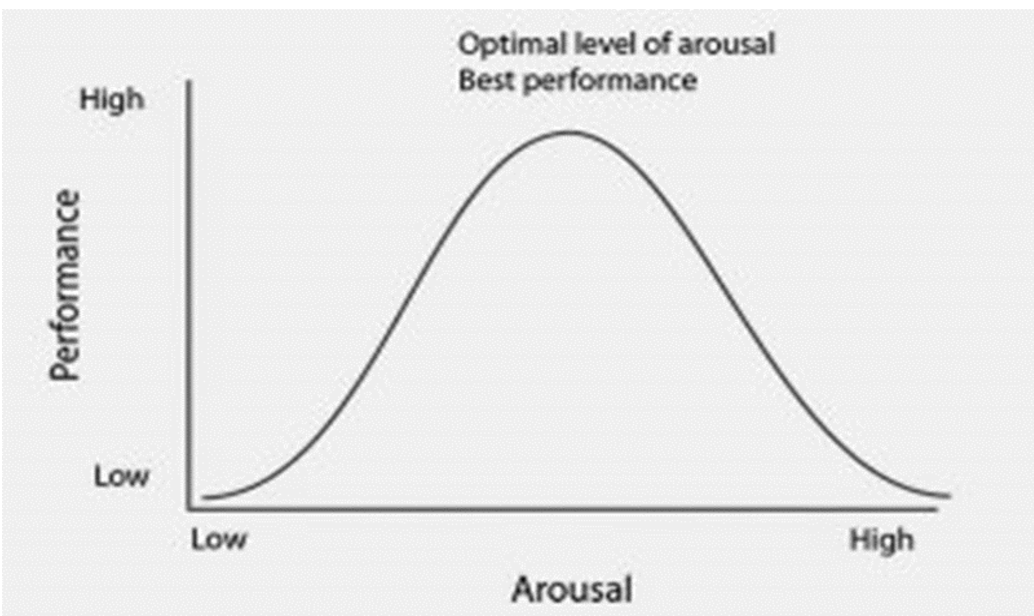

Figure 2.2 Performance/arousal continuum (Margulis, 1984)

2.3 Design Factors for User Productivity and Satisfaction

The main attributes that raise knowledge worker production are management, organization, information technology, and workplace design (Palvalin, 2019). Workplace design should follow the cycles of product and innovation (Kern et al., 1995). The design of the workplaces needs to be linked to the worker's generational styles, working technologies, and interaction scheme in a manner that allows for more knowledge transfer (B. P. Haynes, 2011), and the only way that a worker can be productive is if the design fits the worker’s needs (Chadburn et al., 2017). The office design needs to be incorporated into the way that a worker does the work, and a study classified knowledge workers into four different work mobility needs, which are "anchor, connector, gatherer, and navigator" (Greene & Myerson, 2011).

The workplace design has to merge organizational needs and psychological desires in order to effectively use the workspace (Oseland, 2009) and needs to consider thermal comfort, lighting level to meet activity needs, qualified air and water, noise control, space layout, office color scheme, indoor plants, indoor carbon dioxide, dust, and biological contaminants (Kamarulzaman et al., 2011).

There were four clusters to improve productivity according to 213 respondents from eight companies: layout, communication technology, control over temperature, ventilation, daylighting, proximity to printers and copy machines, building location, building accessibility, privacy, and acoustical control. (Chadburn et al., 2017).

2.4 Assessment Approaches for Productivity and User Satisfactions

2.4.1 Productivity Assessment Development

There is a shortage of research about measuring the productivity of knowledge workers in workplace environments, and most of the measurement applied relies on qualitative means rather than quantitative tools (Bortoluzzi et al., 2018a). Furthermore, there is no commonly recognized tool for assessing workplace productivity (B. P. Haynes, 2008b).

The approaches used in those studies related to multiple physical and non-physical factors, with the difficulty elevated in distinguishing the physical environmental attributes from workplace productivity. Namely, they include the standardized performance tests, standardized tests of emotional states, self-assessment, biophysical measures tests, job statistics, and observed behavior. The most commonly applied assessment tools for measuring productivity was the subjective questionnaire, interviews, and real office field studies (Bortoluzzi et al., 2018a).

The first approach to measuring productivity was traced back to the scientific assessment by Fredrick Taylor, who used the study of motion and time to evaluate the performance and specify the optimum way to perform the work. The result of his concept was the design of the Larkin Building in Buffalo, New York City, in 1904, which was designed by the architect Frank Lloyd Wright. The workstations were designed to provide the optimum way to perform a task and then standardized to provide all workers with a little freedom to move. Hence, the employees were considered a unit of production and clearly depicted; it was an assessment approach for factory workers rather than office knowledge workers (B. P. Haynes, 2007b).

After that period, the approach to assessment had changed to the occupier perspective approach since the conduct of an experiment known as the Hawthorne experiment that illustrated the effect of illumination levels and interpersonal relations on productivity and satisfaction (B. P. Haynes, 2007b).

Since then, the approach to measuring productivity has started with the identification of the attributes that had been perceived by the employees as affecting the level of their performance to be used in the assessment, and it did not stop there; the approach has moved to a totally people-centered approach using either a five-point Likert scale for evaluation or by applying a more holistic outlook to the productivity by using multidimensional measures, including quantifiable measures, indirect measures, and managerial measures, by using the appropriate tools such as surveys, observational methods, organized interviews, focus groups, and job analysis (B. P. Haynes, 2007b).

In addition to earlier approaches, performance measures were used to quantify productivity, such as staff turnover, which can be seen as influencing productivity in terms of costs spent on recruiting and training. The other approach is applying the self-assessment approach, which can be considered the most common approach for workplace productivity measurement (Bortoluzzi et al., 2018a), to surrogate the actual productivity being measured.

2.4.2 Productivity Assessment Challenges

The productivity measure in the office context is a complex activity due to the ambiguity in distinguishing the input and output for knowledge workers as the economy transfers from manufacturing to services (B. P. Haynes, 2007b). A trial for having a common measuring metric for workplace productivity using a theoretical-based framework was conducted by (Kaplan & Aronoff, 1996), but no tangible results were found.

(Harris, 2019b) has stated that no one has presented the missing productivity in arithmetic or monetary terms. Moreover, the office of real property of the US government recognized the challenge of measuring productivity and stated that retaining any measurement is better than nothing.

2.4.3 Assessment Approaches

The literature shows that many attempts were made to assess the work environment's contribution to productivity. One of those approaches is measuring productivity by its perceived elements that considerably impact production, such as applying information technology as per (Brynjolfsson, 1993) and that approach was followed by a trial as per (Kaplan & Aronoff, 1996), to add other measurement tools such as absence records, activity logs, attitude surveys, and opinion surveys without providing a clear framework linking various proposed measures, resulting in the conclusion to emphasize the impact of the physical environment on productivity and put more responsibility on facility managers to upgrade the environmental office quality in the absence of assessable business values.

The approach had shifted to include the perceived workplace environment rather than limiting the view only to the physical side, as researched by Mayo and Roethlisberger (B. P. Haynes, 2007b), but, this has been shifted back to emphasize the importance of considering the physical side of the environment in the measuring approach by (Stallworth

& Kleiner, 1996) due to the varying nature of the work set and acknowledging the link between people, environment, and motivation.

The measuring technique had changed to focus more on people, mainly as adapted by (Leifer, 1998), with satisfaction being ranked by users using a five-point Likert scale. However, another method introduced with a comprehensive view by grouping together tangible, indirect, and organizational measures through the application of data collection tools such as questionnaires and interviews. (B. P. Haynes, 2008b).

The office of real property for the US government, as per (B. P. Haynes., 2008), listed examples of indirect measures of productivity such as turnover, absenteeism, time tracking devices, customer demand, observed downtime for complaints, and churn costs. Furthermore, (D. Clements-Croome & Baizhan, 2000) presented a list of significant indirect measures for employee productivity from " the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE)" such as stoppages to work, quickness and precision of work, phase time from start to finishing point of process, and absence from work, but the ASHRAE proposal has been criticized for being performance indicators rather than productivity indicators and measurement tools, leading to the creation of three different approaches for assessing productivity, including work measures, personal productivity measures, employee costs, and profit measures (B. P. Haynes, 2007b).

2.5 POE and the Productive Workplace

Post occupancy evaluation (POE) is a systematic process to evaluate the building physical performance and user satisfactions. A designer can use it to establish evident performance criteria, aid the facility managers in making decisions for effective improvements, and provide benchmarking (Hassanain et al., 2021). It is a method for evaluating performance aspects of a design after providing solid evidence from the user's perspective (Permana et al., 2021). The application of the POE process has shown a strong relationship between perceived worker productivity and the quality of the workplace environment (Oseland & Burton, 2012). The POE study is a significant analysis tool that reflects the occupants' satisfaction with the built environment and the way it impacts the workers (Salaheldin et al., 2020).

2.6 POE Process

The process to evaluate the occupancy contains two aspects of performance investigation: technical, which covers thermal comfort, acoustics, visual comfort, indoor air quality, and fire safety; and functional, which encompasses space management, interior and exterior finishes, and human factors (Roberts et al., 2019). The process starts with the identification of the performance requirements, followed by a walk-through in order to assess the occupant satisfaction level to report and provide recommendations to rectify any performance defensives (Hassanain & Iftikhar, 2015).

2.7 The Level of Effort for POE

The investigation to evaluate the satisfaction after occupancy depends mainly on the allocated budget, time, and the required goal of the investigation. Therfore, POE is classified based on this into three levels: indicative, investigative, and diagnostic (Adewunmi et al., 2011).

2.7.1 Indicative POE

The indicative POE provides a quick evaluation of the facility's main technical and functional performance (Hassanain & Iftikhar, 2015) by using a less detailed questionnaire with less time that cover the general issues of utmost impact to worker satisfaction and productivity (Maarleveld et al., 2009). The result of the indicative POE is an indication of the facility's functional and technical performance requirements with an appropriate recommendation for improvement (Hassanain & Iftikhar, 2015) and a reactive response to maintain the facility at an effective cost (Adewunmi et al., 2011).

2.7.2 Investigative POE

POE surveys are based on a building type specific approach requiring a thorough assessment using appropriate visual aids and site measurements to detect faults and errors (Hassanain et al., 2021). The investigative POE is less complex, less time-consuming, and more commonly adopted than diagnostic POE, and it measures the occupants' living environment experience (Adewunmi et al., 2011).

2.7.3 Diagnostic POE

The diagnostic POE evaluation is a detailed and concentrated evaluation level that requires adiagnostic effort to investigate the performance of a building (Salaheldin et al., 2020), as it summarizes performance aspects using a survey that was answered by a broad range of building occupants to obtain their opinions about physical measurements. (Hassanain et al., 2021). It is used to get deep understanding on the way the employees are working, the way that the workspace is supporting the process, and the impact of the work technology on space usage and productivity levels (Vischer, 2008). Therfore, measuring the workplace to determine whether it is productive or not (Nappi et al., 2020).

2.8 POE Benefits

POE is regarded as an effective method of evaluating the building from the perspective of its users toward the built environment, as well as the amount of the impact of the different aesthetic components on them (Permana et al., 2021). As a result, it may be utilized in conjunction with approved data to boost worker productivity through the usage of facilities. (Riley et al., 2010). POE makes the best use of space, diminishes operating expenses, and optimizes maintenance expenditures (Roberts et al., 2019). The outcome of the evaluation is to depict the level of an employee's comfort level during the execution of the assigned work tasks in a given workplace environment to determine whether it hinders or improves the process of work (Vischer, 2008).

2.9 POE Implementation Constraints

The limitations of POE are linked to the initial payment of the estimated expenditures for the assessment process, including the professional team that would carry it out, as well as the costs connected with the POE outcome (Riley et al., 2010). The estimated cost to execute POEs without implementation or recommended POE results was found to be within a range of $1800 for a standard survey and $90,000 for an in depth assessment (Preiser, 2001). In addition, the blaming and prosecution culture is an obstacle to applying the recommended evaluation results (Roberts et al., 2019). Furthermore, the knowledge level of the person selected to execute the evaluation and whether he possesses an understanding of it are important (Riley et al., 2010).

2.10 Previous Studies

(Ali et al., 2015) conducted a study on three selected offices owned by three different public universities in Malaysia. The study used three distinct performance measuring methodologies to identify the most frequent metric among them. Namely, they are the "Sink and Tuttle model, performance pyramid, and Harper theory". It was conducted using a quantitative method to accomplish the goal by distributing a closed-ended questionnaire to 30 respondents from each office building, totaling up to 90 respondents, with similar factors related to work function, type, and floor area. The questionnaire used a Likert-scale rating system, to assess the respondent's perception of the physical environment in the workplace through their working time and the impact on the employee's productivity. The findings significantly showed the importance of the physical environment on productivity to the point that failure to satisfy the basic minimum has a negative impact on productivity and performance at work.

(Fassoulis & Alexopoulos, 2015) conducted a study in the administrative personnel at the University of Athens. The study assessed the satisfaction level to predict the employee's productivity, through the distribution of a questionnaire to 160 respondents comprised of small scale models of the work environment diagnostic tool used to check office aspects related to work support. The questionnaire was pilot tested through 34 members excluded from the study respondents. A five-point Likert scale was used to rank the importance of 42 features, covering 21 workplace aspects such as ability to personalize, accessibility, building external features, acoustics, lighting, indoor temperature privacy, and ergonomics of workstations and furniture. The finding shows a significant positive correlation between satisfaction and productivity, to the point where it can be applied to predict the relationship between workplace support and productivity.

(Harris, 2019b) developed a framework to measure the factors affecting productivity in relation to the design and management of the workplace environment. The literature was reviewed to identify the factors, which were then grouped into four collections. The four collections were effectiveness, efficiency, engagement, and a healthy workplace. Within each of these potential measures, measures such as space utilization, the degree of effective collaboration, and turnover rate was introduced. The researcher also introduced the four collections into the workplace lifecycle using Duffy's layers of building endurance, which include site, shell, services, and scenery. In addition, a fifth aspect, which is support, includes the effect of building management and facilities services. This finding provides a practical framework to be used while designing, delivering, and managing workplaces.

(Bortoluzzi et al., 2018a) systematically reviewed the literature through expert interviews for the workplace productivity factors in the office context. The review followed a specific rules for identification, screening, eligibility check, and approval for a broad range of database resources. In parallel to the literature review, a series of semi-structured interviews were conducted in 8 organizations by 12 experts to focus on the types of data recorded by organizations, the use of financial records, assessing individual performance, the use of worker engagement, and the use of post-occupancy evaluations to measure the contributing factors to workplace productivity. The findings show that self-assessment is the most commonly used method for measuring workplace productivity.The review also found that field studies were used to gather specific attributes of physical environmental change in the office context as they relate to actual job tasks. Furthermore, the study revealed that the minimum universally implemented measurement tool was POE.

(Oseland & Burton, 2012) conducted a literature review followed by a meta-analysis of 75 studies and applied it to building case studies to quantify the impact of environmental design factors on productivity. The Atomic Weapons Establishment (AWE) was used for a case study through POE, to assess the satisfaction of 1420 of their staff located in 14 buildings, as there is a correlation between their perceived productivity and the quality of their working environment. The finding pointed to a significant relationship.

(Maarleveld et al., 2009) measured employee satisfaction and perceived productivity using "a work environment diagnosis instrument (WODI)" toolkit with four different POE levels that are diagnostic, indicative, KPIs for satisfaction, and occupancy ratios that can be used distinctly or grouped in a diverse order. The toolkit was developed after reviewing the literature for working environment KPIs that convey a clear view of the user experience by ranking, in order of importance, the factors related to satisfaction and perceived productivity. The study applied the toolkit to evaluate the IT department of the tax and customs administration building of the Dutch Revenue Service in the Netherlands, as a case study using a mix of questionnaires interviews, workshops, and observations to measure the satisfaction rate of occupants at different spaces. The results show a strong correlation between satisfaction and perceived employee productivity.

(Palvalin et al., 2017) discovered the influence of the workplace on individual and team productivity based on survey data from 998 Finnish knowledge workers, mainly in public organizations. The response rate was 47 percent, and the questionnaire included 49 Likert scale statements with six groups, including physical environment. The findings show that workplaces that support concentration and communication influence individual and team productivity.

(Naharuddin, N. M., & Sadegi, 2013) conducted a study to investigate the impact of the office environment on employees' productivity using a case study in Malaysia. The study employed a questionnaire distributed randomly to over 200 employees. 139 responses were collected for data analysis using "a statistical package for social science (SPSS)". The questionnaire was developed to examine three different hypotheses, namely, job aid, supervisor support, and physical workplace environment, as factors affecting an employee's performance. The research showed an important impact of the physical work environment on employees' performances.

(B. P. Haynes, 2008b) developed a theoretical framework for workplace productivity evaluation consisting of both physical and behavioral environments in offices and their impact on occupants' productivity. The initial data set was collected from a study project for local authority research using a paper-based questionnaire from 26 offices with 996 respondents. An online questionnaire with 422 respondents was used to collect additional data from the private sector of one firm with four buildings. The finding shows that the components of interaction and distraction should be well treated to guarantee the physical environment ties with the team work processes and provides quite private spaces for individual productivity.

(Kamarulzaman et al., 2011) studied the literature to investigate the physical environmental factors that affect employees' work performance. The review included the study of factors related to workplace design for layout and workstation arrangements in either open-plan, closed-private, or cubical offices. It also includes the study of indoor temperature on performance, color in the office environment, and noise as psychosocial stress. The review indicated that the indoor environment has a great influence on employees' behavior, attitudes, and work performance.

(B. P. Haynes, 2007b) evaluated different productivity measurement approaches avilable in the literature. The approaches to productivity measurement presented in the study were: identification of the perceived elements that have an impact on employees' performance; application of managerial measuring tools such as activity logs or opinion surveys; using office environmental attributes; and using people-centered approaches. The study indicated that there is no universally accepted measurement of workplace productivity, and using the self-assessed measure is better than no measurement.

(B. P. Haynes, 2007a) conducted a study to provide a validated theoretical framework for office productivity measurement. The study was based on two sizable data sets. The first was obtained from a local authority research forum using a paper-based survey with a response of 996. The second data set was obtained from the private sector and was used to validate the findings of the first data set with a response of 422. The model was then developed with seven different productivity-support dimensions: distraction, environmental services, office layout interaction, interaction designated areas comfort, and informal interaction points. These dimensions include 27 factors for evaluation. The finding indicated that the development of the components of workplace productivity largely depends on the physical environment.

(Nzewi et al., 2018) conducted a study to examine the connection between the physical workplace environment and worker productivity in selected organizations in Nigeria. The data collected was collected through a questionnaire distributed among 233 employees using a 5-point Likert scale questionnaire. The findings indicated that the physical work environment plays a significant role in worker productivity and satisfaction.

(Chadburn et al., 2017) conducted a study to analyze the productivity among knowledge workers due to physical and social environments. The study was based on a distributed questionnaire shared with 500 workers working in eight different companies for consulting, monetary, and media services in London, with 213 responses received. The questionnaire used recommendations found in the literature on the use of a self-assessed approach to measure productivity and applied the technique of asking for productivity as a proxy for productivity. Hence, the questionnaire was split into three parts. The first is about demographics, the second is about asking for personal drivers that match the highest production level of the participant, and the third section is about evaluating the impact of 28 drivers that were found in the literature, and were based on previously conducted pilot interviews. The result shows that worker's productivity is dependent on the physical environment and the way it supports a range of different space setups to serve comfort: good ventilation, temperature control, access to printers and copy machines, desks near windows, access to collaborative spaces for knowledge transfer, and access to quiet spaces for concentration.

(Greene & Myerson, 2011) conducted a study to provide a generic approach for designing the workplace environment for knowledge workers based on four different mobility patterns. The study was based on qualitative research methods, applying semi-structured interviews to 20 knowledge workers from different companies with different mobility patterns. The research utilized in-depth user interviews for two hours with each respondent, with the use of a graphic tool to plan the movement habit during working time. The study resulted in a classification of worker typologies that need to be considered while designing the office space, in order to have a supportive productivity environment.

(Harris, 2019b) conducted a study to provide a framework to inspect the factors related to workplace productivity. The study is based on the main findings of original work conducted in 2017 for the British Council for Offices. The study reviewed the literature to investigate the factors affecting workplace productivity, and then grouped the factors into four generic clusters for potential ways of measuring them. The four clusters are related to healthy workplaces, efficient workplaces, effective workplaces, and engaging workplaces. The study also broadened the frame to be used through the building life cycle. The study concluded with the development of a framework about workplace environments that have a direct impact on employees' productivity, for consideration by office designers, developers, owners, and managers.

(De Been & Beijer, 2014) conducted a study to investigate the effect of workplace environmental type on worker productivity. The study was based on a satisfaction questionnaire distributed to 87 different working environments among the three most common office types in the Netherlands, which are individual, shared, combi, and flex offices, with 11,799 respondents. The study shows that office type has an impact on satisfaction and perceived productivity support. It was found that flex offices have the least support, while combi offices provide the most positive support for satisfaction and perceived productivity.

(McGuire & McLaren, 2009) conducted a study to inspect the effects of physical environmental factors on employees' commitments. The study was based on a sample of 65 volunteered employees on the front lines of a call center in Scotland, where 96 % of their daily working time spent on receiving calls to serve customers. The questionnaire includes 15 physical environmental factors to be rated on a Likert five-point scale. The study pointed out to the strong relationship between employees’ commitment to the work area and the height of the work surface.

Table 2.1 below shows a summary of how this thesis is investigating the subject compared to previous studies through the application of a comprehensive procedure that entails the development of a performance assessment tool for workplace support of productivity and user satisfaction.

Study		Study Aim	Applied technique	Literature Review	Factor Assessment	Real office observation	POE
1	(Ali et al., 2015)	Evaluation of the employee’s perception of the physical environment on the productivity.	Questionnaire	√	×	×	×
2	(Fassoulis &Alexopoulos, 2015)	Evaluation of the level of employee’s satisfaction level to predict the productivity.	Questionnaire	√	×	√	
3	(Harris, 2019b)	A framework to measure the productivity among four generic areas effectiveness, efficiency, engagement and healthy workplace.	Concept paper discussing existing metrics	√	×	×	×
4	(Bortoluzzi et al., 2018a)	a literature review for the past 10 years to rank the measurement tools of the workplace productivity key performance indicators in the office context	Literature Review	√	×	×	×
5	(Oseland & Burton, 2012)	Use a case study to quantify the impact of environmental design factors on productivity.	Case study	√	×	√	×
6	(Maarleveld et al., 2009)	Use the POE tool to measure the productivity.	POE tool and case study	√	×	×	√
7	(Palvalin et al., 2017)	Studied the impact of workplace on individual and team productivity based on a survey data.	Questionnaire	√	√	×	×
8	(Naharuddin, N. M., & Sadegi, 2013)	Conducted a study to investigate the impact of workplace environment towards employee’s performance using a case study.	Case study and Questionnaire	√	×	√	×
9	(B. P. Haynes, 2008b)	Conducted a study to develop a theoretical framework for office productivity evaluation consist of both physical and behavioral environments in offices and its impact on occupant’s productivity.	Concept paper discussing existing metrics	√	×	×	×
10	(Kamarulzaman et al., 2011)	Studied the literature to investigate the physical environmental factors that affect employee’s work performance.	Concept paper discussing existing metrics	√	×	×	×
11	(B. P. Haynes, 2007b)	Evaluated different productivity measurement approaches found in the literature	Concept paper discussing existing metrics	√	×	×	×
12	(B. P. Haynes,	Conducted a study to provide a validated theoretical framework for office	Concept paper	√	×	×	×

	2007a)	productivity measurement.	discussing existing metrics				
13	(Nzewi et al., 2018)	Conducted a study to examine the nature of relationship between the physical workplace environment and employee performance in selected firms.	Case study and Questionnaire	√	×	√	×
14	(Greene & Myerson, 2011)	Conducted a study to provide a generic approach to design the workplace environment for knowledge workers based on four different mobility patterns	Range of qualitative research methods including semi-structured interviews	√	×	√	×
15	(De Been & Beijer, 2014)	Conducted a study to investigate the effect of the workplace environmental type has on workers productivity	Questionnaire	√	×	×	×
16	(McGuire & McLaren, 2009)	Conducted a study to inspect the factors of physical environment on employee's commitment	Questionnaire	√	√	×	×
17	B. P. Haynes, 2008d	Conducted a study to investigate the possibility to segment employees based on their differences on perceived productivity regarding the physical environment	Questionnaire	√	√	×	×

Table 2.1 Summary of previous studies compared to the thesis.

2.11 Preliminary Identification of the Factors Affecting Workplace Support to Productivity and User Satisfaction

The factors found in the literature supporting workplace productivity were grouped into five areas that they are related to. The formed factor, terminologies and, their definitions, are presented in Table 2.2 as follows:

Factor Group		Factor	Terminologies	Definition/ description	Formulated/adopted definition/

	#				description
1.Factors related to workplace design	1	Employees involvement in the planning and design of the workspace	“Sharing own ideas about work environment” (Brunia et al., 2016) “Involving employees in the design and planning phases” (Zamani & Gum, 2019)	“Managers and employees directly affected by the design and construction and need to be given opportunities to be involved or to take decisions directly during or towards the end of a phase, including those less affected need to be informed of what is or will be taking place or even consulted about proposals and plans” (D. J. Clements-Croome, 2018)	Involvement of the employees ideas in the planning and design of the workspace, would serve to document their requirements. Fulfilment of these requirements would potentially contribute to their productivity at the workplace.
	2	Exterior and interior appearance of the building	“Architecture and appearance of the building” (Brunia et al., 2016) “Building depth” (Leaman & Bordass, 1999) “Satisfaction with architecture and appearance of the building” (De Been & Beijer, 2014) “Building whose design is smart and professional” (Chadburn et al., 2017) “Creative physical environment” (B. P. Haynes, 2008c)	“appearance of the building and the interior design” (Brunia et al., 2016)	“appearance of the building and the interior design” (Brunia et al., 2016)
	3	Flexible design to accommodate change.	“Flexibility of design and infrastructure to accommodate	“The capability of a workplace to accommodate changing user	“The capability of a workplace to accommodate changing user

			change" (Thompson, 2008) "Flexibility of design and infrastructure to accommodate change"(Thompson , 2008) "Flexibility" (Vischer, 2008)	requirements through effortless movement of its assets" (Hassanain et al., 2018)	requirements through effortless movement of its assets" (Hassanain et al., 2018)
	4	Functional workspace design for different work settings.	"A blend of work settings that reflect business needs" (Thompson, 2008). "A variety of spaces match the workstyles" (Harris, 2019) "Number and diversity of spaces" (Brunia et al., 2016) "Satisfaction with the number, diversity and functionality of the offered spaces" (De Been & Beijer, 2014) "Office use" (De Croon et al., 2005) "Functionality and comfort of the workspaces" (Brunia et al., 2016) "Functionality of the workspace" (De Been & Beijer, 2014). "Functionality" (Block & Stokes, 1989) "Functionality" (Vischer, 2008)	Functionality : "the actual behavior of the individual to perform a particular action".(D. J. Clements-Croome, 2018)	Functionality : "the actual behavior of the individual to perform a particular action".(D. J. Clements-Croome, 2018)

			"Designated areas" (B. P. Haynes, 2007a)		
	5	Ergonomic design of the workstation and adequate size of workstation.	"Ergonomics" (Appel-Meulenbroek et al., 2011) "Ergonomists involvement in design" (De Croon et al., 2005) "Ergonomics" (Maarleveld et al., 2009) "Furniture" (Hassanain et al., 2018) "Ergonomic work settings and furniture that support a range of workstyles" (Harris, 2019) "Ergonomic workplaces that have been designed to minimize musculoskeletal disorders"(D. Clements-Croome, 2015) "Ergonomic" (Naharuddin, N. M., & Sadegi, 2013) "Furniture layout" (Naharuddin, N. M., & Sadegi, 2013) "Ergonomics" (Vischer, 2008) "Furnishings" (Kaplan & Aronoff, 1996). "Chair" (Kaplan & Aronoff, 1996)	Ergonomics: "ergonomics or human factors as the scientific discipline concerned with the understanding of interactions among humans and other elements of a system, and the profession that applies theories, principles, and methods to design in order to optimize human well-being and overall system performance". (Nzewi et al., 2018) "Ergonomics: ergonomics is the science of designing to fit the worker, rather than physically forcing the workers body to fit the job". (Nzewi et al., 2018)	"Ergonomics: ergonomics is the science of designing to fit the worker, rather than physically forcing the workers body to fit the job. (Nzewi et al., 2018)"

			"Work surface" (Kaplan & Aronoff, 1996) "Work surface suitable for work" (McGuire & McLaren, 2009) "Good condition chair" (McGuire & McLaren, 2009) "Height and position for computer screen" (McGuire & McLaren, 2009) "Desk comfort" (Zamani & Gum, 2019) "Furniture" (Bortoluzzi et al., 2018) "Ergonomics" (Bortoluzzi et al., 2018) "Furniture" (Oseland & Burton, 2012) "Physical comfort" (B. Haynes et al., 2017)		
	6	Proximity of the workplace to nearby amenities	"Design a space based on employee typology" (Greene & Myerson, 2011) "Work typology" (Block & Stokes, 1989) "Considering worker's typology for design" (Greene & Myerson, 2011) "Spatial settings to suit various types of working"(D.	Work type : " looking for differentiate knowledge workers in terms of their activities" (Greene & Myerson, 2011)	Work type : "looking for differentiate knowledge workers in terms of their activities" (Greene & Myerson, 2011)

			Clements-Croome, 2015)		
	7	Provision of window view to the outside	“Working in a building in a desirable or convenient location” (Chadburn et al., 2017). “Accessibility of the building” (Brunia et al., 2016) “Accessibility of the building: Location of the building related to the nearest train station” (Brunia et al., 2016) “Location feel and amenities” (Al Horr et al., 2016)	“Location: refers to the place at which the office worker carries out his/her activities (De Croon et al., 2005)”	“Location: refers to the place at which the office worker carries out his/her activities (De Croon et al., 2005)”
	8	Provision of color schemes suitable for different functions	“Décor”(B. P. Haynes, 2009) “Aesthetic appearance” (B. P. Haynes, 2008a) “Use of colors and materials” (Appel-Meulenbroek et al., 2011) “Aesthetic” (Maarleveld et al., 2009) “Colour” (Kamarulzaman et al., 2011) “Décor” (B. P. Haynes, 2008b) “Colors” (Ulrich, 2008)	“Décor is a surface patterning or removable objects of art for walls, ceilings, theatre sets etc.”(Davies, 2008)	“Décor is a surface patterning or removable objects of art for walls, ceilings, theatre sets etc.”(Davies, 2008)

			"Aesthetic" (Kaplan & Aronoff, 1996) "Décor" (Bortoluzzi et al., 2018) "Colors and textures" (B. Haynes et al., 2017)		
2.Factors related to workplace layout	9	Provision of adequate circulation space	"Circulation space" (B. P. Haynes, 2009) "Desk and circulation space" (B. P. Haynes, 2009) "Circulation space" (B. P. Haynes, 2008c) "Efficient access, entry, exit, circulation and navigation" (Harris, 2019)	"Circulation space: a stair, corridor or gangway space within a building along which people, goods etc. can move or be moved from place to place." (Davies, 2008)	"Circulation space: a stair, corridor or gangway space within a building along which people, goods etc. can move or be moved from place to place." (Davies, 2008)
	10	Provision of adequate way finding system.	"Minimal time spent looking for spaces, people, information or services" (Harris, 2019) "Access to a variety of different places in the office to work" (Chadburn et al., 2017)	"Minimal time spent looking for spaces, people, information or services" (Harris, 2019)	"Minimal time spent looking for spaces, people, information or services" (Harris, 2019)
	11	Workstation distribution within the workplace layout	"Proximity to manager" (B. Haynes et al., 2017) "Spatial distance" (Ashkanasy et al., 2014) "Position to	-Proper design of distance between workstations (De Croon et al., 2005) -Subdivision and overall layout of the building	-Proper design of distance between workstations (De Croon et al., 2005)

			colleagues" (B. Haynes et al., 2017) "Position relative to colleagues" (B. P. Haynes, 2009) "Adequate space between employees" (McGuire & McLaren, 2009) "Distance between co-workers" (B. P. Haynes, 2008a) "Distance between workstations" (De Croon et al., 2005) "location and proximity of spaces"(De Been & Beijer, 2014) "Relative location of the workstation" (Appel-Meulenbroek et al., 2011) "Position relative to colleagues"(B. P. Haynes, 2008b) "Space arrangement" (Hassanain et al., 2018)	(Brunia et al., 2016) -Physical arrangement of office (Kamarulzaman et al., 2011)	
	12	Workstation location relative to equipment	"Position relative to equipment" (B. P. Haynes, 2009) "Position relative to equipment" (B. P. Haynes, 2008b) "Position to equipment" (B. Haynes et al.,	-Position relative to equipment (B. P. Haynes, 2009)	-Position relative to equipment (B. P. Haynes, 2009)

			2017)		
	13	"Access to a variety of different functions in the workplace."	"Access to a variety of different places in the office to work" (Chadburn et al., 2017)	"Access: A means of approach, e.g., a road, street, or walk.(Harris, 2006)"	Accessible layout: a means of approach given to different spaces.
	14	Efficient space utilization	"Space utilization" (B. P. Haynes, 2007c) "Desk space" (B. P. Haynes, 2008b) "Optimizing the use of space" (Harris, 2019)	"Building efficiency: A ratio of the rentable or net lettable area to the gross area, expressed as a percentage.(Cowan & Smith, 2004)"	"Efficient space utilization is a ratio of occupied space or net lettable area to the gross area, expressed as a percent."
	15	Attracting places within a building for workers gathering	"Linking the building" (Joy & Haynes, 2011) "Attracting places to gather people in order to communicate each other to aid in knowledge transfer" (Joy & Haynes, 2011)	Attracting places to gather people in order to communicate each other to aid in knowledge transfer (Joy & Haynes, 2011)	Attracting places to gather people in order to communicate each other to aid in knowledge transfer (Joy & Haynes, 2011)
	16	Availability of personal storage within a workspace.	"Storage facility" (Brunia et al., 2016) "Archive and storage facilities"(De Been & Beijer, 2014) "Personal Storage"(B. P. Haynes, 2009) "General storage" (B. P. Haynes, 2009)	"Store: a building or room within a building devoted to storage or distribution of supplies.(Davies, 2008)" "Store: a room or space in a building in which objects, implements, goods etc. are	"Store: a room or space in a building in which objects, implements, goods etc. are stored when not in use. (Davies, 2008)"

			"Personal storage" (B. P. Haynes, 2008b) "general storage"(B. P. Haynes, 2008b) "Good storage space for information to do work" (McGuire & McLaren, 2009) "Adequate storage for personal items" (McGuire & McLaren, 2009) "Storage" (B. Haynes et al., 2017)	stored when not in use. (Davies, 2008)"	
	17	Ability to personalize the workspace	"Personalization the work environment" (Brunia & Hartjes-Gosselink, 2009) "Personalization of the workspace"(De Been & Beijer, 2014) "Personalization" (Brunia & Hartjes-Gosselink, 2009) "Allow for personal decorating" (Brunia & Hartjes-Gosselink, 2009) "Personalization" (Ashkanasy et al., 2014) "Personal space" (Ashkanasy et al., 2014)	-"It describes the display of personal or work-related items or the arrangement of the workspace to distinguish the occupant from others."(Lottrup et al., 2015)	-"It describes the display of personal or work-related items or the arrangement of the workspace to distinguish the occupant from others."(Lottrup et al., 2015)
3.Factors related to workplace interaction	18	Availability of spaces that allow social interaction	"Spaces for social interaction, relaxation and psychological	"Social interaction : transfer a lot of knowledge and information	"Social interaction : transfer a lot of knowledge and information (Appel-

and engagement			restoration" (Thompson, 2008) "Shared amenity areas to support ad hoc working, recharging and collaborating" (Harris, 2019) "Control of privacy and social interaction" (Appel-Meulenbroek et al., 2011) "Interpersonal relations" (B. P. Haynes, 2007b) "Social interaction" (B. P. Haynes, 2008b) "common interaction areas" (B. P. Haynes, 2008c) "Team room" (Zamani & Gum, 2019) "Interaction" (Bortoluzzi et al., 2018) "Social interaction" (B. Haynes et al., 2017) "Work interaction" (B. Haynes et al., 2017) "Allow for work interaction" (B. P. Haynes, 2008b)	(Appel-Meulenbroek et al., 2011)"	Meulenbroek et al., 2011)"
	19	Availability of spaces for formal and informal meetings	"Formal meetings areas" (B. P. Haynes, 2009) "Accessible to meeting facilities"	"Communication : is the activity that links all other ones (Appel-	"Communication : is the activity that links all other ones (Appel-

			(Chadburn et al., 2017) "Formal/informal meeting areas" (Joy & Haynes, 2011) "Spaces for planned and incidental communication and collaboration" (Harris, 2019) "Enclosed spaces for interview /meeting" (Banbury & Berry, 2005) "Informal/formal meetings" (B. P. Haynes, 2008b) "Space for collaboration" (Palvalin et al., 2017) "Spaces for formal/informal meetings" (Palvalin, 2019) "Formal meeting" areas (Bortoluzzi et al., 2018) "Informal meeting" (Bortoluzzi et al., 2018) "Formal/informal space" (B. Haynes et al., 2017) "Informal interaction points" (B. P. Haynes, 2007a) "Informal interaction" (Bortoluzzi et al., 2018)	Meulenbroek et al., 2011)"	Meulenbroek et al., 2011)"

4. Factors related to indoor environmental quality at the workspace	20	Availability of canteen for employee's refreshment	"Accessible to good tea and coffee facilities" (Chadburn et al., 2017) "Refreshment" (B. P. Haynes, 2009) "Spaces to break out" (Chadburn et al., 2017) "Access to good nutrition and hydration"(Harris, 2019) "Having access to good tea and coffee making facilities" (Chadburn et al., 2017) "Refreshment" (B. P. Haynes, 2008b) "Refreshment area" (B. Haynes et al., 2017) "Canteen" (B. Haynes et al., 2017)	"Canteen is a place in a factory, office, etc. where food and meals are sold, often at a lower than usual price" (Cambridge University Press, 2021)	"Canteen is a place in a factory, office, etc. where food and meals are sold, often at a lower than usual price" (Cambridge University Press, 2021)
	21	Having a workspace acceptable acoustic climate	"Acoustics" (Brunia et al., 2016) "acoustics" (De Been & Beijer, 2014) "Acoustic" (De Croon et al., 2005) "Acoustics" (Maarleveld et al., 2009) "Acoustic enables effective use of each workspace" (Harris, 2019) "Acceptable acoustic climate"	"acoustics The science of sound"(Davies, 2008) Quiet workspace is a space for a work that is at silence or with a moderate level of noise.	"acoustics The science of sound"(Davies, 2008) Quiet workspace is a space for a work that is at silence or with a moderate level of noise

			(D. Clements-Croome, 2015) "Use of better sound absorption material on ceiling" (Banbury & Berry, 2005) "Acoustics" (Kaplan & Aronoff, 1996) "Acoustics" (Zamani & Gum, 2019) "Quiet areas" (B. P. Haynes, 2009) "Quite environment" (Chadburn et al., 2017) "Office space" (B. P. Haynes, 2007b) "Enforced areas of quite (Banbury & Berry, 2005) "Quite areas (B. P. Haynes, 2008b) "Quite spaces" (Ulrich, 2008) "Quite distraction" free areas (B. P. Haynes, 2008d) "Quite areas" (B. Haynes et al., 2017b)		
	22	Provision of measures to eliminate visual disturbance	"Openness and transparency of environment" (Brunia et al., 2016) "Being in open plan" (Chadburn et al., 2017)	"Privacy : is often defined as a state of withdrawal (De Been & Beijer, 2014)." "Privacy: a dynamic process on a scale of	"Privacy : is often defined as a state of withdrawal (De Been & Beijer, 2014)."

			"Proper openness design to control privacy (De Croon et al., 2005) "openness and transparency"(De Been & Beijer, 2014) "Workplace" openness (De Croon et al., 2005) "Level of transparency" (Maarleveld et al., 2009) "Privacy" (Brunia et al., 2016) "Visual privacy" (B. P. Haynes, 2008a) "Visual control enables effective use of each workspace"(Harris, 2019) "Relatively private workstation" (Chadburn et al., 2017) "Few visual distractions" (Thompson, 2008) "Privacy in the office" (De Been & Beijer, 2014). "Privacy" (De Croon et al., 2005) "Visual protection" (De Croon et al., 2005) "Privacy" (Appel-Meulenbroek et al., 2011)	openness and enclosure (De Been & Beijer, 2014)"	

			"Privacy" (B. P. Haynes, 2008b) "Privacy" (Block & Stokes, 1989) "Privacy" (Vischer, 2008) "Degree of openness" (Bortoluzzi et al., 2018) "Visual disturbance" (Bortoluzzi et al., 2018) "Privacy" (B. Haynes et al., 2017)		
	23	Provision of an acceptable thermal environment	"Indoor climate (Brunia et al., 2016) "Indoor climate"(De Been & Beijer, 2014) "Temperature" (B. P. Haynes, 2008a) "Ambiance" (Appel-Meulenbroek et al., 2011) "Humidity" (Leaman & Bordass, 1999) "Temperature range" (Harris, 2019) "Indoor climate" (Appel-Meulenbroek et al., 2011) "Temperature" (Kamarulzaman et al., 2011) "Humidity" (Vischer, 2008)	Indoor climate is the surrounding thermal environment.	Indoor climate is the surrounding thermal environment.

			"HVAC" (Kaplan & Aronoff, 1996) "Environmental services" (B. P. Haynes, 2007a) "Air temperature" (Bortoluzzi et al., 2018) "Relative humidity" (Bortoluzzi et al., 2018) "Supply air temperature" (Bortoluzzi et al., 2018) "Thermal comfort" (Bortoluzzi et al., 2018) "Temperature" (Oseland & Burton, 2012) "Temperature" (B. Haynes et al., 2017) "Thermal comfort" (Al Horr et al., 2016)		
	24	Provision of sufficient ventilation.	"Ventilation" (B. P. Haynes, 2009) "Air movement" (B. P. Haynes, 2008a) "Good ventilation" (Chadburn et al., 2017) "Ventilation" (Leaman & Bordass, 1999) "Ventilation required per employee" (Satish et al., 2011)	"Ventilation: the maintenance of the air quality of spaces in a building by continual provision of fresh air from the outside, either by natural or mechanical means. (Davies, 2008)"	": the maintenance of the air quality of spaces in a building by continual provision of fresh air from the outside, either by natural or mechanical means. (Davies, 2008)"

	25		"Ventilation rates sufficient to provide fresh air with good distribution" (D. Clements-Croome, 2015) "Ventilation" (B. P. Haynes, 2008b) "Ventilation" (Naharuddin, N. M., & Sadegi, 2013) "Ventilation" (Bortoluzzi et al., 2018) "Ventilation" (Oseland & Burton, 2012)		
	25	Provision of sufficient illumination level	"Natural lighting" (B. P. Haynes, 2009) "Maximum daylight" (Thompson, 2008) "Access to natural light" (Harris, 2019) "Good natural lighting" (D. Clements-Croome, 2015) "Natural lighting" (B. P. Haynes, 2008b) "Lighting" (Oseland & Burton, 2012) "Light" (Brunia et al., 2016) "Lighting quality" (B. P. Haynes, 2008a)	"natural light in lighting design, light which comes through windows, roof lights or openings directly or Indirectly from the sun; cf. artificial lighting".(Davies, 2008) -"Artificial light : light produced by means other than by the sun".(Davies, 2008)	"natural light in lighting design, light which comes through windows, roof lights or openings directly or Indirectly from the sun; cf. artificial lighting".(Davies, 2008) -"Artificial light: the light produced by means other than by the sun".(Davies, 2008)

			“Artificial lighting”(B. P. Haynes, 2009) “Lighting” (Leaman & Bordass, 1999) “lighting” (De Been & Beijer, 2014) “Lighting” (Maarleveld et al., 2009) “Quantity of light on the desk” (B. P. Haynes, 2008a) “Lighting appropriate to the task”(Thompson, 2008)se “Lighting” “Illumination level” (B. P. Haynes, 2007b)s “Quantity of light for computer work” (B. P. Haynes, 2008a) “Comfortable light levels” (Harris, 2019) “No lighting glare” (D. Clements-Croome, 2015) “Computer glare” (B. P. Haynes, 2008a) “Lighting” (Kamarulzaman et al., 2011) “Artificial lighting” (B. P. Haynes, 2008b) “Lighting” (Naharuddin, N.		

			M., & Sadegi, 2013) "Lighting"(Ulrich, 2008) "Lighting" (Vischer, 2008) "Lighting" (Kaplan & Aronoff, 1996) "Overhead lighting" (Zamani & Gum, 2019) "Lighting level and quality" (Bortoluzzi et al., 2018) "Lighting" (B. Haynes et al., 2017) "Lighting" (Al Horr et al., 2016)		
	26	Provisions of measures to control the indoor workplace environment.	"Control of temperature" (Chadburn et al., 2017) "Control over indoor temperature" (Leaman & Bordass, 1999) "Gender and indoor climate" (De Been & Beijer, 2014) "Indoor climate" (Maarleveld et al., 2009) "Temperature" (Wyon & Wargocki, 2013) "Ability to alter conditions" (B. P. Haynes, 2008a) "Control of indoor climate" (Appel-Meulenbroek et al.,	The level of freedom to direct the ambient workspace temperature.	The level of freedom to direct the ambient workspace temperature.

			2011) “Control of the immediate environment” (Thompson, 2008) “Control of immediate environment” (Thompson, 2008) “Overall atmosphere” (B. P. Haynes, 2008b) “Temperature” (Naharuddin, N. M., & Sadegi, 2013) “Control over environment” (Ulrich, 2008) “Temperature” (Vischer, 2008) “Control” (Oseland & Burton, 2012)		
5. Factors related to building supportive services.	27	Availability of documented facility management processes and strategies.	“Facility services” (Brunia et al., 2016) “facility services Overall appreciation of facilities”(De Been & Beijer, 2014) “Customer focused facilities management function”(Thompson, 2008) “Productive accommodation” (Jan van Ree, 2002) “Development of building management strategy at the start of the building”	“Facility management The management of resources (people and assets), place and process to optimize an organization’s business”(Cowan & Smith, 2004).	“Facility management The management of resources (people and assets), place and process to optimize an organization’s business” (Cowan & Smith, 2004).

			(Leaman & Bordass, 1999) “Facilities management” (Maarleveld et al., 2009)		
	28	Provision of satisfactory services to the workforce	“High levels of service” (Harris, 2019) “Providing high-quality facilities services” (Harris, 2019)	“Service: technical installation, utility; any system, installation etc. in a building providing water, air, gas, communications and electricity or disposing of waste.”(Davies, 2008)	“Service: technical installation, utility; any system, installation etc. in a building providing water, air, gas, communications and electricity or disposing of waste.”(Davies, 2008)
	29	Provision of effective housekeeping measures.	“A clean and tidy environment” (Harris, 2019) “Cleanliness” (B. P. Haynes, 2008b) “Cleanness of workstation” (McGuire & McLaren, 2009) “Cleanness of workstation” (Zamani & Gum, 2019) “Cleanliness” (Bortoluzzi et al., 2018) “Cleanliness” (B. Haynes et al., 2017) “Cleanliness” (B. P. Haynes, 2009)	Clean and organized: empty place from dirt and stains displayed in systematic order.	Clean and organized: empty place from dirt and stains displayed in systematic order.

	30	Provision of adequate safety and security measures.	“physical security” (B. P. Haynes, 2009) “A safe and secure” environment (Harris, 2019) “Physical security” (B. P. Haynes, 2008b)	“Security: protective measures taken in a building to prevent unauthorized intrusion and burglary”(Davies, 2008)	“Security: protective measures taken in a building to prevent unauthorized intrusion and burglary”(Davies, 2008)
	31	Provision of high quality information technology infrastructure	“ICT and ICT” supporting services (Brunia et al., 2016) “ IT and IT support” (De Been & Beijer, 2014). “Quality of IT hardware” (Appel-Meulenbroek et al., 2011) “Comprehensive Wi-Fi coverage” (Chadburn et al., 2017) “IT” (B. P. Haynes, 2007b) “IT” (Maarleveld et al., 2009). “IT and communication system” (Hassanain et al., 2018) “Comprehensive Wi-Fi coverage” (Chadburn et al., 2017) “IT” (Palvalin, 2019) “Technology”(Zamani & Gum, 2019)	“Information technology the storage, processing and manipulation of information on computer systems”(Davies, 2008)	“Information technology the storage, processing and manipulation of information on computer systems”(Davies, 2008)

Table 2.2 List of Factors and their terminology(s),definition(s) and description

2.12 Summary and Discussion

A review of the literature related to workplace factors that support productivity and user satisfaction is presented in this chapter to identify workplace productivity and knowledge work productivity, the assessment approaches to measure the productivity, and the drivers to enhance perceived productivity within the workplace.

The productivity of employees and the factors that impact the physical environment to boost performance and satisfaction have been discussed in the literature and listed within the presented table, but no study has been found depicting the way to assess and quantify the impact of the surrounding physical environment on employee performance.

There are several factors affecting the perceived productivity of employees within the literature, including factors related to workplace design, factors related to workplace layout, factors related to indoor environmental quality at the workspace, and factors related to building supportive services. Hence, 31 factors were identified from several terminologies in the literature that provide their impact on performance.

Furthermore, previous studies were considered to develop an understanding of the effect of the physical environment on workplace productivity and satisfaction. The next chapter will identify each factor based on a literature review.

CHAPTER 3
FACTORS AFFECTING WORKPLACE PRODUCTIVITY

This chapter in the presence of the factors that are supporting the employees productivity through workplace physical environmental factors. A description of each factor and the impact it has presented.

3.1 Factors Related to Workplace Design

3.1.1 Employees Involvement in the Planning and Design of the Workspace

The involvement of employees in the planning and design of the workspace is a concern to make the workplace supportive of productivity (Zamani & Gum, 2019). Important ideas from user involvement come at the start and end of each design phase (D. J. Clements-Croome, 2018). Documenting end-user feedback on the performance of their workspace and their experience could contribute to the ongoing refinement and development of the workplace design brief (Harris, 2019b). A high level of end-user involvement leads to a high level of satisfaction (Brunia et al., 2016), and in order to avoid workspace misuse or opposition to change in the case of a new way of working, active end-user opinions should be involved in the design process (Appel-Meulenbroek et al., 2011).

3.1.2 Exterior and Interior Appearance of the Building

The exterior and interior appearance of the building affects the worker productivity level. The architecture and appearance of the building were highly appreciated by most employees in order to have a high level of overall building satisfaction (Brunia et al., 2016), and working in a workplace whose design is smart and professional was found to be a strong supporter of employees' productivity (Chadburn et al., 2017). The impression of an office building as a whole has a significant impact on the perception of the workers working on it (De Been & Beijer, 2014).

3.1.3 Flexible design to accommodate change

Flexible design to accommodate change has a positive impact on workplace productivity (Harris, 2019a; Kelly, 2017; Thompson, 2008). Workplace flexibility is the competence of the workplace to house changing user requirements (Hassanain et al., 2018). A low flexibility has a harmful impact on office worker productivity (B. P. Haynes et al., 2019). The design of offices for the future generation and younger employees needs to consider the flexibility of dynamic workspaces (Bortoluzzi et al., 2018b) and the implementation of flexible partitioning to accommodate different work processing activities (Thompson, 2008). The flexible workplace is a tool that delivers value-added organizational performance (B. P. Haynes, 2007b) and would allow for different methods of executing work activities (De Croon et al., 2005).

3.1.4 Functional Workspace Design for Different Work Settings

Having a workspace that reflects business needs would positively impact the worker productivity (Harris, 2019a). The workspace use discussed the manner in which they are allocated to employees (De Croon et al., 2005). The designated areas are one of five offices physical environment components. It was also found that a layout with a mix of workspaces is highly appreciated and leads to a higher level of worker satisfaction (Brunia et al., 2016) with sufficient diverse spaces for different work functions (Brunia et al., 2016). The functionality of the workspace would serve to attain the appropriate employee's psychology toward inspiration and creativity (Fassoulis & Alexopoulos, 2015).

3.1.5 Ergonomic Design of the Workstation and Adequate Size of Workstation.

The repetitive strain injury brought attention to office ergonomics through laws and regulations (Appel-Meulenbroek et al., 2011), and a significant role could be played by ergonomists in safeguarding the employee's well-being if they were involved in design (De Croon et al., 2005). For a healthier workplace, the workers physiological and psychological states need to be supported by providing ergonomic work settings for different work styles (Harris, 2019b). The workplace needs to be ergonomically designed to minimize musculoskeletal disorders, provide an environment conducive to health and well-being (Derek Clements-Croome, 2015a), and avoid nerve injuries (Naharuddin, N. M., & Sadegi, 2013).

3.1.6 Proximity of the Workplace to Nearby Amenities

Employees were found to be more productive if they worked in an office in a desirable or suitable location (Chadburn et al., 2017), and building accessibility is highly appreciated for employee satisfaction and productivity support (Brunia et al., 2016). Workplaces placed near public infrastructure have higher employee satisfaction and productivity (Al Horr et al., 2016).

3.1.7 Provision of Window View to the Outside

The window view of natural elements is important in the workplace for worker satisfaction (Al Horr et al., 2016; Lottrup et al., 2015), and being close to the window has been found to be a significant driver of productivity (Bortoluzzi et al., 2018a; Chadburn et al., 2017). For a healthier physiological and psychological states of workers, workplace need to be supported by providing a link to nature through natural provisions, sights, and green spaces (Harris, 2019b). The landscaped surroundings need to be well-planned through the workplace design stage (Derek Clements-Croome, 2015a) and provide access to an outdoor green environment to improve satisfaction and performance (Lottrup et al., 2015).

3.1.8 Provision of Color Schemes Suitable for Different Functions

The interior colors may either inspire or distract the worker (Appel-Meulenbroek et al., 2011), and productivity is greatly influenced by the office color scheme (Kamarulzaman et al., 2011). The color standards would affect the experience of comfort in the workplace (B. Haynes et al., 2017b) and need to be considered within the layout of the physical workplace (Hassanain et al., 2018), particularly for an open workplace layout (Ashkanasy et al., 2014). Coloring the circulation paths on the floor or carpet will ease the process of finding others, minimize distractions due to foot traffic, and hence boost productivity

(Zamani & Gum, 2019). Workplace coloring needs to be considered within the design stage of the workplace (Kern et al., 1995) due to its effect on the workers attitude toward interaction and performance (Fassoulis & Alexopoulos, 2015).

3.2 Factors Related to Workplace Layout

3.2.1 Provision of Adequate Circulation Space

Having adequate space for circulation within a workplace layout would improve productivity (B. P. Haynes, 2007b) and result in efficient workplace navigation (Harris, 2019b). The circulation space is linked to the office flow and needs to be maintained for individual activities considering the worker's desk space (B. P. Haynes, 2009). The size of the circulation space is reflective of effective accommodation (Appel-Meulenbroek et al., 2011) and the stimulation of worker interaction (Jan van Ree, 2002). The circulation space is a factor in the workplace layout that contributes to productivity (B. P. Haynes, 2008b) and worker comfort (B. P. Haynes, 2007a).

3.2.2 The Provision of an Adequate Way Finding System

The time used to search for employees and space for information or services would affect the workplace efficiency and support productivity (Harris, 2019b) by enriching the layout with access to different spaces (Chadburn et al., 2017), and the office layout should be designed to support the flow of information between workers (B. Haynes et al., 2017a) hence the way the finding system will enhance the workplace efficiency and support productivity.

3.2.3 Workstation Distribution Within the Workplace Layout

The workspace distribution within the layout has the most impact on worker is perceived productivity, whether they are near colleagues or equipment (B. Haynes et al., 2017a). The proper distance distribution among colleagues needs to be maintained as well (McGuire & McLaren, 2009) to satisfy the privacy needs of workers and hence productivity (B. P. Haynes, 2008c) as it affects productivity through crowding stress and job satisfaction (De Croon et al., 2005). The relative location of the workstation has a significant influence on the activities performed (Appel-Meulenbroek et al., 2011).

3.2.4 Workstation Location Relative to Equipment

Workstation location relative to equipment is connected to the level of noise it produces, its contribution to the work process, and other attributes that need to be checked, and this would affect the productivity level as per B. Haynes et al. (2017b; B. P. Haynes, 2008b, 2009). Computer equipment affects workplace layout (Kaplan & Aronoff, 1996) because, all employees need to have access to specialist equipment (Harris, 2019b). The variety of equipment and the provision of access to it would diversely influence the perception of employees productivity (Zamani & Gum, 2019).

3.2.5 Access to a Variety of Different Functions in the Workplace.

Navigating simply within the layout to a quiet space for concentration (Joy & Haynes, 2011) or to a space for a long break or lunch (Mohammad et al., 2019) or to receive a phone call (Chadburn et al., 2017) would result in improving the productivity of employees (Chadburn et al., 2017). The variety of spaces for different functions would meet the various requirements of human basic and life-related psychological needs (Oseland, 2009), especially for older employee needs (B. P. Haynes, 2011). Clear paths were provided to minimize time lost and distraction due to foot traffic (Harris, 2019b).

3.2.6 Efficient Space Utilization

An efficiently occupied space is defined as the ratio of the used area to the total gross area (Cowan & Smith, 2004) and needs to be maintained to achieve optimum organizational performance (B. P. Haynes, 2007b). The spaces must be allocated based on the adapted work pattern (B. P. Haynes, 2008b) and optimized for efficient use (Harris, 2019b). The space utilization is impacting the workers morale and performance (Brunia & Hartjes-Gosselink, 2009). It can also be used to indicate organizational performance through satisfying an efficient accommodation of the workplace (Appel-Meulenbroek et al., 2011) and as one parameter to measure productivity within any organizational performance scorecard (Philip, 2007).

3.2.7 Attracting Places Within a Building for Workers Gathering

Appealing to the workers to gather in places such as canteens or vending facilities would improve the level of productivity for the organization through motivation to communicate, aid in knowledge transfer (Joy & Haynes, 2011), and link workers to each other (Appel-Meulenbroek et al., 2011). Increasing the opportunities to communicate raises the level of satisfaction in a work environment (Brunia et al., 2016) and improves peer relationships and interactions, especially among executives and vice presidents of different departments within the workplace (Stallworth & Kleiner, 1996).

3.2.8 Availability of Personal Storage Within a Workspace

This can be attained by providing a room or a space in the building devoted to storing supplies (Davies, 2008), and having personal storage would improve productivity (B. P. Haynes, 2009). It has been found through studies that many workers complain about not having sufficient storage space (Brunia et al., 2016). The availability of good storage space for information needed to do the work enhances the worker commitment and supports productivity (McGuire & McLaren, 2009).

3.2.9 Ability to Personalize the Workspace.

Permitting workers to use personal or work-related items to distinguish a workspace from others would satisfy human needs, elevate the level of psychological wellbeing, and hence support productivity (Brunia & Hartjes-Gosselink, 2009), and it is used to give one’s character (De Been & Beijer, 2014), and can serve as a temperament enhancer and stress reducer (Ashkanasy et al., 2014).

3.3 Factors Related to Workplace Interaction and Engagement

3.3.1 Availability of Spaces that Allow Social Interaction.

The existence of places for social interaction within the workplace will increase worker satisfaction and productivity (Thompson, 2008) and enable workers to self-manage, self-motivate, and promote the workplace as effectively as possible (Harris, 2019b). Team spaces are also needed for enhanced concentration (Zamani & Gum, 2019), and social interaction has a significant impact on employees' perceived productivity (Bortoluzzi et al., 2018b) and allows for more information and knowledge transfer among employees as per Appel-Meulenbroek et al., 2011).

3.3.2 Availability of Spaces for Formal and Informal Meetings

One of the main reasons for offices is to share information and knowledge, especially through meetings (B. Haynes et al., 2017b). The ease of accessing meeting facilities is a driver of workplace productivity (Chadburn et al., 2017). Formal or informal meetings are a measure of knowledge sharing and exchange (Joy & Haynes, 2011) and a sign of an effective workplace (Harris, 2019b). The availability of isolated rooms for interviews and meetings will support environmental satisfaction (Banbury & Berry, 2005), as knowledge workers need a lot of collaboration with co-workers (Palvalin, 2019). Having formal meeting areas and interaction points is a factor within the work environment that supports productivity (Bortoluzzi et al., 2018b).

3.3.3 Availability of Canteen for Employee's Refreshment

Having access to good tea and coffee (Chadburn et al., 2017) and refreshment (B. P. Haynes, 2009) is a driver of workplace productivity. Good nutrition and hydration, if available within a workplace, would promote a healthy workplace (Harris, 2019b). The availability of canteens and secure work places within working hours would positively affect employee productivity (D. J. Clements-Croome, 2018). The canteen is one of the specialized spaces forming the workplace environment (Thomas, 2010) and points of social interaction (B. Haynes et al., 2017b). The canteen and refreshment spaces need to be carefully selected to avoid being a source of distraction within the workplace layout (B. Haynes et al., 2017a).

3.4 Factors Related to Indoor Environmental Quality at the Workplace

3.4.1 Having a Workspace Acceptable Acoustic Climate

Acoustics is the science of sounds, as per Davis (2008), and it is an aspect of the workplace environment that has an impact on productivity (Brunia et al., 2016). Acoustics is a component of the indoor environment that affects satisfaction and hence productivity (De Been & Beijer, 2014) and needs to be maintained to safeguard the workers wellbeing (De Croon et al., 2005).

Providing quiet areas within the workplace would improve productivity (B. P. Haynes, 2008d) and be considered a driver of an enhanced workplace environment (Chadburn et al., 2017). Having quite spaces would result in environmental satisfaction (Banbury & Berry, 2005), and attention needs to be given to having free distraction spaces within the workplace (Joy & Haynes, 2011).

3.4.2 Provision of Measures to Eliminate Visual Disturbance

Private workstations with controlled openness to eliminate visual disturbance permit the employee to have a state of withdrawal (De Been & Beijer, 2014). The transparency level needs to be maintained for privacy, safety issues (Brunia et al., 2016), visual protection (De Croon et al., 2005), and to improve collaboration in the workplace (De Been & Beijer, 2014). The innovative workplace has recorded a high satisfaction level with a degree of openness and transparency (Maarleveld et al., 2009), controlled visually for effective use of space (Harris, 2019b), and fewer visual distractions to improve satisfaction (Thompson, 2008).

3.4.3 Provision of an Acceptable Thermal Environment

The satisfaction of the work environment is significantly affected by the indoor environment (Brunia et al., 2016) and affects worker productivity (De Been & Beijer, 2014). Temperature is one of the most important factors impacting worker productivity and needs to be under personal control (Palvalin et al., 2017) and maintained to reach comfort (Bortoluzzi et al., 2018b). The workplace temperature should be within an optimum range to promote a healthier environment (Harris, 2019b).

3.4.4 Provision of Sufficient Ventilation

Providing sufficient ventilation for the workspace atmosphere is crucial for personal health to maintain proper conceptual and thinking tasks through the constant delivery of fresh air using natural or mechanical means (Davies, 2008). Ventilation is one aspect of environmental satisfaction (Banbury & Berry, 2005), and having a good range of air movement would result in enhanced office productivity (Chadburn et al., 2017) and satisfy the minimum required rate per person for different workplace productivity (Satish et al., 2011).

3.4.5 Provision of Sufficient Ilumination level.

Providing access to the maximum good natural lighting effects productivity. Natural lighting is described as light derived directly or indirectly from the sun, whereas artificial lighting is light produced by means other than the sun, as per Davis (2008). Natural lighting is one of the office comfort factors that support productivity (B. P. Haynes, 2009) and raises the satisfaction if maximum daylight is allowed (Thompson, 2008). Access to natural light would also promote the workplace toward a healthier environment (Harris, 2019b).

3.4.6 Provisions of Measures to control the Indoor workplace environment

Allowing employees to control the temperature would enhance office productivity (Chadburn et al., 2017). Consideration of gender reactions to the temperature (De Been & Beijer, 2014) needs to be made to allow them to alter the immediate conditions (B. P. Haynes, 2008c). Giving the person control over the indoor climate is one of the most important factors in supporting productivity (Palvalin et al., 2017).

3.5 Factors Related to Workplace Supportive Services

3.5.1 Availability of Documented Facility Management Processes and Strategies

The availability of documented facility management processes and strategies through effective management of resources (people and assets), place, and process to optimize an organization's business as per Cowan & Smith (2004) will affect productivity, as revealed from the literature review. An overall appreciation of facilities was found to affect worker productivity (De Been & Beijer, 2014). Providing a customer-focused management function impacts the satisfaction and hence productivity (Thompson, 2008).

3.5.2 Provision of Satisfactory Services to the Workforce

Provision of satisfactory services to the workforce by supplying utilities, water, air, communications, electricity, and disposing of waste as per (Davies, 2008). A high level of service was found to affect the level of productivity (Harris, 2019b). Building services are one of the major components of building performance, forming a third of the building cost for a fifteen-year life cycle (Duffy, 1990). The services are responsible for comfort and the worker's wellbeing (B. P. Haynes, 2007a) and hence will positively impact productivity if control over them is provided (B. Haynes et al., 2017b).

3.5.3 Provision of Effective Housekeeping Measures.

Housekeeping is the process of keeping a space clean and well-operated (Cowan & Smith, 2004). Keeping the office space clean and organized by keeping it free from dirt and stains and arranged in a systematic display order found to affect the level of productivity would promote a healthier and more productive workplace (Harris, 2019b). Cleanliness influences the experience of comfort (B. Haynes et al., 2017b). The workplace needs to be free of waste (B. P. Haynes, 2008c) and waste avoidance in order to satisfy workers and be productive (Leaman, 1995).

3.5.4 Provision of Adequate Safety and Security Measures

Providing a secure workplace is an essential need for people to continue their work. Security can be defined as a protective measure taken in the building to prevent unauthorized intrusion and burglary, as per (Davies, 2008). Providing physical security has been found to affect productivity (B. P. Haynes, 2007a) and promote the workplace toward a healthier environment (Harris, 2019b).

3.5.5 Provision of High Quality Information Technology Infrastructure

Having a qualified information technology infrastructure that allows to store, process, and manipulate the data (Davies, 2008). It is essential to have qualified IT hardware system due to the amount of work done virtually (Appel-Meulenbroek et al., 2011). In addition to comprehensive WI-FI coverage to elevate the productivity level of the workplace

(Chadburn et al., 2017) and the usage of technology to fit organizational needs (Zamani & Gum, 2019).

3.6 Summary and Discussion

The preliminary identification of the factors affecting workplace productivity has been discussed in this chapter. The consideration of each factor is important for boosting organizational performance and employee satisfactions. Further, it guides the designer of the workplace or the facility manager dealing with the office building.

As reviewed in the literature, a questionnaire survey was established to assess the identified 31 factors based on facility managers' practices, designer perspectives, and building users' perceived experiences. The next chapter will discuss the methodology for assessing the identified factors and list the findings.

CHAPTER 4

METHODOLOGY OF ASSESSING THE IDENTIFED FACTOR

In order to achieve the goals of this study, the thirty-one factors obtained were listed in a web-based questionnaire to collect responses about the importance level of each one. A five-point Likert scale was used to evaluate the importance of each factor on employees' perceived productivity. The questionnaire was sent to a population working in an office environment comprimising of architectural design engineers, facility managers, and building users to be analyzed after responses had been received and ranked according to their importance survey level.

4.1 Questionnaire Development

A web-based questionnaire was developed to speed up the process of filling out and collecting the required data. A cover letter was developed to introduce the respondent to the study purpose and the data being collected (see Appendix C). The questionnaire contains three parts: questions about demographic information, an assessment of factors affecting productivity, and any additional comments or notes.

The demographic information contains personal information, which includes the name, organization name, address, phone, email, and job title of either a facility manager or architectural designer or a building user, years of experience, and some specific questions for each job title.

The following part includes the assessment of the factors in which the respondent were presented with thirty one factor grouped into five clusters h, as follows:

1. Factors related to workplace design.
2. Factors related to workplace layout.
3. Factors related to workplace interaction and engagement.
4. Factors related to indoor environmental quality at the workplace.
5. Factors related to building supportive services.

4.2 Piloting the Questionnaire Survey

The questionnaire was initially piloted with a small group of two respondents from each survey practicipants groups to identify any problems that may arise due to either misinterpretation of the applied phrases or the use of some deep technical words.

All group members have adequate experience with the types of questions and questionnaire formations, which has resulted in modifications to some phrases to make them clearer and more understandable.

4.3 Distribution of the Questionnaire

The identified measures were distributed to ninety professionals, including thirty facility managers, thirty designers, and thirty building users, to assess the importance of the productivity factors.

The factors were assessed by asking the respondent to indicate the level of importance of each factor by selecting the appropriate rate among five choices on a Likert scale. The evaluation terms used, along with their corresponding weights, were "extremely important" with 4 points. "very important" with 3 points, "important" with 2 points, "slightly important with 1 point, and "not important" with 0 point, as shown in Appendix B.

4.3.1 Respondents Analysis

The majority of respondents have experience, with 47% having 10 to 20 years of experience, followed by 37% having 5 to 10 years of experience, as shown in Table 4.1. According to Table 4.2, the size of the organization in which the respondents are formed is 40% for 1 to 50 workers, 37% for more than 100 employees, and 23% for 50 to 100 employees.

Respondent	Years of Experience				Total
	Less than 5 years	5 to 10 years	10 to 20 years	Over 20 years	
Architect / Engineer.	0	11	15	4	30
Facility manager.	0	13	14	3	30
Building User.	6	9	13	2	30

Table 4.1 Respondent analysis by experience

Number of employees in Respondent Organization			Total
1-50 employee.	50-100 employee.	More than 100 employees.	
36	21	33	90

Table 4.2 Respondent analysis by organization volume

4.4 Data Analysis

4.4.1 Calculation of the Relative Importance Index

The obtained data from the three groups of respondents were tabulated and analyzed. The Relative Importance Index (RII) was calculated for each factor, using the following equation (Holt, 2014).

$$RII = \frac{\sum_{i=0}^{4}(a_i)(x_i)}{4\sum_{i=1}^{4}(x_i)} \times 100\ \%$$

where:

i: Response category index;

ai: Weight given to i response; and

xi: is the variable expressing the frequency of i

Error! Reference source not found.presents the assigned weight to each importance rate (i). The table provides an

adopted scale to interpret the calculated RIIs and determine the importance rate for each

factor.

Importance rating	Weight (ai)	Scale (%)
Exteremly important (x0)	4	87.5-100
Very important (x1)	3	62.5-87.5
Important (x2)	2	37.5-62.5
Slightly important (x3)	1	12.5-37.5
Not important (x4)	0	0-12.5

Table 4.3 The adopted weighting and scale of interpretation for each importance rating

The values of the calculated RII for the productivity factors are shown in Table 4.4 Assessment of the factors affecting workplace productivity

Since all the factors had a relative importance index of more than 50%, they have all been included within the assessment checklist which is going to be used in the assessment of the three case study buildings.

	Factors Affecting workplace productivity	RII (%)
	Factors related to workplace design	
1	Employees involvement in the planning and design of the workspace	**63.06%**
2	Exterior and interior appearance of the building	**70.83%**
3	Flexible design to accommodate change.	**71.11%**
4	Functional workspace design for different work settings	**68.61%**
5	Ergonomic design of the workstation and adequate size of workstation.	**76.11%**
6	Proximity of the workplace to nearby amenities	**60.56%**
7	Provision of window view to the outside	**63.06%**
8	Provision of color schemes suitable for different functions	**56.11%**
	Factors related to workplace layout	
9	Provision of adequate circulation space	**65.83%**
10	Provision of adequate way finding system.	**65.00%**
11	Workstation distribution within the workplace layout	**67.78%**
12	Workstation location relative to equipment	**66.39%**
13	Access to a variety of different functions in the workplace.	**60.00%**
14	Efficient space utilization	**71.39%**
15	Attracting places within a building for workers gathering	**58.06%**
16	Availability of personal storage within a workspace.	**52.22%**
17	Ability to personalize the workspace	**52.50%**
	Factors related to workplace interaction and engagement	
18	Availability of spaces that allow social interaction	**60.00%**
19	Availability of spaces for formal and informal meetings	**73.89%**
20	Availability of canteen for employee's refreshment	**68.61%**
	Factors related to indoor environmental quality at the workspace	
21	Having a workspace acceptable acoustic climate	**67.50%**
22	Provision of measures to eliminate visual disturbance	**67.50%**
23	Provision of an acceptable thermal environment	**75.83%**
24	Provision of sufficient ventilation	**80.28%**
25	Provision of sufficient illumination level	**79.17%**
26	Provisions of measures to control the indoor workplace environment	**70.28%**

Factors related to building supportive services.		
27	Availability of documented facility management processes and strategies	**67.50%**
28	Provision of satisfactory services to the workforce	**70.28%**
29	Provision of effective housekeeping measures	**77.22%**
30	Provision of adequate safety and security measures	**87.22%**
31	Provision of high quality information technology infrastructure	**82.50%**

Table 4.4 Assessment of the factors affecting workplace productivity

4.4.2 Development of a Checklist for Productivity Measures

The factors of productivity are listed after the literature has been reviewed and then categorized as per their type into five groups with 31 factors. The cases will be evaluated using the form shown below in Table 4.5.

The number of factors presented in the case study being checked will reflect its level of support for employee productivity, resulting in a higher rank in supporting productivity and employee satisfaction.

Workplace productivity criteria		**RII (%)**	**Availability**		**Score**
			Yes	**No**	**100%**
Criteria related to workplace design					
1	Employees involvement in the planning and design of the workspace	63.06%			
2	Exterior and interior appearance of the building	70.83%			
3	Flexible design to accommodate change.	71.11%			
4	Functional workspace design for different work settings	68.61%			

5	Ergonomic design of the workstation and adequate size of workstation.	76.11%			
6	Proximity of the workplace to nearby amenities	60.56%			
7	Provision of window view to the outside	63.06%			
8	Provision of color schemes suitable for different functions	56.11%			
Criteria related to workplace layout					
9	Provision of adequate circulation space	65.83%			
10	Provision of adequate way finding system.	65.00%			
11	Workstation distribution within the workplace layout	67.78%			
12	Workstation location relative to equipment	66.39%			
13	Access to a variety of different functions in the workplace.	60.00%			
14	Efficient space utilization	71.39%			
15	Attracting places within a building for workers gathering	58.06%			
16	Availability of personal storage within a workspace.	52.22%			
17	Ability to personalize the workspace	52.50%			
Criteria related to workplace interaction and engagement					
18	Availability of spaces that allow social interaction	60.00%			
19	Availability of spaces for formal and informal meetings	73.89%			
20	Availability of canteen for employee's refreshment	68.61%			
Criteria related to indoor environmental quality at the workspace					
21	Having a workspace acceptable acoustic climate	67.50%			
22	Provision of measures to eliminate visual disturbance	67.50%			

23	Provision of an acceptable thermal environment	75.83%			
24	Provision of sufficient ventilation	80.28%			
25	Provision of sufficient illumination level	79.17%			
26	Provisions of measures to control the indoor workplace environment	70.28%			
Criteria related to building supportive services.					
27	Availability of documented facility management processes and strategies	67.50%			
28	Provision of satisfactory services to the workforce	70.28%			
29	Provision of effective housekeeping measures	77.22%			
30	Provision of adequate safety and security measures	87.22%			
31	Provision of high quality information technology infrastructure	82.50%			

Table 4.5 Workplace productivity factors checklist

4.4.3 Calculation of the Productivity Index

The productivity checklist will be applied on all the three case studies to determine the productivity index of each case study, which will be calculated as follows:

- Step 1: Every case study building will be subjected to the developed productivity checklist, to verify the availability of the 31 productivity factors.
- Step 2 : An individual score for each factor is determined based on factor verification within the case study. If a productivity factor was verified then, it is multiplied by 1, while if it isn't verified then, it is multiplied by 0.
- Step 3 : The sum of all individual scores will be made to use in the calculation of

productivity index.

- Step 4: The grand total of all scores will be divided by the sum of all relative importance indecies.

The case study with the highest productivity index will be selected for conducting the post occupancy evaluation (POE).

CHAPTER 5
CASE STUDIES

This chapter presents three different workplaces that were used as case studies in this research. The walkthrough assessment was conducted, and the checklist of productivity measures was used to check their availability in each of case study.

5.1 Selection Criteria for the Case Study

5.1.1 The Workplace Employee

The office building should have a minimum of 100 knowledge workers, such as architects and engineers, who create and use knowledge as a primary work resource. The workers involved in the assessment should have spent a minimum of one year in the building under assessment.

5.1.2 The Workplace Design

The workplace design should contain the largest possible number of the 31 productivity factors assessed to investigate the enhancement of user satisfaction whenever these factors are available.

5.1.3 Type of Work Plans

The work layout should have a mixture of open, shared, and closed workspaces. In addition to the availability of supportive facilities, evaluate the impact of their presence on productivity and user satisfactions.

5.1.4 The Office Building Age

The office building should have a maximum of 10 years of service life or less in order to avoid the impact of associated factors such as building appearance have on the employees productivity and user satisfaction.

5.1.5 The Office Building Function

The office building should contain a mixture of work functions for knowledge workers such as architects, accountants, administration, and engineering work.

5.2 Description and Assessment of the first Case Study Building

The office building is located in Dammam, Saudi Arabia. The office building was designed in 2008 and built in 2012 with a footprint equal to 22000 square meters on two floors, houses ninety offices, and is open for 700 to 1000 stakeholder visits per day.

The building office houses different organization-related activities for administration, technical activities, engineering tasks, and design orders. The full capacity of the office building is about 1000 workers with various of office types that are open, semi-closed, combined, and closed workspaces.

The ground floor office footprint is equal to 2720 square meters occupied by 300 employees distributed among shared open offices, closed workspaces, and shared closed offices. The floor includes other spaces for meetings, focus, rest, reception, storage, and other support services.

The first-floor office footprint is equal to 3000 square meters occupied by 350 employees and consists of closed, shared, and open office types. The floor includes spaces for different activities, such as spaces to pray, meet, and rest, and other spaces for supportive services.

In this case study, a walkthrough was carried out on the ground and first floors of the office building, as shown in Figures 5.1 and 5.2.

The interior design of the workplace environment gives a sense of industrial and work-style interiors. The floors were classified to deliver the organizational culture and management style applied. The work layout tends toward team communication and community engagements. The spaces are filled with multiple types of functional workspaces resulting from an analysis of the required job process and employee behavior related to it.

The types of materials used in the office is of high quality and for heavy-duty purposes, as shown in the figure. A mixture of colored furniture, flooring materials (carpet, wood, vinyl, and porcelain), and colored panels between workstations were used to create a fabulous interior.

The paint color applied was uniform to all walls as per the work standard quality and work condition with simple decoration. Off-white paint is used to give a wider sense of space and a higher lighting reflection ratio than other dark colors.

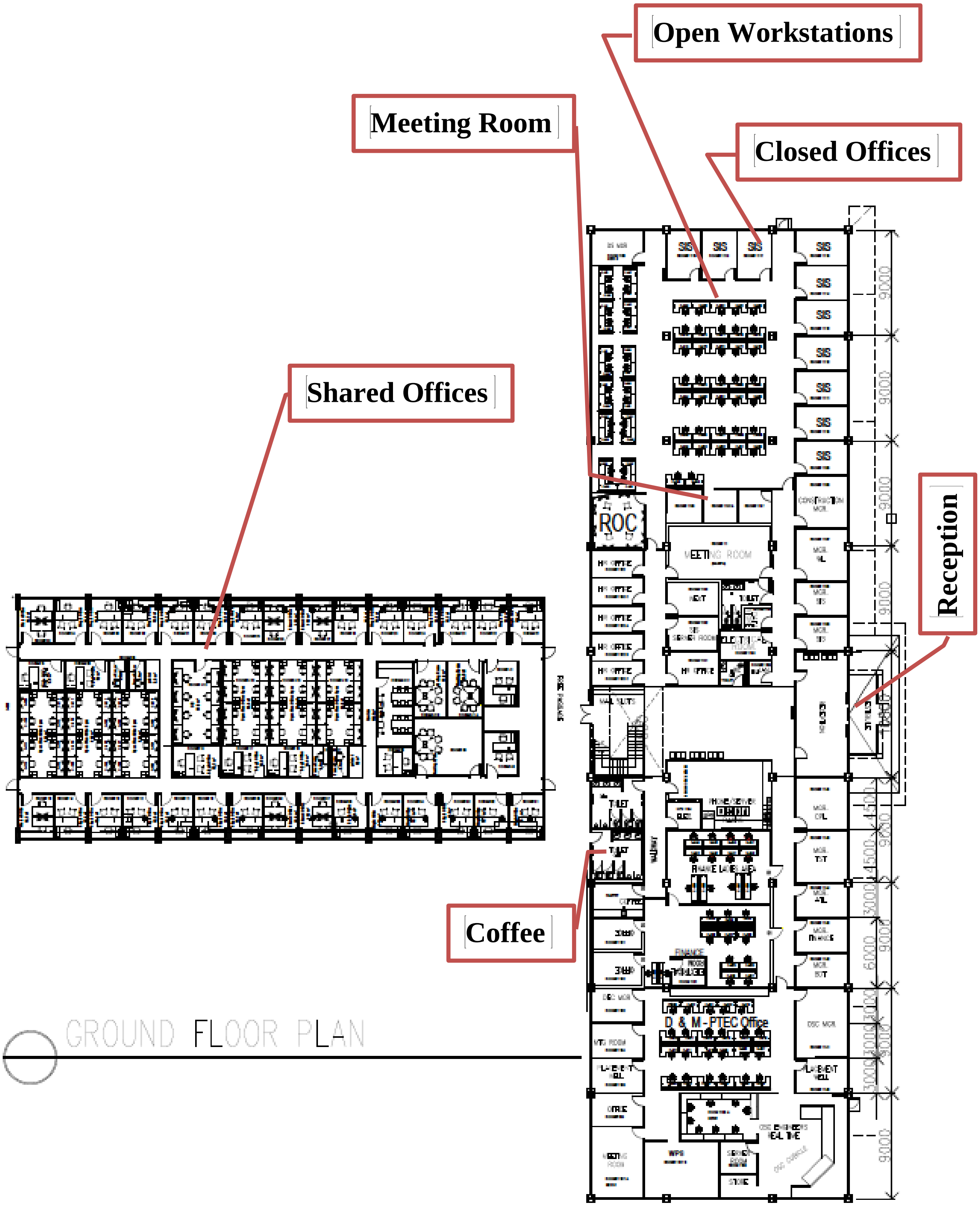

Figure 5.1 Ground Floor Plan of Case Study 1

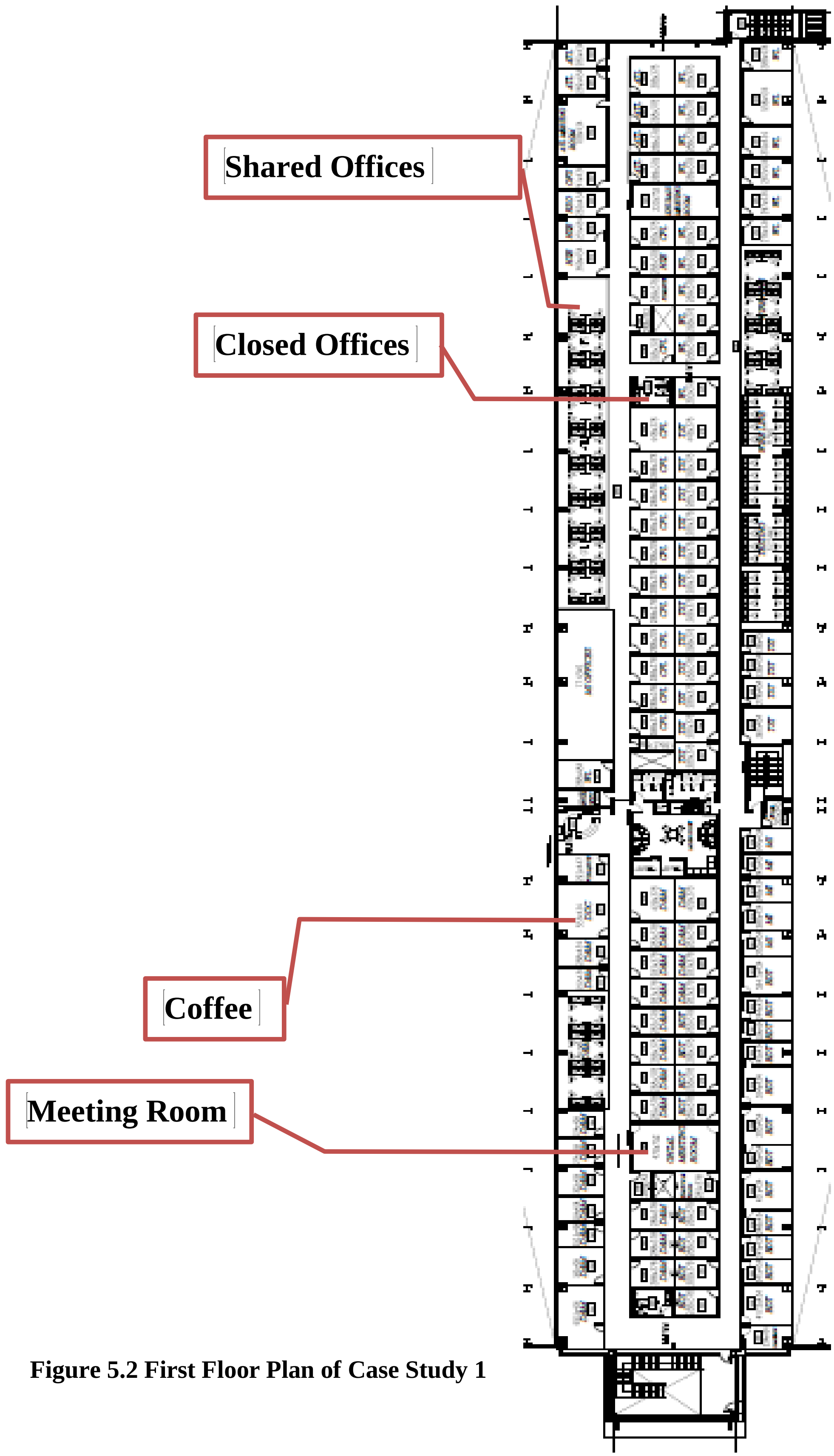

Figure 5.2 First Floor Plan of Case Study 1

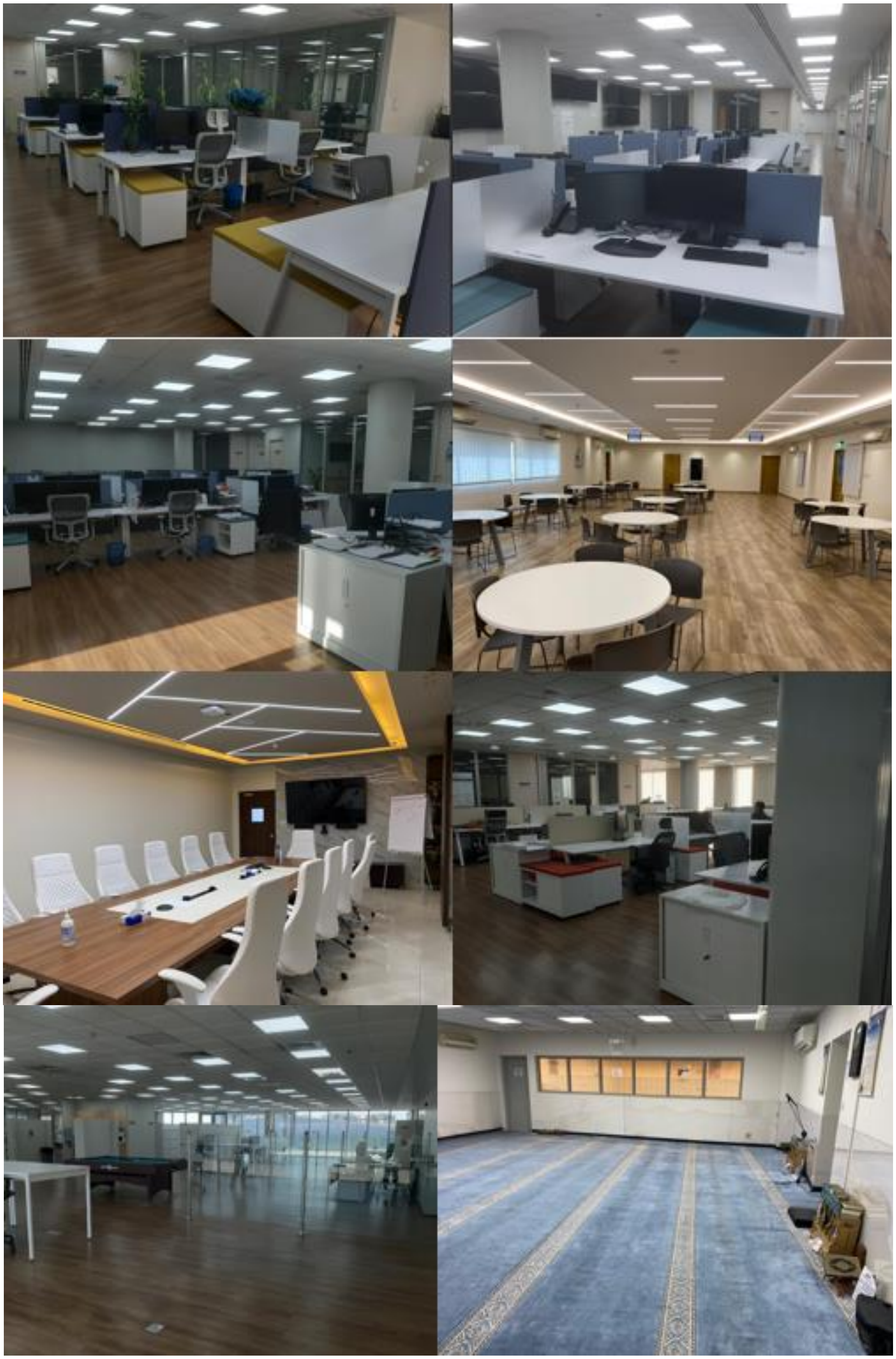

Figure 5.3 Photos of different spaces in case study 1

The list of the measures that were previously identified, along with their calculated significance and level of importance, was applied to the case study 1. A walkthrough was conducted together with the building facility manager to check the appearance of the listed measures in the office building, as shown in Table 5.1.

It was noticed that all productivity measures are available in this workplace. Hence, to evaluate the level that the case study environment has to support the employee's productivity, we divide the total of means for available factors " by the total mean for all factors "yes" and "no," and once we know the total percentage, we will determine the productivity level within a range as previously demonstrated in the methodology section.

As per the stated method, the case study's total percentage of productivity support = (total of means for available factors "yes" / total mean for all factors "yes" and "no") x 100. Hence, the total percentage is = (1988.34% / 2116.40%) X 100 = 93.95%.

Workplace productivity criteria		RII (%)	Availability		Score
			Yes	**No**	**100%**
Criteria related to workplace design					
1	Employees involvement in the planning and design of the workspace	63.06%		No	0%
2	Exterior and interior appearance of the building	70.83%	yes		70.83%
3	Flexible design to accommodate change.	71.11%	yes		71.11%
4	Functional workspace design for different work settings	68.61%	yes		68.61%
5	Ergonomic design of the workstation and adequate size of workstation.	76.11%	yes		76.11%
6	Proximity of the workplace to nearby amenities	60.56%	yes		60.56%
7	Provision of window view to the outside	63.06%	yes		63.06%
8	Provision of color schemes suitable for different functions	56.11%	yes		56.11%
Criteria related to workplace layout					
9	Provision of adequate circulation space	65.83%	yes		65.83%
10	Provision of adequate way finding system.	65.00%		No	0%

11	Workstation distribution within the workplace layout	67.78%	yes		67.78%
12	Workstation location relative to equipment	66.39%	yes		66.39%
13	Access to a variety of different functions in the workplace.	60.00%	yes		60.00%
14	Efficient space utilization	71.39%	yes		71.39%
15	Attracting places within a building for workers gathering	58.06%	yes		58.06%
16	Availability of personal storage within a workspace.	52.22%	yes		52.22%
17	Ability to personalize the workspace	52.50%	yes		52.50%
Criteria related to workplace interaction and engagement					
18	Availability of spaces that allow social interaction	60.00%	yes		60.00%
19	Availability of spaces for formal and informal meetings	73.89%	yes		73.89%
20	Availability of canteen for employee's refreshment	68.61%	yes		68.61%
Criteria related to indoor environmental quality at the workspace					
21	Having a workspace acceptable acoustic climate	67.50%	yes		67.50%
22	Provision of measures to eliminate visual disturbance	67.50%	yes		67.50%
23	Provision of an acceptable thermal environment	75.83%	yes		75.83%
24	Provision of sufficient ventilation	80.28%	yes		80.28%
25	Provision of sufficient illumination level	79.17%	yes		79.17%
26	Provisions of measures to control the indoor workplace environment	70.28%	yes		70.28%
Criteria related to building supportive services.					
27	Availability of documented facility management processes and strategies	67.50%	yes		67.50%
28	Provision of satisfactory services to the workforce	70.28%	yes		70.28%
29	Provision of effective housekeeping measures	77.22%	yes		77.22%
30	Provision of adequate safety and security measures	87.22%	yes		87.22%
31	Provision of high quality information technology infrastructure	82.50%	yes		82.50%

Table 5.1 Workplace productivity factors checklist at case study 1

5.3 Description and Assessment of the Second Case Study Building

The office building is located in Al Khobar, Saudi Arabia. The office building was occupied by 2011 with a footprint equal to 1050 square meters. The building office houses different organization-related activities for administration, technical activities, and engineering tasks. The full capacity of the office floor is about 70 workers, and a variety of office types are used in the office building, including open, semi-closed, combined, and closed workspaces. The floor includes other spaces for meetings, rest, reception, storage, and other support services.

In this case study, a walkthrough was carried out on the ground floor of the office building, as shown in the layout in Figure 5.4.

The interior design of the workplace environment gives the sense of a modernized work style. The floors were classified into groups that belong to their project managers and use different activity desks to deliver the projects' different requirements.

The work layout tends toward team communication and community engagements. The spaces are filled with multiple types of functional workspaces resulting from an analysis of the required job process and employee behavior related to it.

The types of materials used in the office is of high quality and for heavy-duty purposes, as shown in Figure 5.5. A mixture of colored furniture, flooring materials (carpet, wood, vinyl, and porcelain), and colored panels between workstations were used to create a fabulous interior.

The paint color applied was uniform to all walls as per the work standard quality and work condition with simple decoration. White paint is used to give a wider sense of space and a higher lighting reflection ratio than other dark colors.

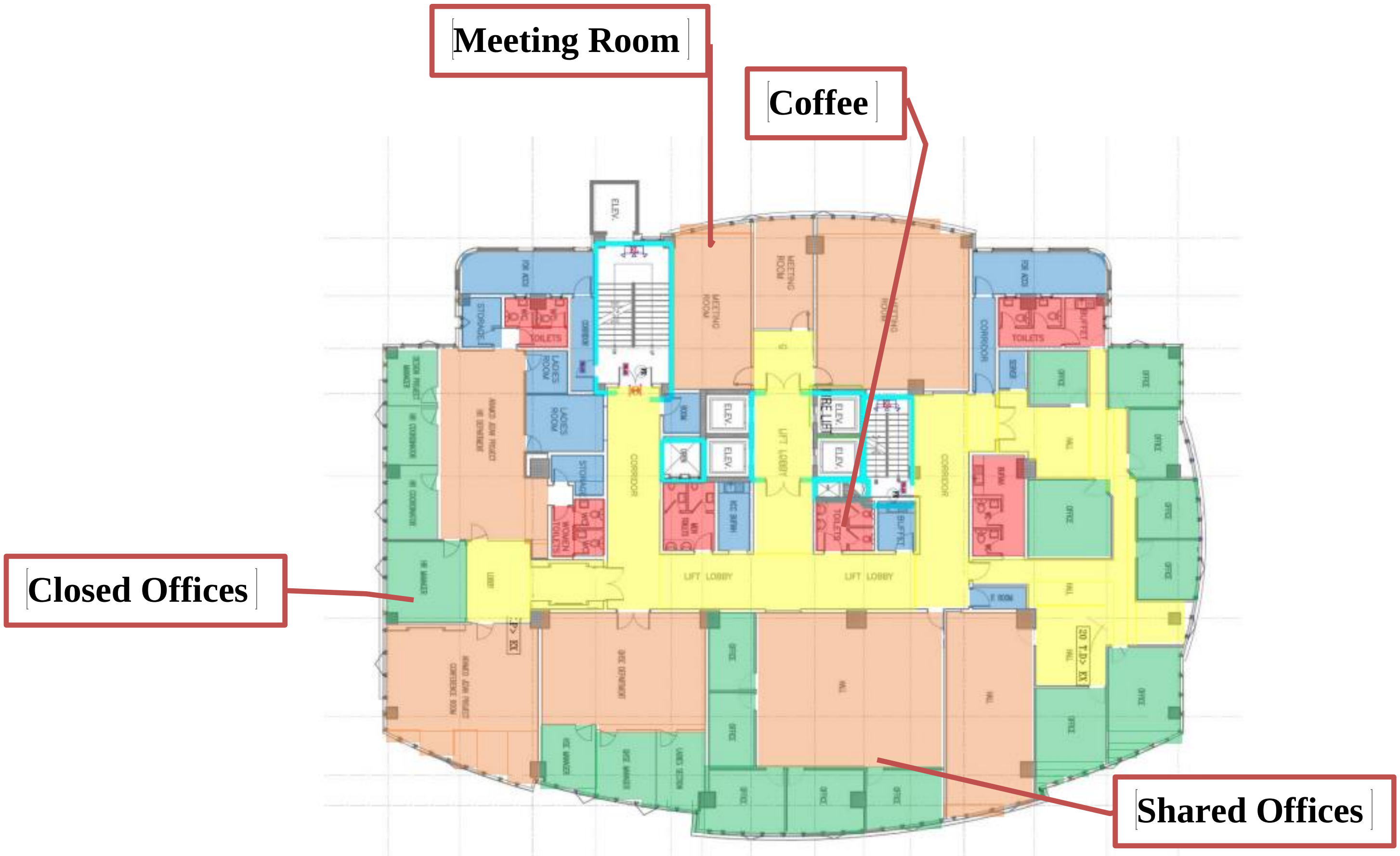

Figure 5.4 Plan Layout of Case Study 2

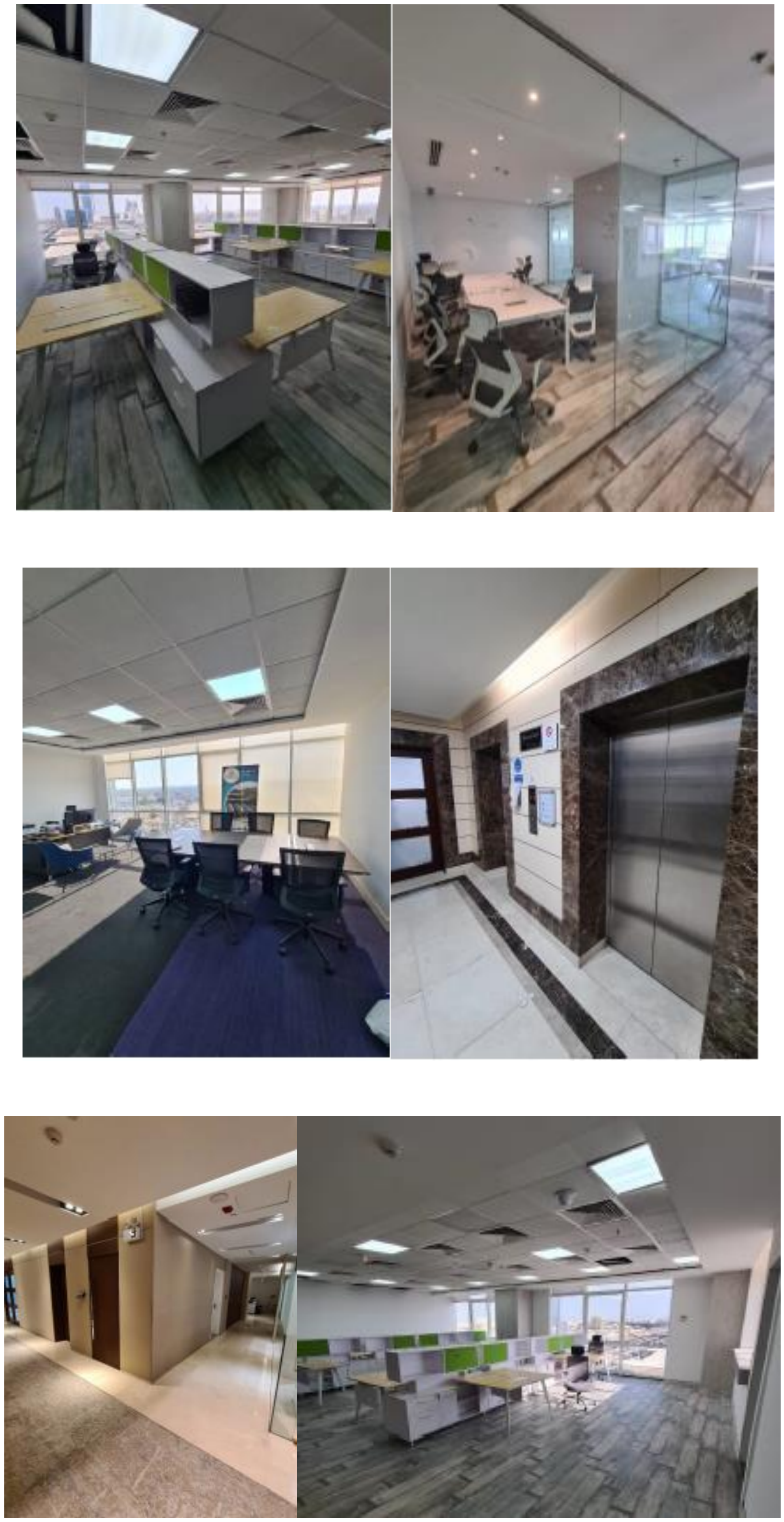

Figure 5.5 Photos of different spaces in case study 2

The list of the measures that were previously identified, along with their calculated significance and level of importance, was applied to the case study. 1. A walkthrough was conducted together with the building facility manager to check the appearance of the listed measures in the office building, as shown in Table 5.2.

It was noticed that all the productivity measures are available in this workplace. Hence, to evaluate the level that the case study environment has to support the employee's productivity, we divide the total of means for available factors " by the total mean for all factors "yes" and "no" and once we know the total percentage, we will determine productivity level within a range as previously demonstrated in the methodology section.

As per the stated method, the case study's total percentage of productivity support = (total of means for available factors "yes" / total mean for all factors "yes" and "no") x 100. Hence, the total percentage is = (1591.95% / 2116.40%) X 100 = 75.222%.

Workplace productivity criteria		RII (%)	Availability		Score
			Yes	**No**	**100%**
Criteria related to workplace design					
1	Employees involvement in the planning and design of the workspace	63.06%		**No**	0%
2	Exterior and interior appearance of the building	70.83%	**Yes**		70.83%
3	Flexible design to accommodate change.	71.11%	**Yes**		71.11%
4	Functional workspace design for different work settings	68.61%	**Yes**		68.61%
5	Ergonomic design of the workstation and adequate size of workstation.	76.11%	**Yes**		76.11%
6	Proximity of the workplace to nearby amenities	60.56%	**Yes**		60.56%
7	Provision of window view to the outside	63.06%	**Yes**		63.06%
8	Provision of color schemes suitable for different functions	56.11%		**No**	0%
Criteria related to workplace layout					
9	Provision of adequate circulation space	65.83%		**No**	0%
10	Provision of adequate way finding system.	65.00%	**Yes**		65.00%

11	Workstation distribution within the workplace layout	67.78%		**No**	0%
12	Workstation location relative to equipment	66.39%		**No**	0%
13	Access to a variety of different functions in the workplace.	60.00%	**Yes**		60.00%
14	Efficient space utilization	71.39%	**Yes**		71.39%
15	Attracting places within a building for workers gathering	58.06%	**Yes**		58.06%
16	Availability of personal storage within a workspace.	52.22%	**Yes**		52.22%
17	Ability to personalize the workspace	52.50%		**No**	0%
Criteria related to workplace interaction and engagement					
18	Availability of spaces that allow social interaction	60.00%	**Yes**		60.00%
19	Availability of spaces for formal and informal meetings	73.89%	**Yes**		73.89%
20	Availability of canteen for employee's refreshment	68.61%	**Yes**		68.61%
Criteria related to indoor environmental quality at the workspace					
21	Having a workspace acceptable acoustic climate	67.50%		**No**	0%
22	Provision of measures to eliminate visual disturbance	67.50%	**Yes**		67.50%
23	Provision of an acceptable thermal environment	75.83%	**Yes**		75.83%
24	Provision of sufficient ventilation	80.28%	**Yes**		80.28%
25	Provision of sufficient illumination level	79.17%	**Yes**		79.17%
26	Provisions of measures to control the indoor workplace environment	70.28%		**No**	0%
Criteria related to building supportive services.					
27	Availability of documented facility management processes and strategies	67.50%	**Yes**		67.50%
28	Provision of satisfactory services to the workforce	70.28%	**Yes**		70.28%
29	Provision of effective housekeeping measures	77.22%	**Yes**		77.22%
30	Provision of adequate safety and security measures	87.22%	**Yes**		87.22%
31	Provision of high quality information technology infrastructure	82.50%		**No**	0 %

Table 5.2 Workplace productivity factors checklist at case study 2

5.4 Description and Assessment of the Third Case Study Building

The office building is located in Dammam, Saudi Arabia. The office building was designed in 2008 and built in 2010, with a footprint of 2000 square meters. The building office houses different organization-related activities for administration, technical activities, and engineering tasks. The full capacity of the office building is about 150 workers with various office types that are open, semi-closed, combined, and closed workspaces. The floor includes other spaces for meetings, rest, reception, storage, and other support services.

In this case study, a walkthrough was carried out on the ground floor of the office building, as shown in the layout in Figure 5.6.

The interior design of the workplace environment gives a sense of industrial and work-style interiors. The floors were classified to deliver the organizational culture and management style applied. The work layout tends toward team communication and community engagements. The spaces are filled with multiple types of functional workspaces resulting from an analysis of the required job process and employee behavior related to it.

The types of materials used in the office is of high quality and for heavy-duty purposes, as shown in Figure 5.7. A mixture of colored furniture, flooring materials (carpet, wood, vinyl, and porcelain), and colored panels between workstations were used to create a fabulous interior.

The paint color applied was uniform to all walls as per the work standard quality and work condition with simple decoration. Off-white paint is used to give a wider sense of space and a higher lighting reflection ratio than other dark colors.

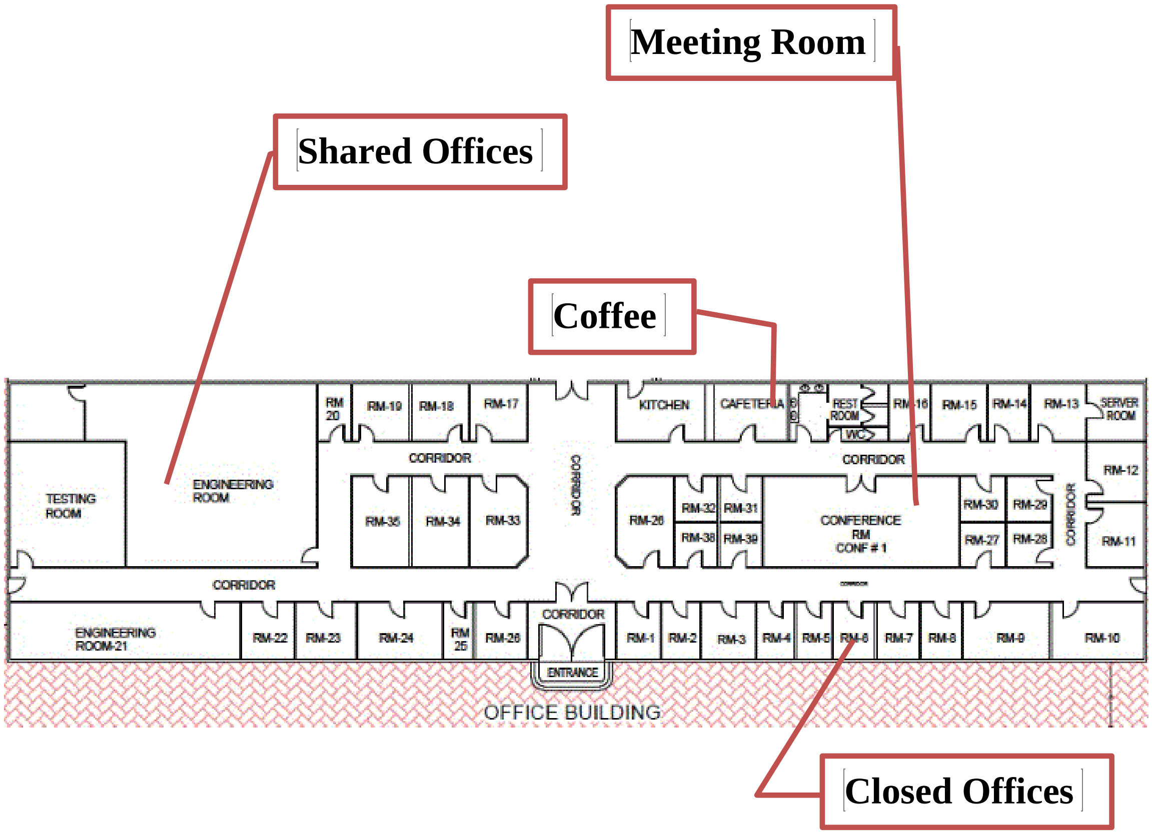

Figure 5.6 Plan Layout of Case Study 3

Figure 5.7 Photos of different spaces in case study 3

The list of the measures that were previously identified, along with their calculated significance and level of importance, was applied to Case Study 1. A walkthrough was conducted together with the building facility manager in order to check the appearance of the listed measures in the office building, as shown in Table 5.3 of the workplace productivity factors checklist in Case Study 3.

It was noticed that all productivity measures are available in this workplace. Hence, to evaluate the level that the case study environment has to support the employee's productivity, we divide the total of means for available factors " by the total mean for all factors "yes" and "no," and once we know the total percentage, we will determine the productivity level within a range as previously demonstrated in the methodology section.

As per the stated method, the case study's total percentage of productivity support = (total of means for available factors "yes" / total mean for all factors "yes" and "no") x 100. Hence, the total percentage is = (816.95% / 2116.40%) X 100 = 38.6%.

Workplace productivity criteria		**RII (%)**	**Availability**		**Score**
			Yes	**No**	**100%**
Criteria related to workplace design					
1	Employees involvement in the planning and design of the workspace	63.06%		**No**	0%
2	Exterior and interior appearance of the building	70.83%		**No**	0%
3	Flexible design to accommodate change.	71.11%		**No**	0%
4	Functional workspace design for different work settings	68.61%		**No**	0%
5	Ergonomic design of the workstation and adequate size of workstation.	76.11%		**No**	0%
6	Proximity of the workplace to nearby amenities	60.56%	**Yes**		60.56%
7	Provision of window view to the outside	63.06%	**Yes**		63.06%
8	Provision of color schemes suitable for different functions	56.11%	**Yes**		56.11%
Criteria related to workplace layout					
9	Provision of adequate circulation space	65.83%	**Yes**		65.83%

10	Provision of adequate way finding system.	65.00%	**Yes**		65.00%
11	Workstation distribution within the workplace layout	67.78%	**Yes**		67.78%
12	Workstation location relative to equipment	66.39%	**Yes**		66.39%
13	Access to a variety of different functions in the workplace.	60.00%	**Yes**		60.00%
14	Efficient space utilization	71.39%		**No**	0%
15	Attracting places within a building for workers gathering	58.06%		**No**	0%
16	Availability of personal storage within a workspace.	52.22%		**No**	0%
17	Ability to personalize the workspace	52.50%		**No**	0%
Criteria related to workplace interaction and engagement					
18	Availability of spaces that allow social interaction	60.00%		**No**	0%
19	Availability of spaces for formal and informal meetings	73.89%	**Yes**		73.89%
20	Availability of canteen for employee's refreshment	68.61%	**Yes**		68.61%
Criteria related to indoor environmental quality at the workspace					
21	Having a workspace acceptable acoustic climate	67.50%		**No**	0%
22	Provision of measures to eliminate visual disturbance	67.50%		**No**	0%
23	Provision of an acceptable thermal environment	75.83%		**No**	0%
24	Provision of sufficient ventilation	80.28%		**No**	0%
25	Provision of sufficient illumination level	79.17%		**No**	0%
26	Provisions of measures to control the indoor workplace environment	70.28%		**No**	0%
Criteria related to building supportive services.					
27	Availability of documented facility management processes and strategies	67.50%		**No**	0%
28	Provision of satisfactory services to the workforce	70.28%		**No**	0%
29	Provision of effective housekeeping measures	77.22%		**No**	0%
30	Provision of adequate safety and security measures	87.22%	**Yes**		87.22%
31	Provision of high quality information technology infrastructure	82.50%	**Yes**		82.50%

Table 5.3 Workplace productivity factors checklist at case study 3

5.5 The Selection of Case study building for Post Occupancy Evaluation

Table 5.4 productivity indecies for case stydiesshows the productivity indecies for all three case study buildings. The table shows the first case study building is the highest. Therfore it will be selected for the post occupancy evaluation to determine the level of satisfaction of the occupants with that building.

Case study	Productivity index
Case study No.1	93.95%.
Case study No.2	75.22%
Case study No.3	38.60%

Table 5.4 productivity indecies for case stydies

CHAPTER 6: ASSESSMENT OF USER SATISFACTION IN THE PRODUCTIVE WORKPLACE

In this chapter, a survey for post occupancy evaluation has been developed with the measures related to technical, functional, and behavioral performance indicators. The measures are assessing the employees satisfaction with the selected productive workplace case study.

6.1 The Satisfaction Survey

The questionnaire composed of 47 questions covers all the occupancy evaluation aspects toward the satisfaction in the office building. Technical performance indicator part includes thermal comfort, acoustical comfort, visual comfort and indoor air quality for assessment with the related indicators as follows:

1. Thermal comfort includes: the indoor temperature comfort in the extreme seasons over the year during winter and summer and the level of control the occupant has over the thermal environment.
2. Acoustical Comfort: Includes reporting the noise sources from lighting fixtures, HVAC system, and the noise from an exterior source.
3. Visual comfort includes: the amount of daylight and the control over it, the amount of artificial light and the ability to control it within the workspace.
4. Indoor air quality: Includes the adequacy of natural and mechanical ventilation, odor of the air, and the control over ventilation within the workspace.

The functional performance indicators include workspace design, workspace layout and other parameters of building supportive services with the related indicators as follows:

1. Workspace design: Includes the adequacy of the workspace design for different work settings, the fitness of the workstation to the user needs, and the proximity of the workplace to a nearby amenities.
2. Workspace layout: Consist of adequacy of the circulation space, adequacy of the way finding system and directional signs, workstation distribution within the workplace layout, workstation relative to printers and IT shared equipment, access to a variety of different functions in the workplace, efficiency of the space utilization, availability of personal storage within a workspace, sufficiency of the space between workstation and location and size of the cafeteria within the workplace.
3. Building supportive services: includes the availability of documented facility management processes and strategies, adequacy of support services to the work force, adequacy of housekeeping measures, and adequacy of IT infrastructure.

The behavioral performance indicator includes safety and security, management and maintenance and employees interaction with the workplace.

1. Safety and security: consist of the adequacy of safety and security measures and the ease of identifying emergency escape routes.
2. Management and maintenance: compromise of elevator quality of finishes, travel speed, capacity, and continuous runtime. It also includes the efficiency of handling user complaints and the cleanliness of wash rooms.

3. Employees interaction with workplace: consist of employees involvement in the planning and design of the workspace, exterior and interior appearance of the building, adequacy of window view to the outside, adequacy of color schemes for different functions, adequacy of places within a building designated for workers gathering, ability to personalize the workspace, and availability of spaces that allow social interaction.

The questionnaire applied a four-point Likert scale to evaluate the performance indicators, and the respondent was asked to select one out of four terms related to satisfaction, namely, "strongly satisfied", "satisfied", "dissatisfied" and "strongly dissatisfied". In addition to that, there is an open-ended section to gather any data the respondents may not have listed within the questioner and for further aspects in the satisfaction field within the workplace environment. The questionnaire form (Appendix C) was filled out by 107 respondents, and the following sections elaborate on the analysise the collected data.

6.2 Respondent Analysis

The questionnaire was filled out by experienced employees as shown in Table 6.1, which gives a pure workplace environmental satisfaction evaluation result away from the effect of work-related processes as being mostly a group of repeated routine tasks. More than 93 percent of the respondents had occupied the office building for more than two years, which leads to a strong environmental experience about the satisfaction of different indicators, as shown in Table 6.2. As per the tabulated respondent's need to get out of the workplace environment to get refreshed in Table 6.3, less than 90% of employees are lifting the workspace between one and six times a day, implying an average of one time for each two continuous working hours, including the time for prayer, canteen, and toilets.

Occupant's	Years of Experience				Total
	Less than 5 years	5 to 10 years	10 to 20 years	Over 20 years	
	30	36	37	4	107

Table 6.1 Respondent analysis by Employee's Experience

Respondent	Years of Working in the Office Being Evaluated			Total
	1 Year	2 Years	More than Two years	107
	1	6	100	

Table 6.2 Respondent Analysis by Building Occupancy Duration

Number of Times The Employee should get out The Environment For Refreshment					Total
Respondents	1-3 Times.	4-6 Times	7-10 Times	More than 10 Times	
	45	51	9	2	107

Table 6.3 Times of employee exited the workplace environment for refreshment.

6.3 Data Analysis

The 107 responses occupying the highest ranked office in supporting productivity were shown and analyzed below to investigate the level of employee satisfaction over all 47 indicators by applying the related weighted formula for each one of them as following equation:

$$S_j = \frac{\left(\sum_{i=1}^{4} W_{ij} \; N_i\right)}{\sum_{i=1}^{4} N_i} \qquad \text{Where;}$$

(S_j), is the weighted mean response.

(N_i), is the count of occupant's responses to the satisfaction survey.

(W_{ij}), reflects the assigned weights of satisfaction rating statements (where i represents a weight ranging from 1 to 4) as shown in Table 6.4

Rate of satisfaction	Weight Value	Range of weighted mean
Strongly satisfied (SS)	4	3.50-4
Satisfied (S)	3	2.5-3.49
Dissatisfied (D)	2	1.5-2.49
Strongly dissatisfied (SD)	1	0-1.49

Table 6.4 Ranges of the weighted means

All the mean responses of all performance indicators, including their related rates of the occupant satisfaction, been tabulated and analyzed for technical elements, functional elements, and behavioral performance elements, as shown in Table 6.5 below.

No	ELEMENTS OF PERFORMANCE	EVALUATION TERMS				MEAN RESPONCE	DEGREE OF SATISFACTION
		STRONGLY DISSATISFIE (SD)	DISSATISFIE D (D)	SATISFIED (S)	STRONGLY SATISFIED (SS)		
A. TECHNICAL PERFORMANCE INDICATORS							
A1. THERMAL COMFORT							
1	Indoor temperature in winter	0	6	24	77	3.66	SS
2	Indoor temperature in summer	0	1	33	73	3.67	SS
3	Control over the indoor temperature	0	1	27	79	3.73	SS
4	Overall satisfaction with thermal environment	0	1	19	87	3.80	SS
A2. ACOUSTICAL COMFORT							
5	Level of noise from the lighting fixtures	0	1	39	67	3.62	SS
6	Level of noise from the HVAC system	0	3	27	77	3.69	SS
7	Level of noise from outside the building	0	1	24	82	3.76	SS
8	Overall satisfaction with acoustical environment	0	1	20	86	3.79	SS
A3. VISUAL COMFORT							
9	Amount of daylight	0	1	33	73	3.67	SS
10	Control over the amount of daylight	0	1	28	78	3.72	SS
11	Amount of artificial lighting	0	0	24	83	3.78	SS
12	Control over the amount of artificial lighting	0	0	22	85	3.79	SS
13	Overall perception of the quality of lighting in the building	0	0	20	87	3.81	SS
A4. INDOOR AIR QUALITY							
14	Adequacy of natural ventilation	0	1	23	83	3.67	SS
15	Adequacy of mechanical ventilation	0	1	22	84	3.72	SS
16	Ambient air Odor.	0	0	18	89	3.78	SS

17	Control over the ventilation level in the workspace	0	1	20	86	3.79	SS
18	Overall satisfaction with indoor air quality	0	0	15	92	3.81	SS

B. FUNCTIONAL PERFORMANCE INDICATORS							
B1. WORKSPACE DESIGN							
19	Adequacy of the workspace design for different work settings	0	2	29	76	3.77	SS
20	Fitness of the workstation to the user needs.	0	1	25	81	3.78	SS
21	Proximity of the workplace to nearby amenities	0	0	23	84	3.83	SS
22	Overall satisfaction with the building finishes.	0	0	24	83	3.79	SS
B2. WORKSPACE LAYOUT							
23	Adequacy of the circulation space.	0	1	26	80	3.74	SS
24	Adequacy of the way finding system and directional signs	0	0	21	86	3.80	SS
25	Workstation distribution within the workplace layout	0	0	22	85	3.79	SS
26	Workstation location relative to printers and IT shared equipment	0	0	21	86	3.80	SS
27	Access to a variety of different functions in the workplace.	0	0	18	89	3.83	SS
28	Efficiency of space utilization.	0	0	21	86	3.80	SS
29	Availability of personal storage within a workspace.	0	1	22	84	3.78	SS
30	Sufficiency of the space between the workstation	0	0	17	90	3.84	SS
31	Location and size of the cafeteria within the workspace	0	0	16	91	3.85	SS
B3. BUILDING SUPPORTIVE SERVICES							
32	Availability of documented facility management processes and strategies	0	1	21	85	3.79	SS
33	Adequacy of support services to the workforce.	0	1	20	86	3.79	SS
34	Adequacy of housekeeping measures.	0	1	17	89	3.82	SS
35	Adequacy of IT infrastructure.	0	1	16	90	3.83	SS
C. BEHAVIORAL PERFORMANCE INDICATORS							

C1. SAFETY AND SECURITY							
36	Adequacy of safety and security measures.	0	1	15	91	3.84	SS
37	Ease of identifying emergency/escape route.	0	1	16	90	3.83	SS
C2. Management and Maintenance							
38	Elevators (quality of finishes, travel speed, capacity and continuous runtime).	1	1	17	88	3.79	SS
39	Efficiency of handling user's complaints.	0	0	17	90	3.84	SS
40	Level of cleanliness of wash rooms.	0	0	14	93	3.87	SS
C3. Employees interaction with the workplace							
41	Employees involvement in the planning and design of the workspace	0	0	19	88	3.50	SS
42	Exterior and interior appearance of the building	0	0	18	89	3.83	SS
43	Adequacy of window view to the outside	0	0	17	90	3.84	SS
44	Adequacy of color schemes for different functions.	0	0	19	88	3.82	SS
45	Adequacy of places within a building designated for workers gathering.	0	0	15	92	3.86	SS
46	Ability to personalize the workspace.	0	0	18	89	3.83	SS
47	Availability of spaces that allow social interaction.	0	0	14	93	3.87	SS

Table 6.5 Performance elements and their satisfaction rates

Note(s): SS 5 Strongly Satisfied; S 5 Satisfied; D 5 Dissatisfied; and SD 5 Strongly Dissatisfied

6.4 Findings and Discussion

Based on the resulted data analysis for the whole of the responses to the survey and means calculations for each indicator as in Table 6.3.2, the analysis finding will be discussed and elaborated through the following sections

6.4.1 Technical Performance Indicators

1. **Thermal comfort:** This performance category has four elements as tabulated above, and the respondents responded were "strongly satisfied". These include indoor temperature in winter, indoor temperature in summer, control over the indoor temperature, and overall satisfaction with the thermal environment. During the walkthrough assessment of the building we felt a balanced thermal environment.

2. **Acoustic comfort :** It includes four indicators: level of noise from the lighting fixtures, level of noise from the HVAC system, level of noise from outside the building, and overall satisfaction with acoustical environment. The mean value ranged from 3.62 to 3.79 which implies that they are strongly satisfied with the building acoustical environment.

3. **Visual Comfort:** Consist of five performance indicators belong to amount of daylight, control over the amount of daylight, amount of artificial lighting, control over the amount of artificial lighting, and overall perception of the quality of lighting in the building. The mean responses ranged from 3.67 to 3.81, which implies a strong satisfaction with the visual comfort environment.

4. **Indoor air quality:** consist of five indicator: adequacy of natural ventilation, adequacy of mechanical ventilation, ambient air Odor, control over the ventilation level in the workspace, and overall satisfaction with indoor air quality. The mean

responses were ranged from 3.77 to 3.86, which indicates a strong satisfaction level with indoor air quality.

6.4.2 Functional Performance Indicators

1. Workspace design: consist of four indicators: adequacy of the workspace design for different work settings, fitness of the workstation to the user needs, proximity of the workplace to nearby amenities, and overall satisfaction with the building finishes. The resulting responses ranged from 3.69 to 3.79, which promote the strong satisfaction level with the design of the workspace.
2. Workspace layout: consists of nine indicators: adequacy of the circulation space, adequacy of the way finding system and directional signs, workstation distribution within the workplace layout, workstation location relative to printers and IT shared equipment, access to a variety of different functions in the workplace, efficiency of space utilization. , availability of personal storage within a workspace, sufficiency of the space between the workstation, and location and size of the cafeteria within the workspace. The resulting response means were ranges from 3.74 to 3.85, which indicates a high satisfaction with the layout of the workplace.
3. Building supportive services: This indicator has four elements: availability of documented facility management processes and strategies, adequacy of support services to the workforce, adequacy of housekeeping measures, and adequacy of IT infrastructure. The resulting mean for responses ranged from 3.79 to 3.83, which shows a strong satisfaction with the provided building supportive services.

6.4.3 Behavioral Performance Indicators

1. Safety and security: it contains two elements: the adequacy of safety and security measures and the ease of identifying an emergency/escape route. The mean responses were found 3.84 and 3.83 for the two elements, respectively, as this shows a strong satisfaction level with the safety and security performance indicators.
2. Management and maintenance: has three elements: quality of finishes, travel speed, capacity, and continuous runtime, the efficiency of handling user complaints, and the level of cleanliness of wash rooms. The responses were found to be 3.79, 3.83 and 3.87, which implies a high satisfaction with the implementation of management and maintenance behavior.
3. Employees interaction with the workplace: this indicator has seven elements which are employees involvement in the planning and design of the workspace, exterior and interior appearance of the building, adequacy of window view to the outside, adequacy of color schemes for different functions, adequacy of places within a building designated for workers gathering, ability to personalize the workspace, and availability of spaces that allow social interaction. The resulting response rate between 3.5 and 3.86 shows a strong satisfaction level resulted from employee interaction.

CHAPTER 7: CONCLUSIONS AND RECOMMENDATIONS

7.1 Summary

The study has shown with clear evidence that paying attention to the workplace environment by designers, consultants, and facility managers to its productivity elements of design, layout, design for employee interaction and engagement, indoor air quality, and building supportive services will bear fruit in getting a productive and satisfied employee.

The study synthesized the literature, including recent published papers, with the aim of identifying the employee's productivity-supportive factors within the workplace environment, which are then evaluated by the level of importance with the input of experts. The author developed a productive measure checklist to determine the productivity that a workplace under evaluation has. A post-occupancy evaluation of the highest-ranked productive workplace was then evaluated to prove the validity of a supportive workplace toward productivity and user satisfaction.

The study has revealed the significance of sustaining the most important factors of a productive workplace, which are safety and security measures, a qualified information technology infrastructure, indoor air quality, visual comfort, thermal comfort, and competent facility management, to positively influence productivity and grant user satisfaction.

The study also showed the importance of having a workplace design that considers the human beings need to engage through different work settings such as formal and informal meetings, social interaction, refreshment needs, and other behavioral performance indicators.

The study noted many differences in terms of the impact of factors on the productivity of employees in different countries, according to the literature review, and their impact on the productivity of local employees. The factors that have a high impact ranking on employee productivity based on the literature, such as the ability to personalize the workspace, the availability of personal storage, the provision of color schemes suitable for different functions, attracting places for gathering, and the proximity of the workplace to nearby amenities, have received the lowest degrees of attention in terms of impact on the productivity of local employees within the assessed list of factors.

In addition, the study identified direct linkage to sustainability as one of the introduced factors in the productivity compromise of the sustainability aspects of social, environmental, and economic aspects.

The knowledge presented in this research was limited to the workplace environments of knowledge workers at different scales and organizational sizes in Saudi Arabia.

7.2 Recommendations

The study provides practitioners, regulators, designers, and facility managers with a guide toward having a productive workplace through initiatives to improve the performance and quality of the built environment that can be summarized within the following recommendations:

1. Raising the consciousness of office building designers to the impact of the productivity

factors to be carefully implemented through the design

2. The importance of overseeing the latest post-occupancy evaluations of the designed office buildings to satisfy the needs of modern generations
3. The workplace designer should consider the impact of privacy needs in, the range of acceptable background noise, illumination level for the required tasks, circulation requirements, location of shared IT equipment, providing control over the immediate environment, and proximity of workstations to each other.
4. The window view and its content need to be considered as they impact the employee's productivity and satisfaction.
5. Having a divided work zone with 15 or fewer work stations will keep the environment supportive of productivity by eliminating background noise and sustaining qualified air quality.
6. Facility managers should pay attention to the recent development of IT and the required infrastructure to be implemented.
7. Paying attention to the modernized trends in the application of ergonomically designed furniture for different environmental patterns suitable for the required activities.
8. The facility manager needs to train and communicate the safety regulations at regular intervals.
9. The location of the canteen and refreshment needs to be selected and designed to serve the organization needs out of the employee's social interaction and human needs.
10. Facility managers should maintain qualified services, housekeeping measures, and up-to-date management processes to support organizational strategies.

7.3 Suggestions for Future Research

The suggestion for future research as a further step using this research output as a benchmark can be summarized as follows:

1. Perform many case studies with more respondents to enhance the measurement processes and provide strong validation for the existing methodology.
2. Perform research to establish a framework to design a productive workplace with the involvement of several experts.
3. Suggestions to conduct research on the factors affecting workers based on gender and generation.

Appendix A: Development of a Checklist for Workplace Productivity Measures.

The review of literature revealed with factors affecting the workplace support to productivity. Total of thirty one measures were identified as shown in table 2 to be applied later on among the selected case studies to get a conclusion of the percentage of productivity support.

No.	Productivity measures
1	Employees involvement in the planning and design of the workspace
2	Exterior and interior appearance of the building
3	Flexible design to accommodate change.
4	Functional workspace design for different work settings
5	Ergonomic design of the workstation and adequate size of workstation.
6	Proximity of the workplace to nearby amenities
7	Provision of window view to the outside
8	Provision of color schemes suitable for different functions
9	Provision of adequate circulation space
10	Provision of adequate way finding system.
11	Workstation distribution within the workplace layout
12	Workstation location relative to equipment
13	Access to a variety of different functions in the workplace.
14	Efficient space utilization
15	Attracting places within a building for workers gathering
16	Availability of personal storage within a workspace.
17	Ability to personalize the workspace
18	Availability of spaces that allow social interaction

19	Availability of spaces for formal and informal meetings
20	Availability of canteen for employee’s refreshment
21	Having a workspace acceptable acoustic climate
22	Provision of measures to eliminate visual disturbance
23	Provision of an acceptable thermal environment
24	Provision of sufficient ventilation
25	Provision of sufficient illumination level
26	Provisions of measures to control the indoor workplace environment
27	Availability of documented facility management processes and strategies
28	Provision of satisfactory services to the workforce
29	Provision of effective housekeeping measures
30	Provision of adequate safety and security measures
31	Provision of high quality information technology infrastructure

Appendix B: Checklist of Productivity Measures Including the Evaluation Terms

No	Productivity measure	Extremely Important (4)	Very Important (3)	Important (2)	Slightly Important (1)	Not Important (0)
1-Factors Related to workplace design						
1	Employees involvement in the planning and design of the workspace					
2	Exterior and interior appearance of the building					
3	Flexible design to accommodate change.					
4	Functional workspace design for different work settings					
5	Ergonomic design of the workstation and adequate size of workstation.					
6	Proximity of the workplace to nearby amenities					
7	Provision of window view to the outside					
8	Provision of color schemes suitable for different functions (design)					
2-Factors related to workplace layout						
9	Provision of adequate circulation					

	space					
10	Provision of adequate way finding system.					
11	Workstation distribution within the workplace layout					
12	Workstation location relative to equipment					
13	Access to a variety of different functions in the workplace.					
14	Efficient space utilization					
15	Attracting places within a building for workers gathering					
16	Availability of personal storage within a workspace.					
17	Ability to personalize the workspace(layout)					
3- Factors related to workplace layout						
18	Availability of spaces that allow social interaction					
19	Availability of spaces for formal and informal meetings					
20	Availability of canteen for employee’s refreshment					
4- Factors related to workplace interaction and engagement						

21	Having a workspace acceptable acoustic climate					
22	Provision of measures to eliminate visual disturbance					
23	Provision of an acceptable thermal environment					
24	Provision of sufficient ventilation					
25	Provision of sufficient illumination level (daylight and artificial light)					
26	Provisions of measures to control the indoor workplace environment					
5- Factors related to indoor environmental quality at the workspace						
27	Availability of documented facility management processes and strategies					
28	Provision of satisfactory services to the workforce					
29	Provision of effective housekeeping measures					
30	Provision of adequate safety and security measures					

31	Provision of high quality information technology infrastructure					

APPENDIX C: POE Qustionnaier Form

No	ELEMENTS OF PERFORMANCE	EVALUATION TERMS				MEAN RESPONCE	DEGREE OF SATISFACTION
		STRONGLY DISSATISFIE	DISSATISFIED	SATISFIED	STRONGLY SATISFIED		
		(SD)	(D)	(S)	(SS)		
A. TECHNICAL PERFORMANCE INDICATORS							
A1. THERMAL COMFORT							
1	Indoor temperature in winter						
2	Indoor temperature in summer						
3	Control over the indoor temperature						
4	Control of thermostate						
5	Overall satisfaction with thermal environment						
A2. ACOUSTICAL COMFORT							
6	Level of noise from the lighting fixtures						
7	Level of noise from the HVAC system						
8	Level of noise from outside the building						
9	Overall satisfaction with acoustical environment						
A3. VISUAL COMFORT							
10	Amount of daylight						
11	Control over the amount of daylight						
12	Amount of artificial lighting						
13	Control over the amount of artificial lighting						
14	Overall perception of the quality of lighting in the building						
A4. INDOOR AIR QUALITY							
15	Adequacy of natural ventilation						
16	Adequacy of mechanical ventilation						
17	Ambient air Odor.						
18	Control over the ventilation level in the workspace						
19	Overall satisfaction with indoor air quality						

B. FUNCTIONAL PERFORMANCE INDICATORS							
B1. WORKSPACE DESIGN							
20	Adequacy of the workspace design for different work settings						
21	Fitness of the workstation to the user needs.						
22	Proximity of the workplace to nearby amenities						
23	Overall satisfaction with the building finishes.						
B2. WORKSPACE LAYOUT							
24	Adequacy of the circulation space.						
25	Adequacy of the way finding system and directional signs						
26	Workstation distribution within the workplace layout						
27	Workstation location relative to printers and IT shared equipment						
28	Access to a variety of different functions in the workplace.						
29	Efficiency of space utilization.						
30	Availability of personal storage within a workspace.						
31	Sufficiency of the space between the workstation						
32	Location and size of the cafeteria within the workspace						
B3. BUILDING SUPPORTIVE SERVICES							
33	Availability of documented facility management processes and strategies						
34	Adequacy of support services to the workforce.						
35	Adequacy of housekeeping measures.						
36	Adequacy of IT infrastructure.						
C. BEHAVIORAL PERFORMANCE INDICATORS							
C1. SAFETY AND SECURITY							
37	Adequacy of safety and security measures.						
38	Ease of identifying emergency/escape route.						
C2. Management and Maintenance							
39	Elevators (quality of finishes, travel speed, capacity and continuous runtime).						
40	Efficiency of handling user’s complaints.						
41	Level of cleanliness of wash rooms.						

C3. Employees interaction with the workplace							
42	Employees involvement in the planning and design of the workspace						
43	Exterior and interior appearance of the building						
44	Adequacy of window view to the outside						
45	Adequacy of color schemes for different functions.						
46	Adequacy of places within a building designated for workers gathering.						
47	Ability to personalize the workspace.						
48	Availability of spaces that allow social interaction.						

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