



An Analysis of the Workplace Environment and Its Impact on Employee Health, Satisfaction, and Productivity in Jordan

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ABSTRACT

The purpose of this research is to investigate the impact of indoor environmental quality, behavioral, and functional factors on employee productivity and satisfaction in both open and closed office designs, as well as their relationship with building features and indoor environmental parameters. Literature review, questionnaire survey, and measurement of the indoor environment, were all used to collect data for this study. Statistical analysis was carried out using the SAS JMP program.

It was found that employees in closed offices have higher levels of satisfaction with their indoor environment and behavioral aspects of their workplace, whereas employees in open workplaces have higher levels of satisfaction with their functional components and indoor air quality. As the study further reveals, Jordanian employees generally prefer working in closed offices since they provide privacy, which directly affects their satisfaction and productivity.

Overall, the study emphasizes how occupant health, satisfaction, well-being, and productivity are affected by their office environment. When designing and selecting office spaces that prioritize employee satisfaction and productivity, architects and business owners can gain valuable insights from this study.

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INTRODUCTION

Limited natural resources and the small size of Jordan make its economy face great challenges. Thus, it has high costs since 96.5% of the energy is imported (Tewfik & Ali, 2014). Layout design plays a crucial role in improving efficiency and reducing costs in manufacturing and office environments, Building industry is finding it difficult to embrace new technological advancements because of unskilled workers, expensive tools and scanty financial support for R&D (Alwashah et al., 2024). In result, this has increased the number of people who go for white collar jobs in services leading to more than seventy five percent of GDP coming from the service sector resulting in a higher demand for offices (Altamimi et al., 2023).

An office environment has a significant impact on the productivity and satisfaction of its occupants. An improvement in the indoor environmental quality can improve productivity and satisfaction in both closed and open offices. Furthermore, it is affected by several functional and behavioral factors (Weerasinghe et al., 2024). Despite this, each workplace has its own requirements and needs that can affect the productivity and satisfaction of each employee and their ability to get work done, as indicated by (De Been and Beijer, 2014). In addition, Al-Omari and Okasheh (2017) emphasize the term office work-environment as the physical locations and immediate surroundings, including the work environment, the culture within the office, and collaboration among colleagues, all of which have an important impact on the wellbeing of employees, their productivity, and their health.

In manufacturing, the Design-office work space change is due to a shift towards specialized robotic and IT systems which in turn necessitate new industrial architecture (Horn, 2018), Smart manufacturing systems today are moving from rigid hierarchical models to flexible networks of interconnected components which will promote more agility, productivity and quality. (Lu et al., 2016), While e-commerce has been transforming the face of warehouse design and logistics, traditional office design space is integral in reinforcing organizational effectiveness and for attracting talent (Charlesworth et al., 2014).

Some of the major components that have an impact on the office work environment and affect occupant productivity and satisfaction in the Jordanian office environment include indoor environmental quality and behavioral and functional parameters (Bauer, 2015; Wargocki et al., 2000) An understanding of the relationship between these factors in the work environment can help designers and architects improve interior design for better performance in offices (Kegel, 2017). It is possible to increase the productivity and satisfaction of workers in this type of work environment by improving the indoor environmental quality and the workplace's design and layout (Frontczak, 2012).

The study examined two types of offices, open plan, and closed plan. It has been demonstrated by some researchers that closed-plan offices are private offices that are used by one or a few individuals (Seddigh, 2015; Bauer, 2015). Closed offices provide employees with a sense of privacy, allowing them to concentrate on their work more effectively (Soules, 2014; Bernstein and Turban, 2018). Furthermore, a closed office could negatively affect employee communication and make it difficult for managers to determine whether employees are still on task (Danielsson and Bodin, 2009).

In contrast, an open-plan office does not have any walls from floor to ceiling and does not have any interior borders. It is described as a large open space with workstations (Haynes, 2008). In addition, open-plan offices provide an environment that increases work efficiency and communication (Kamarulzaman et al., 2011), enhances air quality and natural lighting, and may offer views of the outdoors and enhanced aesthetics (Heerwagen and Zagreus, 2005). Open plan offices often fail to prevent employees from being exposed to unwanted sounds or losing control over their personal space (Gharaei and Ghomeishi, 2024). Several studies have addressed poor privacy conditions within the open-plan office, resulting in decreased employee satisfaction with their privacy, personal space, and proximity to their colleagues (Leder et al., 2016).

Jordan experienced a significant development in architecture parallel to the development of business, intellectual, and technological industries. It has been necessary to redesign the work environment of offices in Jordan to make them more suited to the needs of the workforce. Nowadays, work environments support new ways of working and flexible workplaces that allow easy communication and interpersonal access contrasting open-plan and closed office designs with ease of communication and interpersonal access. The office design concept was developed to provide a comfortable work environment and a high-quality workspace to promote a healthy lifestyle. Therefore, the problem here is not a lack of new organizations and companies, but poor environment set-up and poor management by owners which may provide workspaces deficient in safety, health, and comfort, which has made this research important in the region through its focus on these issues.

The study investigated the effects of different types of offices on employee behavior and perceptions. It also seeks to determine whether the office environment in Jordan affects the satisfaction and productivity of employees based on environmental, behavioral, and functional factors. Therefore, the study focuses on the development of a productivity and satisfaction index which will enable accurate measurement of employees' levels of satisfaction and productivity at work. The study includes an assessment of office design and layout, which are important factors in determining job satisfaction as well as productivity in the workplace.

CONCEPTS OF CLOSED AND OPEN OFFICES

In this study, the history of office design and its relationship to business development has been traced over many countries over a period of time, contrasting two main types of office organization across countries. In the beginning, there were no specific buildings designed for offices, but rather they were part of an architectural type known as a “Honeycomb” using small rooms that were not specifically designed for such purposes (Noorian, 2009; Rolfö et al., 2018; Irving, 2016). Until the late 19th century, office building design was not widely used until the invention and use of the telegraph and telephone (Soules, 2014; Choi, 2011).

The most popular theory in office building design, Taylor’s theory, focuses on generating low-cost production while providing maximum workspace for employees (Radziunaite, 2016). In the early 20th century, this theory was responsible for the emergence of the open-plan office, which became increasingly popular (Bos et al., 2017). During this period, architects also influenced the modern and international style of architecture, resulting in skyscrapers and tall buildings containing both types of offices.

In the early 1960s, the workplace began to change significantly in terms of social and interactive plans. This encouraged employees to interact with each other and participate in the workplace environment. This style of office design became known as the office landscape (Bauer, 2015; Rolfö et al., 2018). Later, in the mid-1960s, this type of office evolved into the action office, which provided improved work settings for employees and a circulation system that allowed free movement and greater privacy (Daniel, 2015).

In the 1980s and 1990s, the demand for flexible office buildings accompanied the availability of cheap, but efficient types of office space. In response, a new office design was created that consisted of workstations with partitions between each employee to provide more privacy (Seddigh, 2015). Since the end of the twentieth century, open plan offices have become more popular because they are cost-effective, encourage teamwork, and have flexibility for future needs (Radziunaite, 2016). Nowadays, modern workplaces tend to have warm colors, soft seating, and intimate lighting. Additionally, it emphasizes the comfort and well-being of employees (Shklyar & Vasilyev, 2017).

According to some popular architects in Jordan interviewed, offices began as small sections of houses that were later converted into enclosed buildings. This continued until the end of the 1990s. Due to the increasing awareness of new architectural styles during this time and the increasing number of experienced architects working in this field, office building design flourished during this period (Kutsevych, 2023). An office building with a restricted open-plan design was included in this development, protecting the privacy of the user, and respecting Jordanian cultural traditions.

In recent years, companies have increasingly developed open-plan offices in order to reduce costs, improve employee communication, and increase flexibility (Pilder, 2011).

WORKPLACE SATISFACTION AND PRODUCTIVITY

It was found in Liang et al. (2014) study that many factors may influence employee satisfaction at the workplace, including the office layout, the office arrangement, and the office furniture. Further, researchers have found that employee satisfaction is related to IEQ (Indoor Environmental Quality) factors (thermal comfort, acoustic level, lighting level, access to daylight, view, electric lighting, office layout, and gender combinations (Sakellaris et al., 2016; Bos et al., 2017). Increasing research has examined the relationship between the indoor environment (IEQ) and employee comfort and satisfaction, as well as how a lifestyle that combines employee satisfaction and indoor environmental quality may improve health and well-being (Frontczak and Wargocki, 2011).

Literature review revealed that the IEQ with its various parameters has a significant impact on user satisfaction and productivity, and it should be taken into account when designing an office building (Leblebici, 2012; Massoudi and Hamdi, 2017). These parameters may have an impact on productivity, production quality, waste levels, and turnover rates (Tharim et al., 2017). It has been hypothesized by several studies that an unsafe and insecure work environment leads to employee dissatisfaction and low productivity, leading to employee absences and delays, resource waste, rebellion, and other negative actions (Samani, 2015).

METHODOLOGY

A Sequential Mixed Research approach was adopted with greater emphasis on the quantitative phase (Goodrick, 2020). Phase one reviewed over 70 historical documents related to office development, which clarified indoor environmental quality, functional and behavioral parameters from which the main variables were derived. A second phase of the study consisted of a survey covering a specific sample of respondents, where the targeted population was surveyed using a questionnaire. Employee satisfaction and productivity were measured in ten different buildings in relation to factors affecting the work environment. Following a comprehensive review of previous research, the study was able to identify three main factors in the working environment, along with their sub variables, as shown in Figure 1. Moreover, a data monitoring method was used to measure the IEQ components by using various instruments and taking measurements relating to various factors that affect employee satisfaction with their workplace.

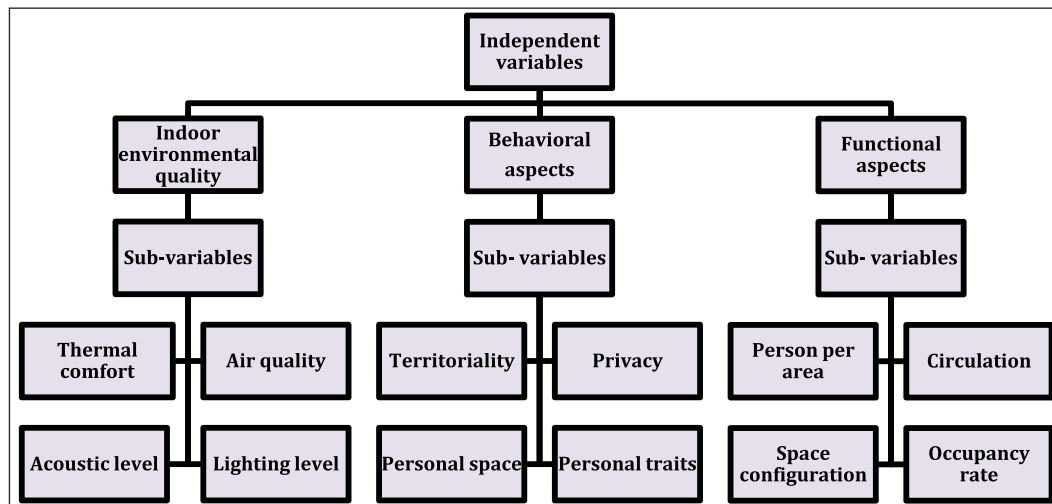


Figure 1 Work environment factors that affect employees.

OCCUPANT SURVEY DATABASE

For this study, employees working in 10 Jordanian companies selected for this purpose were surveyed about their satisfaction with the office working environment using a well-designed questionnaire survey. A total of 300 employees at each of the companies in both types of offices received questionnaires. The collected data was analyzed using SAS's JMP software.

We selected 150 employees from a closed office and 150 from an open plan design using a simple random sampling technique. In Irbid, the sampling of closed offices included the Municipality of Irbid headquarters, the Directorate of Education, and the Chamber of Commerce. Additionally, closed offices were used at the Commercial Bank, Ahmed al Tarawneh Construction Company, Mada Securities Company, and Engicon Construction Company. Staff from banks such as El-Etihaad and Jordan Commercial Bank were included in the open-plan office design.

The survey questionnaires were developed based on the most recent literature (Thiruchelvan, 2017; Frontczak and Wargocki, 2011; Stanley, 2016). An IEQ survey was conducted by the University of California, Berkeley Center for the Built Environment (CBE (Center for the Built Environment)). An explanation of the survey's purpose was included in the questionnaire.

Four major sections of the survey were used to measure satisfaction with the work environment based on its variables, such as the indoor environmental quality (thermal comfort, lighting level, acoustic and air quality) as well as behavioral variables (privacy, territoriality, personal space, personality). Many functional variables were also considered (persons per area, occupancy rate, space configuration, circulation), and confounding variables (gender, education level, age).

The target employees were asked about their working conditions and performance on a seven-point Likert scale

ranging from -3 "strongly dissatisfied" to +3 "strongly satisfied/strongly agree". As shown in Table 1, employers were asked to rate their workers' job performance on a Likert scale ranging from -3 "completely dissatisfied" to +3 "completely satisfied". From January to May 2022, the questionnaires were administered, and information was collected at the end of winter and spring. Offices were selected based on their type and function. The procedure was to arrange an appointment with each firm to administer questionnaires to employees.

PHYSICAL MEASUREMENTS AND MONITORED PARAMETERS RELATED TO IEQ

Based on their function, three types of instruments were used. As shown in Table 2, the Air Visual Node collected information on PM₁₀, CO₂, air temperature, and relative humidity. By using a laser sensor, this node can calculate the amount of pollutants and carbon dioxide in the air. Additionally, it displays a color-coded interface in the foreground screen, which indicates the indoor air condition in terms of the different percentages calculated from the monitored parameters. To determine the air quality index, PM₁₀ and CO₂ readings were used, and the air temperature and relative humidity were used to determine the IAQ (Indoor Air Quality) rating.

To measure the noise level in the work environment of both types of office buildings, we used the sound level meter model SL-4013. Acoustic measurements are performed with a sound level meter. To measure the sounds in an office environment, a hand-held instrument with a microphone is used to record the response to changes in air pressure caused by sound waves. Finally, the Extech 45170:4 in 1 environment meter was used to measure illumination levels. Using this tool, we can measure light intensity in the work environment using humidity, temperature, air speed, and light meter.

PARAMETER	QUESTIONNAIRE ITEM
Confounding parameters	
Gender	Male\female
Age	30 or less 50–31 More than 50
Hours of working per week	10 or less 11–30 More than 30
Work position	Administration Technical Supervisor Engineer Designer Governmental employee Other
Sensitivity in eyes and nose	Yes\no
Do you have asthma?	Yes\no
Environmental parameters	
Temperature	Too cold (–3) – Too hot (+3) Varies too much during the day (+3) – Not enough variation (–3)
Comfort level	Very Uncomfortable (–3) – very Comfortable (+3) Completely dissatisfied (–3) – completely satisfied (+3)
Air movement	Draughty (–3) – Still (+3)
Air quality	Humid (+3) – Dry (–3) Stuffy (–3) – Fresh (3) Smelly (–3) – Odorless (+3) Completely dissatisfied (–3) – completely satisfied (+3)
Light	Natural Light: Completely dissatisfied (–3) – completely satisfied (+3) Artificial Light: Completely dissatisfied (–3) – completely satisfied (+3) Reflection or glare: Glare (–3) – No glare (3) Light Overall: Completely dissatisfied (–3) – completely satisfied (+3)
Noise	Noise from outside the building: Completely dissatisfied (–3) – completely satisfied (+3) Noise from building systems (e.g., heating, plumbing, ventilation, air conditioning): Completely dissatisfied (–3) – completely satisfied (+3) Noise from within the building other than from building systems (e.g., phone calls, colleagues chatting, photocopiers, etc.): Completely dissatisfied (–3) – completely satisfied (+3) Noise overall: Completely dissatisfied (–3) – completely satisfied (+3)
View from window\importance of window	Strongly disagree (–3) – strongly agree (+3)
Functional parameters	
Office Layout	Overall satisfaction: Completely dissatisfied (–3) – completely satisfied (+3) Comfortable with colors\floors: yes\no Comfortable with office furniture: yes\no
Office Aesthetic	Completely dissatisfied (–3) – completely satisfied (+3)
Circulation System	Connectivity between function: yes\no Easy to reach spaces: yes\no Social places existence: yes\no
Amount of Space	Completely dissatisfied (–3) – completely satisfied (+3)
Behavioral parameters	
Amount of Privacy	Privacy in talking on phone never (–3) – always (3) Crowding existence, no\yes Completely dissatisfied (–3) – completely satisfied (+3)
Personal Space	Flexibility: Strongly disagree (–3) – strongly agree (+3) Satisfaction: Completely dissatisfied (–3) – completely satisfied (+3)
Territoriality	Productivity in own office: Strongly disagree (–3) – strongly agree (+3) Connectivity between colleagues: Strongly disagree (–3) – strongly agree (+3) Commitment: yes\no Completely dissatisfied (3–) – completely satisfied (+3)
Personal traits	Personal qualities: Strongly disagree (–3) – strongly agree (+3) Satisfaction: Completely dissatisfied (–3) – completely satisfied (+3)

Table 1 List of parameters assessed in the questionnaire survey.

CATEGORY	DEVICE	QUANTITY	PARAMETER	ACCURACY
IAQ	Air visual Node	1	AQI	–
			CO ₂ (PPM)	30 ppm + 3% of measured value
			PM10 (µg/m ³)	4 µg/m ³ (+/-) 0.8 µg/m ³
ITC	Air visual Node	1	Air temperature (Celsius)	(+/-) 0.05 Celsius
			Relative Humidity (RH%)	(+/-) 2%
IL	Light Meter	1	Interior luminance level	(Lux) + or – 3%
IAP	Sound Meter	1	Noise Level (dB)	–

Table 2 Devices utilized for obtaining indoor environmental measurements.

As part of this context, physical analysis consists of evaluating the office layout and arrangement of workspaces. The measurement includes the occupant's personal space (size of desk, etc.), window wall ratio, and personal working space based on the office layout: number of workstations or room size. Mobile applications that allow measurement of length and width are used to calculate this. Further, it is important to calculate the circulation in offices to determine what the ideal percentage should be compared with other offices.

DESCRIPTION OF THE CASE STUDIES

As part of the study, closed offices were examined, particularly government buildings such as City Hall and private organizations such as Commercial Bank and Ahmed al Tarawneh Construction Company. There were primarily open plan offices found in construction companies such as Engicon Construction Company, as well as banks such as El Etihad and Jordan Commercial Bank. A variety of office layouts and furniture arrangements related to window locations were studied in this research. Visibility and accessibility were also assessed for each type of office. In this study, it was determined that closed offices, favored primarily by government offices and some companies in Jordan, were the most popular office types. This was primarily because of the opportunity for privacy that it affords, and the work performed by each department. as shown in Table 3.

Several open-plan office prototypes, including several departments, have been studied in Jordanian construction companies and banks as part of this study. As shown in Table 4, each department performs a variety of functions and has several groups working on a variety of projects. Communication between these groups varies according to the type of projects under consideration.

ANALYZING JORDANIAN OFFICE BUILDING PROTOTYPES

It was studied that office buildings existed in the cities of Amman and Irbid. The evolution of office buildings in Jordan was traced, and the most popular prototypes were identified. The following sections present the most common prototypes.

ANALYSIS OF CLOSED OFFICE PROTOTYPES

These prototypes were designed to optimize the user experience and maximize the use of space. They were tested for efficiency, comfort, and productivity in a range of office settings. Results showed that the prototypes were successful in meeting the design goals.

Table 3 illustrates the most common prototypes of closed offices in Jordan.

Prototype A: This is a single closed office for administrative staff, usually occupied by one individual. This layout provides a sense of privacy and minimizes distractions. Generally, employees in this type of office score it highly in terms of satisfaction with the space provided, circulation and lack of noise disturbance, which leads to higher productivity levels. Offices rely on natural lighting and ventilation rather than central heating and cooling, with a WWR ranging from 12% to 57%. However, the furniture was deemed uncomfortable due to its age and wear, as the government offices are offices are generally old.

Prototype B: This model provides a shared office space used by two employees, allowing each to have a personal and storage area of about 10 square meters and a circulation area of about 5.5 square meters. The office has natural light, is soundproof, and is equipped with the necessary technology to facilitate remote work. It also includes a kitchenette and a small library. To facilitate collaboration and communication among co-workers, the design of the office desk allows the worker to take various positions relative to the other colleague. Some offices had comfortable and well-maintained furniture, while others did not. Natural lighting, ventilation or fans are commonly used by employees. Workspaces in old buildings are less satisfied with privacy than prototype A, but productivity is better.

Prototype C: This prototype had a lower level of privacy than prototypes A and B, as well as less satisfaction regarding sound interference and air quality, which are related to the number of employees and the size of the office. As well as natural lighting, this type of office also relies primarily on artificial light for greater visual comfort. The employee had an area of 8 meters per person for personal and storage space, and 5.5 meters for circulation.

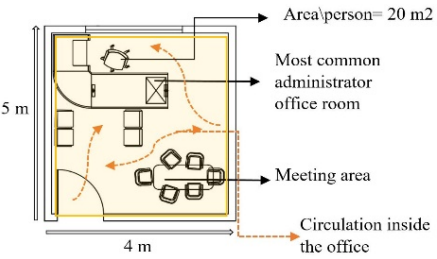
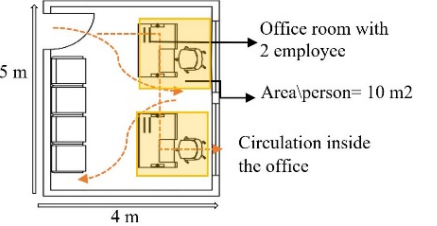
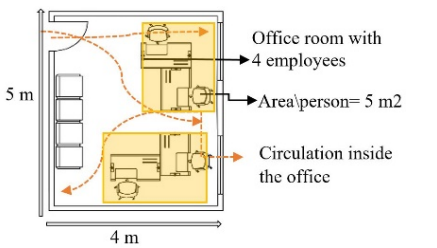
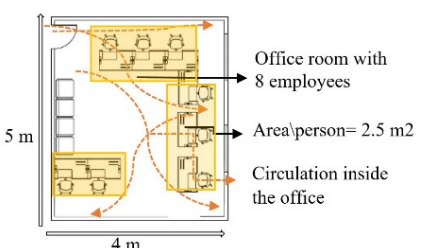
DESCRIPTION	CLOSED OFFICE PROTOTYPE
General layout: closed plan with full height walls or partitions dividing the space into offices and support space by floor to ceiling partitions (walls) with doors. Layout according to the job function: All administrators at these buildings are allocated in single closed offices which are next to the offices of senior staff. The rest of the employees share offices, with the number of employees per office increasing as the level of responsibility in the job decreases	Prototype A:  Area\person= 20 m² Most common administrator office room Meeting area Circulation inside the office
Spatial arrangement: a group of employees in each department is in the most adjacent area: Larger departments take up several floors, located above each other to limit the walking distance within the department as much as possible.	Prototype B:  Office room with 2 employee Area\person= 10 m² Circulation inside the office
Circulation: In the closed plan design circulation is through the corridors space.	Prototype C:  Office room with 4 employees Area\person= 5 m² Circulation inside the office
WWR: windows in all prototypes range between 12%–57%.	Prototype D:  Office room with 8 employees Area\person= 2.5 m² Circulation inside the office

Table 3 Closed office prototypes in Jordan.

Prototype D: The prototype D design provided a minimum personal space of 2.5 square meters per colleague and an area for circulation of 5.5 square meters for eight or more colleagues. There was a lower level of satisfaction with privacy, sound distraction, and air quality than in the other prototypes. This resulted in a lower productivity level. Because some offices are located far from windows, the lighting system relies entirely on artificial light. Some buildings have natural ventilation systems, while others employ air conditioning systems.

ANALYSIS OF OPEN-PLAN OFFICE PROTOTYPES

The most common open office prototypes in Jordan are shown in Table 4.

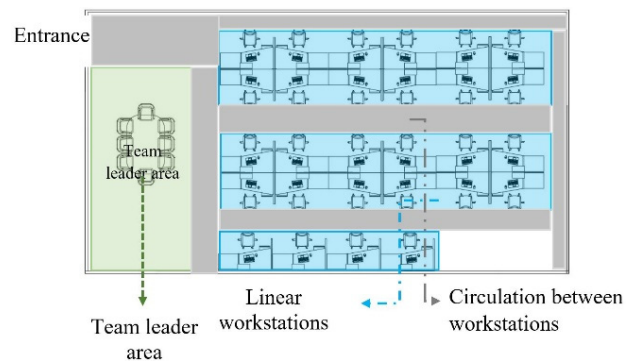
Prototypes A and B: The prototypes A and B allow employees to move freely between workstations. Various

designs and configurations of modular desk units are available, and the maximum number of employees can range from 20 to 45, and the circulation area can range between 16.3 and 24.3 square meters. Due to the glazed façade, the office is naturally illuminated. However, some employees were not positioned near the windows, so artificial light was found. Central heating and cooling are required to provide clean air through the ventilation system. With this type of layout, more employees can be accommodated with the maximum use of space, resulting in an area of 1.8 to 2.87 square meters per person, combined with 7.2 to 11.48 cubic meters of air per person. The employees were satisfied with the office design in the companies and banks visited because they were all new and modern with comfortable furniture. Nevertheless, some employees were dissatisfied with the

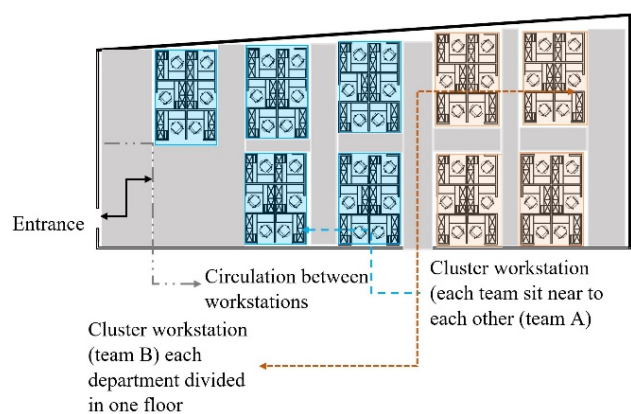
DESCRIPTION

Layout: Open plan here provides greater opportunity to maximize the utilization and minimize the circulation space required between workstations. It also provides communication and interaction for information- sharing, discussion, collaboration, and teamwork in one department, with linear and cluster workstations.

WWR (Window to Wall Ratio): Windows are open to the space with fixed glazed façade for natural lighting with WWR range between 27% and 88%.

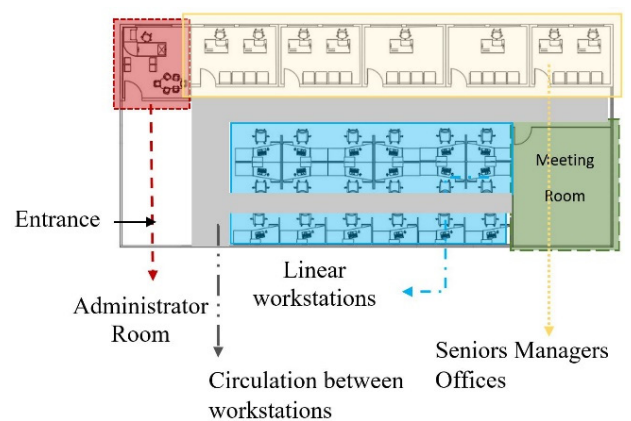
OPEN PLAN PROTOTYPES**Prototype A:**

Number of employees: Ranges from 20 to 45 employee in workstations

Prototype B:

Layout: General arrangement for workstations is linear and cluster. In a closed plan full height walls or partitions divide the space into offices with glazed walls and doors.

WWR: An open plan concept here locates all workstations in an open space without divisions and with fixed and portable glazed facades that open to the interior spaces with a WWR range from 27% to 69%.

Prototype C:

Number of employees: The range is from 15–20 employees in workstations and 1–4 employees in each closed office.

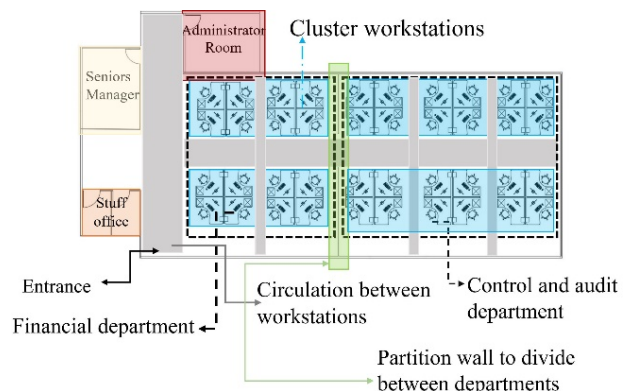
Prototype D:

Table 4 Open office prototypes in Jordan.

sound and visual distractions, while others were content to be with their group members. As shown in Table 3 these layouts were fully open with each department occupying one floor and all the administrative offices located on the same story, which provided an environment where employees were free to work without restrictions. Additionally, not all employees had access to fixed and moveable glazed facades and the WWR ranged from 27% to 69%. However, shade treatments were available. Patios were available for employees but were situated near the cafeteria.

Prototypes C and D: These prototypes combine private closed offices for administrative personnel and managers with open workstations for employees. In prototype C, the closed offices faced the workstations where supervisors controlled all the work and could observe the employees, which resulted in some employees feeling stressed and demotivated. However, prototype D gives staff the opportunity to work freely because the managers' offices do not overlook the open-plan space. There were between 15 and 20 employees in these two prototypes. Each floor had a circulation area between 7.5 and 16.3 square meters.

The open space in prototype C is at the center of the floor. As most windows are in the managers' offices, the other staff are forced to rely more on artificial light since most are in the managers' offices. The ventilation system here was central heating and cooling. This type of layout also allows more employees per square meter, allowing 2–2.88 square meters per person. The air supply was between 10 and 14.4 cubic meters per employee. The employees in the companies and banks visited were satisfied with their overall office design because all of them were up-to-date and modern and had comfortable furniture.

ANALYSIS AND RESULTS

This study was conducted using a questionnaire and a physical analysis to gather data from respondents. For statistical analysis, JMP software is used. This analysis was performed in the first stage using a subset of data arranged into four sections: IEQ components, behavioral components, and functional components. To determine a formula for calculating satisfaction and productivity based on the differences between mean and standard deviation, a general regression model was applied. T-tests were administered to determine the differences between the sections based on the type of office. Simple linear regression was employed to determine a correlation between productivity and satisfaction. To compare the data monitoring related to the IEQ components in the two types of offices in the second part of the analysis, general regression was used.

For all the tests, the results were considered statistically significant when $p < 0.05$.

ANALYZING EMPLOYEE RESPONSES TO THE QUESTIONNAIRE

The database contains information about demographic characteristics of survey participants. This study was conducted between January and May 2022. Each organization was sampled for eight hours a day from 8am to 5pm during working hours. Based on the collected responses, the following table summarizes the frequency of the following gender parameters: 139 respondents are male (46.3%), and 161 respondents are female (53.7%). The table also shows that most employees are aged 50 or less, with 276 out of 300 employees. It also shows the number of years employees have worked at the same company, 126 for more than five years and 128 from one to five years. Another area shows the work pattern of the employees with 243 working from 11–30 hours and more per week. The highest number of employees working in administration and having other work is shown in Table 5, where 199 employees work in these positions.

In general, the answers to the above questions were negative regarding smoking habits, sensitivity to the eyes and nose, asthma, colds, or general illness. As part of each questionnaire section, it was examined whether the answers to the personal questions were related to overall satisfaction of employees. This study used a significance level of 0.05 as the acceptable level of significance. There is no significant difference between the results of these questions and those of the other sections of the questionnaire.

SATISFACTION WITH WORK ENVIRONMENT COMPONENTS AND PRODUCTIVITY OF EMPLOYEES

To determine the relationship between workplace components and job satisfaction and productivity, a correlation analysis was conducted. Based on the results shown in Table 6, these conditions had a significant positive relationship with job satisfaction and productivity for both types of office layout.

Using Wilcoxon/Kreskas-Wallis, we conclude the results show a significant difference between the two types with respect to the space configuration with a p-value of 0.0245, indicating that employees in closed offices are more satisfied with their work. Additionally, there was a significant difference between employees in closed and open offices' circulation systems, with open office employees being more satisfied and productive than those in closed offices. According to the table, the office design did not impact employees' satisfaction in either type of office. However, open offices with a mean of 5, were more productive than closed offices with a mean of 3.52.

PERSONAL CHARACTERISTIC	CATEGORIES	EMPLOYEES TOTAL NUMBER (N%)	EMPLOYEES IN CLOSED OFFICES (N%)	EMPLOYEES IN OPEN PLAN OFFICES (N%)
Gender	Male	139 (46.3%)	64 (42.7%)	75 (50%)
	Female	161 (53.7%)	86 (57.3%)	75 (50)
Age	≤30	122 (40.6%)	45 (30%)	77 (51.3%)
	31–50	154 (51.3%)	90 (60%)	64 (42.7%)
	>50	24 (8%)	15 (10%)	9 (6%)
Employment duration	≤1 year	46 (15.3%)	30 (20%)	16 (10.6%)
	1–2 year	52 (17.3%)	20 (13.3%)	32 (21.3%)
	3–5 year	76 (25.3%)	29 (19.3%)	47 (31.3%)
	>5 years	126 (42%)	71 (47.3%)	55 (36.6%)
Weekly working hours	≤10 hours	57 (19%)	37 (24.7%)	20 (13.3%)
	11–30 hours	52 (17.3%)	32 (21.3%)	20 (13.3%)
	>30	191(63.7%)	81(54%)	110 (73.3%)
Work position	Administration	120 (40%)	56 (37.3%)	64 (42.7%)
	Technical	21 (7%)	11 (7.3%)	10 (6.7%)
	Supervisor	25 (8.3%)	13 (8.7%)	12 (8%)
	Engineer	26 (8.6%)	11 (7.3%)	15 (10%)
	Designer	11(3.6%)	3 (2%)	8 (5.3%)
	Government	18 (6%)	18 (12%)	0
	Others	79 (26.3%)	38 (25.3%)	41 (27.3%)
Smoking habits	Non-smokers	198 (66%)	99 (66%)	99 (66%)
	Smokers	102 (34%)	51 (34%)	51 (34%)
Employees' experience of sensitivity in eyes and nose	No	183 (61%)	82 (54.7%)	101 (67.3%)
	Yes	117 (39%)	68 (45.3%)	49 (32.7%)

Table 5 Personal Statistics based on Questionnaire Responses.

FUNCTIONAL PARAMETERS	JOB SATISFACTION/ PRODUCTIVITY	CLOSED OFFICE		OPEN OFFICE		T-TEST
		MEAN	STANDARD DEVIATION	MEAN	STANDARD DEVIATION	p-VALUE p < 0.05
Functional aspects						
Space configuration	Job satisfaction	3.2	1.72	2.6	1.51	0.0245
Circulation system						
Satisfaction with the location in the building and the proximity to utilities and facilities.	Job satisfaction	3.33	2.044	4.97	1.79	0.0285
Estimation of increase or decrease in productivity with relation to the circulation system.	Job productivity	4.06	2.01	5.627	1.57	0.0281
Office design						
Satisfaction with the arrangement of offices and the design of workplace.	Job satisfaction	3.38	2.1	4.99	1.84	0.0623
Estimation of increase or decrease in productivity as an impact of office design.	Job productivity	3.52	1.92	5	1.97	0.0267

Table 6 Mean, Standard deviation and p-value for satisfaction with functional parameters and productivity in both types of office.

The findings show in Table 7 that the satisfaction of employees with the thermal comfort in the closed office was greater, with mean 5.55, than in open offices with mean 4.12. As a result, productivity was not affected. Furthermore, employees' satisfaction with the cleanliness and purity of the air in open offices was higher than that of closed offices. Productivity was not

affected by indoor air quality. A significant difference in satisfaction and productivity was found, however, in relation to light and acoustic levels, with greater satisfaction and productivity in open offices related to the lighting system ($p = 0.0111$). Due to unsatisfactory acoustic levels in open offices, employees were not satisfied and less productive.

ENVIRONMENTAL PARAMETERS	JOB SATISFACTION/ PRODUCTIVITY	CLOSED OFFICE		OPEN OFFICE		T-TEST
		MEAN	STANDARD DEVIATION	MEAN	STANDARD DEVIATION	p-VALUE p < 0.05
Thermal comfort						
Satisfaction with the temperature in the workspace.	Job satisfaction	5.55	1.929	4.12	1.855	0.0275
Increase or decrease in productivity related to temperature in the workplace	Job productivity	5.1	1.98	4.7	1.85	0.4031
Indoor air quality						
Satisfaction with the quality of air in workspace (e.g., dirty, stale air, cleanliness, odors)	Job satisfaction	4.5	1.948	5.5	1.83	0.0323
Estimation of productivity increase or decrease related to the quality of air	Job productivity	4.92	2.03	4.91	1.759	0.6548
Lighting Level						
Satisfaction with the visual comfort of lighting (e.g., glare, reflections, and contrast in lighting).	Job satisfaction	3.45	1.78	4.88	1.65	0.0165
Estimation of productivity increase or decrease in relation to lighting	Job productivity	4.23	1.72	5.67	1.57	0.0203
Acoustic level						
Satisfaction with the noise level in workspace	Job satisfaction	5.61	1.89	4.15	1.71	0.0111
Estimation of productivity increase or decrease in relation to noise level	Job productivity	5.36	1.63	4.17	1.98	0.0212

Table 7 Mean, Standard deviation and p-value for satisfaction with environmental parameters and productivity in both types of office.

BEHAVIORAL PARAMETERS	JOB SATISFACTION/ PRODUCTIVITY	CLOSED OFFICE		OPEN OFFICE		T-TEST
		MEAN	STANDARD DEVIATION	MEAN	STANDARD DEVIATION	p-VALUE p < 0.05
Privacy Level						
Satisfaction with privacy in workspace.	Job satisfaction	4.513	1.93	3.08	1.74	<.0001
Estimation of productivity increases or decreases according to the level of privacy within the workspace.	Job productivity	5.88	1.88	4.23	1.74	0.0295
Personal space						
Satisfaction with the possibility of modifying employee offices.	Job satisfaction	5.4	2.1	4.12	1.95	0.0580
Estimation of productivity increase or decrease related to employee's personal space.	Job productivity	5.2	1.748	5.14	1.72	0.9033

(Contd.)

BEHAVIORAL PARAMETERS	JOB SATISFACTION/ PRODUCTIVITY	CLOSED OFFICE		OPEN OFFICE		T-TEST
		MEAN	STANDARD DEVIATION	MEAN	STANDARD DEVIATION	p-VALUE p < 0.05
Territoriality						
Employees' satisfaction with the sense of belonging to their workplace.	Job satisfaction	5.2	1.89	4.28	1.73	0.0893
Increase or decrease of productivity according to employee's sense of belonging.	Job productivity	5.57	2.1	4.39	1.71	0.0248
Personal traits						
Satisfaction related to personal qualities of colleagues in the work environment.	Job satisfaction	5.01	1.7	4.95	1.67	0.4944
Estimation of productivity increases or decreases because of personal qualities within the workspace.	Job productivity	5.39	1.67	5.35	1.54	0.5809

Table 8 Mean, Standard deviation and p-value for satisfaction and productivity with relation to behavioral parameters in both types of office.

WORK ENVIRONMENT PARAMETERS	SATISFACTION FORMULA
Functional parameters	
Satisfaction with circulation system	$1.272 - 0.369 * \text{Getting the workplace easily} - 0.223 * \text{easy access} - 0.276 * \text{circulation design} + 0.672 * \text{movement between facilities} - 0.108 * \text{office type}$
Satisfaction with office design	$4.086 - 0.729 * \text{Office Furniture} - 0.439 * \text{design elements} + 0.294 * \text{Office Design} - 0.086 * \text{office type}$
Satisfaction with space configuration	$1.232 - 0.269 * \text{space layout}$
Environmental parameters	
Satisfaction with thermal comfort	$0.31 + 0.174 * \text{temperature in winter} + 0.127 * \text{humidity} + 0.144 * \text{air circulation} - 0.467 * \text{thermal control} + 0.285 * \text{differences in employees' temperature} + 0.371 * \text{comfort Level} + 0.128 * \text{temperature inside office} + 0.36 * \text{office type}$
Satisfaction with IAQ	$-0.24 + 0.153 * \text{air flow} + 0.086 * \text{Office ventilation in summer} + 0.106 * \text{office cleanliness} + 0.256 * \text{ventilation System} + 0.404 * \text{Indoor ventilation} - 0.61 * \text{office type}$
Satisfaction with lighting level	$1.124 - 0.166 * \text{natural Light} + 0.371 * \text{electrical light} + 0.387 * \text{amount of daylight} - 0.01 * \text{office layout}$
Satisfaction with acoustic level	$5.67 - 0.172 * \text{distracted noise} - 0.376 * \text{noise level} - 0.21 * \text{equipment Noise} - 0.045 * \text{office type}$
Behavioral parameters	
Satisfaction with privacy	$2.677 + 0.359 * \text{work privacy} - 0.174 * \text{noise level} + 0.294 * \text{employee distraction} + 0.474 * \text{Office Layout} + 0.316 * \text{Employ privacy} - 0.269 * \text{Closing device} + 0.255 * \text{office type}$
Satisfaction with personal space	$0.41 + 0.333 * \text{Personal spaces needs} + 0.292 * \text{Personal items} + 0.292 * \text{possibility of modifying office} + 0.097 * \text{office type}$
Satisfaction with territoriality	$0.451 - 0.234 * \text{Owning workspace} + 0.219 * \text{Identity of workplace} + 0.349 * \text{Employee more productive in the workplace} + 0.288 * \text{Employee Commitment} + 0.236 * \text{office type}$
Satisfaction with personal traits	$0.953 + 0.163 * \text{employee collaborative} + 0.277 * \text{job preferences} + 0.372 * \text{personal grow} - 0.022 * \text{office type}$

Table 9 Satisfaction formula for each factor in the office work environment.

It can be concluded from the findings in Table 8 that there is a significant difference in opinions regarding privacy levels: $p .0001$ indicates that the opinion of the respondents is that private offices are preferred over open offices because employees are more satisfied with them. Furthermore, the closed office had a significantly greater

productivity rate in relation to territoriality than the open office p -value 0.0248, whereas the job satisfaction was not affected by territoriality in the closed office. However, there were no significant differences in satisfaction and productivity related to the personal space provided and personal traits experienced in the different office types.

OVERALL SATISFACTION AND PRODUCTIVITY FORMULA

By using a general regression model, the study determined that certain constructs are significantly related to satisfaction with each of the office work environment parameters. As indicated in Table 9, some constructs were significant in relation to satisfaction with each of these parameters.

Each parameter in the satisfaction formula (functional, environmental, and behavioral) contains a number of factors that are significant in affecting employee satisfaction with their work environment as shown in Table 9. Functional parameters include: satisfaction with the circulation system, overall office design, and space configuration. Employee satisfaction with the circulation system was primarily affected by the ease with which employees could access their office facilities, while other factors, such as the layout of the offices or the ease of access between offices, played a lesser role. Secondly, satisfaction with the office design was primarily determined by the overall interior and exterior design, followed by the design elements, surface finishes, and office furniture. Finally, the office's configuration was determined by the office space's layout.

Among the environmental parameters that affect the employees' level of comfort most is their satisfaction with thermal comfort, which includes differences in temperature between offices, the temperature of the office in winter, and the direction of the airflow. The air flow, office ventilation in summer, and office cleanliness had a less significant impact on satisfaction with indoor air quality than the office indoor ventilation and ventilation system. In terms of lighting satisfaction, daylight, electrical light, and natural light were factors, whereas acoustic satisfaction was dependent on distraction from noise produced by colleagues, although distraction from echoes and movement of equipment and furniture had a lesser impact.

Finally, the behavioral parameters associated with employee satisfaction with privacy were determined by the employees' preference for a closed or open office environment. On the other hand, the main factors that affected satisfaction with personal space were the possibility of modifying the office and having privacy to use personal items. Employee satisfaction with aspects of territoriality is influenced by the perception that the employee is productive at work, the sense of employee commitment and the sense of ownership. Lastly, satisfaction with personal traits was influenced by factors such as personal development within the organization and job preferences.

Overall Satisfaction (closed/open) = S. office layout + S. circulation + S. space configuration + S.IAQ + S. thermal comfort + S. lighting + S. acoustic + S. privacy + S. territoriality + S. personal space + S. personality traits.

The study applies a simple linear regression to determine the correlation between satisfaction and productivity in both type of offices to know if satisfied employees will be productive, based on the overall satisfaction with IEQ, behavioral and functional aspects. Figure 2 illustrates a relationship between satisfactions toward the employees work environment conditions and their productivity.

The following formula determines the overall satisfaction in both closed and open offices and every factor has a specific percentage that affects the employee's overall satisfaction.

$$\begin{aligned} \text{Overall Satisfaction (closed/open)} = & S. \text{ office layout} \\ & + S. \text{ circulation} + S. \text{ space configuration} + S. \text{IAQ} \\ & + S. \text{ thermal comfort} + S. \text{ lighting} + S. \text{ acoustic} \\ & + S. \text{ privacy} + S. \text{ territoriality} + S. \text{ personal space} \\ & + S. \text{ personality traits} \end{aligned}$$

The study applies a simple linear regression to determine the correlation between satisfaction and productivity in both type of offices to know if satisfied employees will be productive, based on the overall satisfaction with IEQ, behavioral and functional aspects. Figure 2 illustrates a relationship between satisfactions toward the employees work environment conditions and their productivity.

The model for each type of office to determine the overall productivity is developed as follows:

$$\begin{aligned} \text{Overall productivity (closed/open)} = & 23.233 + 0.51 \\ & * \text{Overall satisfaction (closed/open)} \end{aligned}$$

SATISFACTION AND PRODUCTIVITY INDEX AND WORK ENVIRONMENT

Table 10 below presents the overall satisfaction of employees with their work environment components, and productivity. The results show the differences in mean levels of satisfaction, with IEQ mean in closed offices 5.3, greater than in open plan 4.5 and the

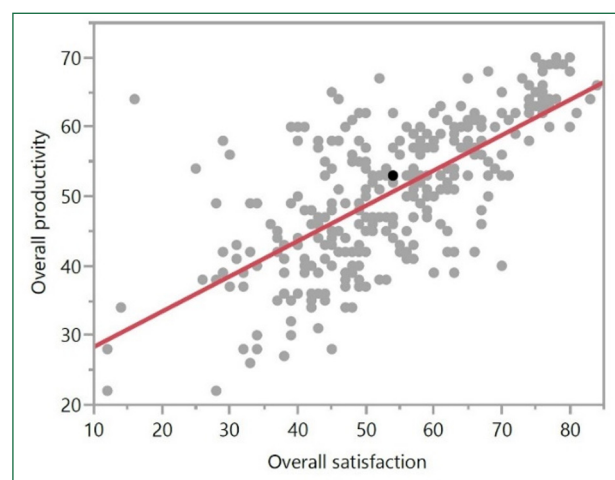


Figure 2 Relationship between Satisfaction and Productivity.

productivity in close office 5.2, more than in open office 4.3. Like the outcomes of satisfaction and productivity regarding behavioral components, the mean levels show different degrees of satisfaction with the closed office mean 5 and productivity mean 5.71, while in open office the satisfaction mean 3.9 and the productivity mean 4.5.

The dashed squares in Figure 3 represent overall satisfaction with functional components. The mean level of satisfaction in the open-plan office is 4.8, which is higher than the mean level in the closed office at 3.8. Moreover, the productivity means with functional components in open plan is 5.3, while in closed offices 3.81. This is linked to the modern design of open-plan offices in companies and the condition of their furniture.

An employee satisfaction index is a convenient way of measuring the level of satisfaction employees have with their work environment. A satisfaction index attempts to measure how employee satisfaction influences performance within the organization (Koshy, 2018). However, employee satisfaction is determined by factors related to the work conditions of everyday life at work, including the benefits and work environment (Edmans et al., 2024).

A productivity index is a measure of the potential or ability to produce work in companies according to certain conditions in the work environment.

$$\text{Productivity index} = \text{Overall productivity/hours worked}$$

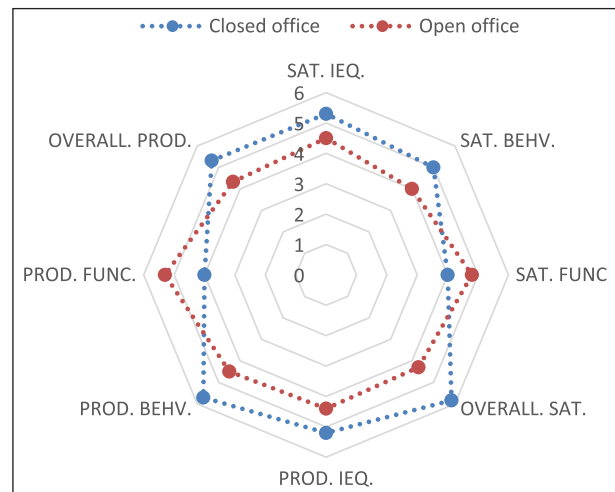


Figure 3 Overall satisfaction and productivity with reference to work environment components.

GENERAL COMPARATIVE ANALYSIS BETWEEN CLOSED AND OPEN-PLAN OFFICES BASED ON MONITORED PARAMETERS

To determine the correlation level between the monitoring results and the questionnaire results, the parameters in Figure 4 below were measured for every employee in closed and open-plan offices to create a correlation between them. In order to compare the parameters of the two types of offices, a t-test has been used based on the accepted level of significance of 0.05.

OFFICE TYPE	SATISFACTION				PRODUCTIVITY			
	SAT IEQ MEAN	SAT BEHV. MEAN	SAT FUNCT. MEAN	OVERALL SAT MEAN	PROD IEQ MEAN	PROD BEHV. MEAN	PROD FUNCT. MEAN	OVERALL PROD MEAN
Closed office	5.3	5	3.8	5.84	5.2	5.71	3.81	5.32
Open-plan office	4.5	3.9	4.8	4.3	4.4	4.5	5.3	4.33

Table 10 The overall mean levels of satisfaction and productivity.

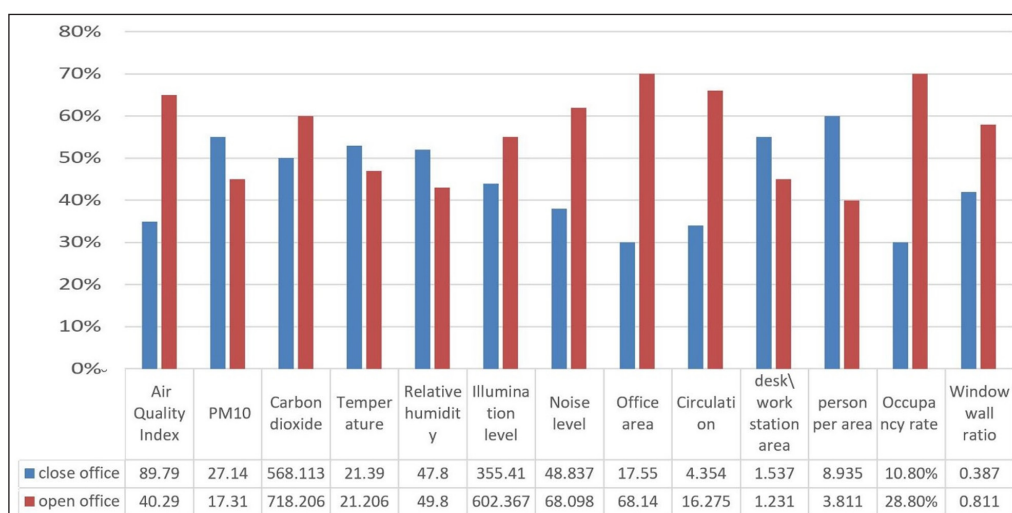


Figure 4 Differences in mean levels of measurements between closed and open-plan offices.

Closed offices have an average Indoor Air Index of 89.79, which compares favorably to open-plan offices, which have an average Indoor Air Index of 40.29. In both offices, the Indoor Air Index is between 1–100. As shown by the table, the PM10 reading is much higher in closed office designs, with 27.14 micrograms/m³, compared with the same reading in open-plan offices at 17.31 micrograms/m³. There is a lower mean CO₂ level in closed offices, 568.113 ppm, which indicates a good ventilation system and adequate air circulation. On the other hand, the mean CO₂ level in open offices is 718.206, which is still within the standard.

Both types of offices exhibit similar temperatures as well as close relative humidity readings, with a difference of 2%. The level of illumination in closed offices is within the standard range at 355.41 lux. However, the illumination level in open-plan offices, 602.367 lux, exceeds the requirements at both ends of the spectrum. In addition, the WWR of 0.387 in the closed design is less than in open offices where it stands at 0.811 and this difference between the illumination level and WWR relates to factors such as the orientation of buildings, the use of curtains and blinds and the location of the employee in the office.

The monitoring results also demonstrate that the noise level in closed offices is lower than the noise level in open offices, where it rises to 65.098 dB, demonstrating that closed offices provide a quieter working environment. As a result of the findings, there is a significant difference between the mean surface area of closed offices at 17.55 square meters and that of open-plan offices at 68 square meters, which meets the objective of this office design with an occupancy rate of 10.8% for closed offices and 18.9% for open offices.

Open plan offices have a circulation area of 16.275 m², larger than closed-plan offices, which have a circulation area of 4.354 m². This is a result of the floor area and number of workstations. Closed offices have similar desk areas to open-plan offices. On the other hand, closed offices have an average personal space per square meter of 8.935 square meters, which is significantly greater than the average personal space in open plan offices of 3.81 square meters. There may be a connection between this and the number of employees in the office.

DISCUSSION

According to the summary of earlier studies, there may be some similarities regarding employee satisfaction and productivity in Jordan offices. Researchers have demonstrated an interest in studying the parameters of indoor environmental conditions and building features. The satisfaction of office building occupants has been the subject of earlier studies. As indicated in the results of the survey, the most dissatisfying features of open-

plan offices in Canada were the acoustics, thermal comfort, and air quality. Furthermore, building occupants expressed the lowest degree of satisfaction with noise and conversational privacy. This may be attributed to the fact that most of the responses were collected in open-plan offices. The results indicated that satisfaction and productivity were significantly lower with acoustic privacy in open offices than in single offices (Candido et al., 2019; Kwon et al., 2017; Kok et al., 2015; De Been and Beijer, 2014). According to this study, occupants of open-plan offices are more satisfied with the quality of air than those of closed offices.

To determine which self-assessed parameters, influence the overall satisfaction of occupants with their workspace, this study attempts to identify these parameters. By understanding the priorities of building occupants, guidelines can be provided to building constructors and renovators so that building occupant satisfaction can be increased (Al Horr et al., 2016). In this study of 300 office workers, it was found that satisfaction with functional parameters was higher in open-plan offices since most of these offices were newly constructed and modern. This finding was consistent with earlier findings of (Rasheed et al., 2019), who carried out the study among 67 office workers in which the following parameters were ranked in order: air quality and ventilation, privacy, noise level, temperature, lighting, size of workstations, and window access. This may be due to differences in the methodology of the studies. In this study, statistical analysis was conducted to estimate the extent to which workspace satisfaction is related to satisfaction with the parameters of workspace.

Linear regression and the t-test were used in this study to investigate the relationship between workspace satisfaction and satisfaction with indoor environmental quality parameters and building features. This study employs the same method as the present study, which demonstrates the correlation between noise levels, visual privacy, indoor air quality, thermal comfort, lighting, and employee satisfaction and productivity. This confirms that these factors influence occupant satisfaction and productivity in any office setting (Shahzad et al., 2017). Another study confirmed that the satisfaction of office occupants linearly correlates with their productivity when all indoor environmental parameters are considered (Massoudi and Hamdi, 2017).

CONCLUSION

Employees in closed offices in Jordan are satisfied with the following elements of their work environment: thermal comfort, acoustic level, space configuration, privacy, territoriality, personal space, and personal characteristics. The nature of respondents' work, their expectations regarding concentration, respondents' desire for privacy,

and respondents' culture are all contributing factors. According to respondents in open-plan offices, interior air quality, office design, circulation system, and lighting levels were generally satisfied with work environment components. Additionally, colleagues in private offices were more able to control the environment in their work environment than their colleagues in open-plan offices.

Considering the fact that there are few studies that evaluate the influence of the office environment on employee satisfaction in Jordan, it is necessary for us to conduct a study in which we examine the differences between open and closed plan office designs and how they affect employee satisfaction and productivity. A comprehensive understanding of the way work environment and office design affect employee behavior can be developed through this project. This will be beneficial for architects, interior designers, business owners, and even employees themselves. In addition, this study may serve as a foundation for a series of future studies which would examine topics such as gender, job type, position, culture, and personal preferences, along with some of the parameters selected for this thesis (environmental, behavioral, functional) and how these factors influence employee satisfaction and productivity in Jordanian office buildings.

This research mainly investigates the potential impact of workplace design (open offices and closed offices) on employee performance using field study. This study examines the role of indoor environmental quality (IEQ), as well as their behavioral and functional factors, to predict employee well-being in different office settings. Data were collected by questionnaires, indoor environment measurements and studies of literature. The statistical analysis was performed by SAS JMP. The results show that, in general, Jordan employees tend to closed offices for the privacy which enhance their productivity and job satisfaction. The study also drives home the close relationship between office design and employee welfare, health and productivity. The work suggests that architects and business owners may need to think about this data while designing their future flexible workplaces.

COMPETING INTERESTS

The authors have no competing interests to declare.

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