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Literature Review Article

The effect of indoor environmental quality on the productivity of factory workers: A case of pharmaceutical factories in Southwest Nigeria

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ABSTRACT

The indoor environment of pharmaceutical factory building is known to be a very active place with industrial equipment, machineries, full of light, noise, particulate matter, and other gaseous elements. Having this all-in-one place can be a challenge to the wellbeing and possibly the productivity of the workers of the factory. As a result, the study investigated the effect of indoor environmental quality (IEQ) on the productivity of the pharmaceutical factory workers. This review of relevant literature from e-books, articles, conference proceedings, technical reports, textbooks, thesis and periodicals was conducted between 2010-2022. 14 pharmaceutical factories were investigated within 13 months (October 2020-November 2021). The factors of indoor environmental quality influencing workers' wellbeing as well as their productivity, were thoroughly investigated using a strategic procedure. It was discovered that the factors involved in a pharmaceutical factory building's IEQ and the productivity factors of the workers were complex and diverse. This paper concludes that the previous studies reviewed do not show that indoor environmental quality of PFB have any significant impact on the productivity of the pharmaceutical factory workers.

Keywords: indoor environment quality; pharmaceutical factory buildings; workers' wellbeing; workers' productivity

1. INTRODUCTION

Both Sreekumar et al., (2018) and Ali et al., (2013) agree that workers' productivity in manufacturing industries is a major challenge. According to Sreekumar et al., (2018), the productivity of workers is the most important factor influencing the growth of industries. This is due to its impact on operating costs and return on investment. In this light, indoor environmental quality (IEQ) is important to consider because it determines the working conditions in the factory building. According to Ali et al., (2013), working conditions in a manufacturing factory are positively associated with employee productivity. This implies that in factory buildings the productivity of workers and the IEQ can be interdependent.

Froman (2010) advanced that productivity is psychological, as a measure of progress toward something real. Carrasquel (2019) identified employee engagement, work environment, and technology use as the three factors influencing workers' productivity. The purpose of this research is to determine the magnitude of the effect of IEQ on the productivity of pharmaceutical factory building (PFB) workers in South-Western Nigeria. This is consistent with Stocker et al., (2015)'s explanation that the factors for productivity may differ from one country to the next due to variations in growth, for example, in most of the sources assessed by Stocker et al., (2015), labor productivity has grown the fastest in inverse variation to resource productivity, which has grown the slowest. While Vargas and Garrido (2022) added that productivity is dependent on workers' psychology (state of mind),

According to Kamaruzzaman and Sabrani (2011), studying IEQ is complex and involves many variables. This involves reflects the breadth of IEQ in the built environment. The study also stated that IEQ is important in the design of building spaces in order to achieve low energy consumption and high levels of indoor comfort. According to Abdulaali et al., (2020), because of its importance, there is a need for a better understanding of IEQ, its parameters, and how it affects the inhabitants of the building space. Okanya et al., (2021) added that the IEQ of any part of a building can have an impact on the people who live there. Thus, studies have revealed that the influence in the building cannot be overstated.

2. METHOD

This article was developed through a review of carefully collecting and examined literature related to the subject field. This was designed to compile progressive literature from many sources such as e-books, essays, journals, internet resources and field work conducted for 13months between October 2020 and November 2021 in Lagos and Ogun states in southwest, Nigeria. The contexts covered in this analysis began with a look at the nature of industrial building employees' work, followed by the identification and survey of the elements that influence IEQ using handheld measuring instruments such

as Multifunctional Air Quality Detector, Digital Sound Level Meter and Digital Lux Meter AS803. And, finally, the recognized consequences on the occupants of structured spaces. Reviews were also conducted to examine the primary factors influencing worker productivity. These reviews were completed by finding and linking the effects of indoor environmental quality on worker productivity in pharmaceutical factory buildings.

3. RESULTS AND DISCUSSION

3.1 Indoor Environmental Quality Factors

The complexity of the research of the indoor environmental quality was underlined by Kamaruzzaman et al., (2011), who cited the multitude of elements impacting it as part of the issue. According to Asadi and Hussein (2014), the cost of building maintenance, occupants' efficiency, energy consumption, and occupants' health records can all be influenced by indoor environmental quality (IEQ). In agreement with Asadi and Hussein (2014), Kamaruzzaman et al., (2017) confirmed that inadequate IEQ has an impact on the comfort, health, performance, productivity, satisfaction, and well-being of building occupants. Volatile organic compounds (VOCs), lighting, natural ventilation, thermal quality, acoustic conditions, and indoor air quality (IAQ) were highlighted by (Shuang, 2011) as major IEQ elements that influence building occupant activity. Physical, chemical, and biological agents have a large impact on these IEQ parameters. Asadi and Hussein (2014) classified IEQ elements based on the impact on light level, indoor air quality, noise level, and thermal comfort. Kamaruzzaman et al., (2017) classified the elements influencing IEQ and thus health into seven categories: acoustic comfort factors, building-related factors, climate condition factors, indoor air quality factors, occupants' factors, thermal comfort factors, and visual comfort factors. Figure 1 indicates certain IEQ factors' perceptions of factory workers at the two extremes, for example thermal condition at the extremes can either be too cold or too hot.

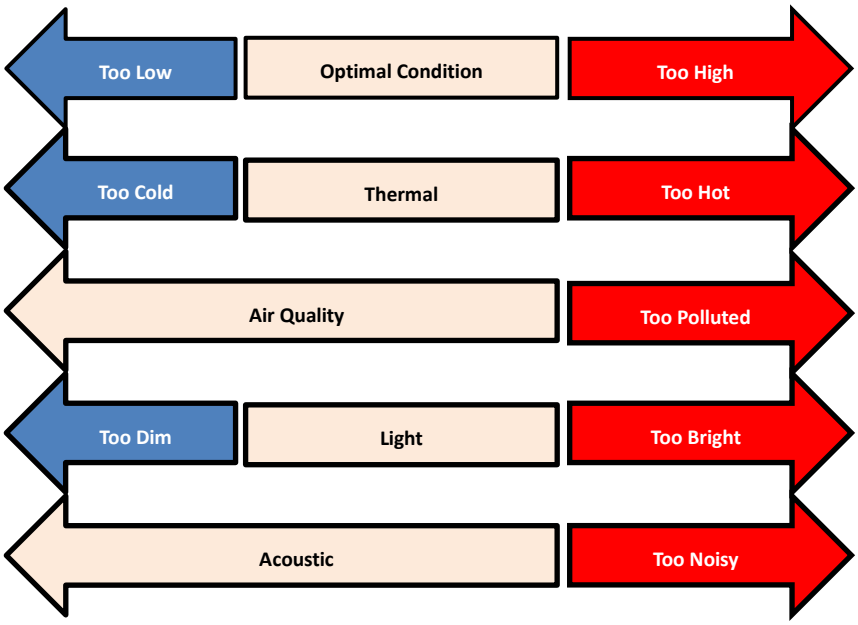

Figure 1. The Effects of Various Conditions of IEQ Factors on the Perception of Workers

Source: Esfandiari et al., (2017)

3.2 Lighting Quality

Among these characteristics, research has revealed that building occupants are dissatisfied with low daylight, which causes visual discomfort and can decrease productivity (Kamaruzzaman et al., 2011). Esfandiari et al., (2017) also stated that studies have demonstrated that natural light and high-quality light have the power to boost workers' output, wellbeing, and perceptions of satisfaction and comfort.

3.3 Indoor Air Quality

According to the Indoor Air Quality Association, indoor air quality (IAQ) is the airborne constituents of air in buildings, chemical characteristics (presence of gaseous contaminants such as CO, Radon, and VOCs), and physical characteristics (air temperature and humidity), which have a distinct distress for the effect on occupant health and comfort. According to the EPA (2014), Indoor Air Quality (IAQ) is a result of contact between building occupants, the building system, climate, construction techniques, pollutant sources, and the site. According to Esfandiari et al., (2017), the IAQ has a direct relationship with worker well-being and has a significant impact on budgets.

3.4 Thermal Condition

The thermal state of an IEQ, as measured by temperature, has a significant impact on human psychology and physical condition, which can affect both worker behaviour and productivity (Esfandiari et al., 2017).

3.5 Acoustic Control

Unpleasant noise from outside, the mechanical system in the building, inhabitants, and customers may reduce productivity in particular types of work and have a direct impact on workers' well-being and psychology (Esfandiari et al., 2017).

3.6 Effects of IEQ on Building Occupants

The UL enterprise technical brief (2016) elaborated on interior environmental quality (IEQ) and building performance, stating that the building envelope effects the comfort of the indoor space's occupants, as well as helping to reduce accidents and provide healthy environments. According to Haghlesan et al., (2013), different biological, chemical, and other environmental vulnerabilities exist in indoor environments. Bacteria and viruses are two examples of biological vulnerabilities that are infectious. In addition to IAQ, Khan (2017) stated that IEQ considers pollutants, economic stressors, illumination, noise, and overcrowding in an indoor environment. According to Bawa et al., (2022a), IAQ can have an impact on the well-being of factory workers. While Jung et al., (2021), stated that the World Health Organization (WHO) standard for formaldehyde (HCOH) is 100g/m3, whereas the WHO standard emission for TVOC is 500g/m3, which can be influenced by materials on portions of the building space in the indoor environment. Contaminant gases and particles from machinery, construction operations, water-damaged building materials, microbiological development (fungal, mold, and bacterial), insects, and outside pollutants all have an impact on IEQ and, as a result, occupant health (Khan, 2017). Indoor environmental quality, according to Haghlesan et al., (2013), influences the thermal, olfactory, or sensory comfort, health, and job productivity of building inhabitants. As a result, poor IEQ may allow pollutants such as formaldehyde to enter the environment and cause ailments such as the common cold, influenza, Legionnaires' disease, asthma, eye irritation, nose irritation, throat irritation, skin irritation, sick building syndrome (SBS), and allergies (Muddari, 2010). According to Haghlesan et al., (2013), earlier research has revealed that the interior environment contains allergenic elements, which is linked to the rise in asthma cases in society.

3.7 Indoor Environmental Quality and Workers' Productivity

Productivity was defined by Goel et al., (2017) as the ratio of output generated to inputs used. According to Gikonyo (2017), the productivity of an organization's employees is determined by performance appraisal, leadership, motivation, and learned skills. While Ailabouni et al., (2010) stated that better productivity indicates the optimum use of labour resources, which includes an increase in the accuracy of the cost to build, profits, employee morale, and employer-employee relations. Environmental factors, Group factors, Organizational factors, and Personal factors are among the factors influencing productivity, according to the study. Ailabouni et al., (2010) further noted that environmental factors which include the IEQ, have an influence on an organization and cause it to move in a way to suit the environment and ultimately affecting the productivity while Bawa et al., (2022b) added that the IEQ in some ways can affect the productivity of Factory workers.

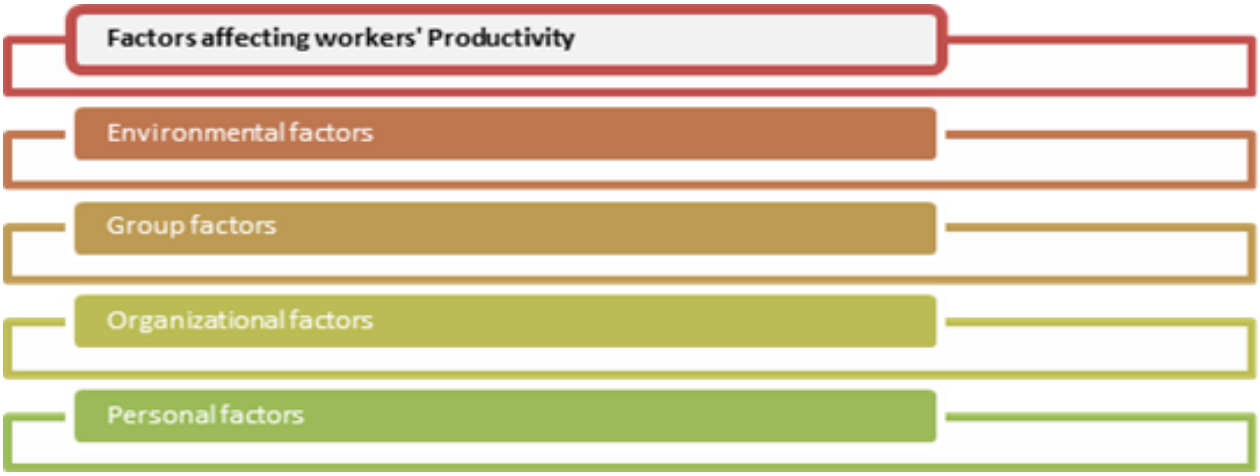

Figure 2. The Effects of Various Conditions of IEQ Factors on the Perception of Workers

Source: Ailabouni et al., (2010)

Jobs with Justice Education Fund (2016) demonstrated how appropriate management of the working structure allows workers to perform to their full potential. Workers' productivity is linked to the level of rivalry found in the nature of the manufacturing sector where companies are located. According to Esfandiari et al., (2017), factors influencing IEQ can decrease worker productivity; similarly, Khan (2017) stated that the sources of indoor environmental contaminants and their treatment can be useful in preventing or addressing building-related worker health symptoms. As a result, there is a link between the indoor environmental quality and the health of the workers and, as a result, their productivity, which is consistent with (Fisk 2002). According to Onyeizu and Byrd (2014), the effects of poor equipment, poor management, work relationships, and workers' health are apparently competitively contesting the importance of the IEQ on workers' productivity, despite the fact that workers' productivity is also complex and difficult to truly define in the context of a work environment.

4. CONCLUSION

According to studies, complex interrelated factors such as acoustic comfort factors, building-related factors, climate condition factors, indoor air quality factors, occupants' factors, thermal comfort factors, and visual comfort factors influence the cost of lifecycle of buildings, comfort, satisfaction, efficiency of building occupants, energy consumption, and health and well-being. A built environment's IEQ is generally determined by the indoor air quality, light quality, thermal condition, and acoustic control. Indoor Environmental Quality (IEQ) and building performance have an impact on human comfort and, as a result, the health and productivity of building occupants. In conclusion, while the studies presented are not completely persuasive, there are assertions that point out by implication that the IEQ can affect worker productivity.

RECOMMENDATIONS

The paper recommends a need for re-evaluation of the architecture of PFBs intending to provide a healthy working environment for its workers in Nigeria.

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AUTHOR'S CONTRIBUTIONS

The author discussed the results and contributed to from the start to final manuscript.

CONFLICT OF INTEREST

The author declare that he has no competing interests.

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