Journal of Research Administration
Society of Research Administrators International

# THE ROLE OF INDOOR ENVIRONMENTAL QUALITY ON HUMAN HEALTH, COMFORT, PERFORMANCE, AND PRODUCTIVITY FOCUSING AND MANAGEMENT INFORMATION SYSTEM ON INDOOR AIR QUALITY, AND ITS RELATIONSHIP WITH THERMAL, ACOUSTIC, LIGHT, AND VENTILATION: AN EMPIRICAL ANALYSIS

**LI Xin**
**Zhang Miaoran**
**Zhu Bo**
**Han Zhaopeng**
**Lincoln University College, Malaysia**

## Abstract

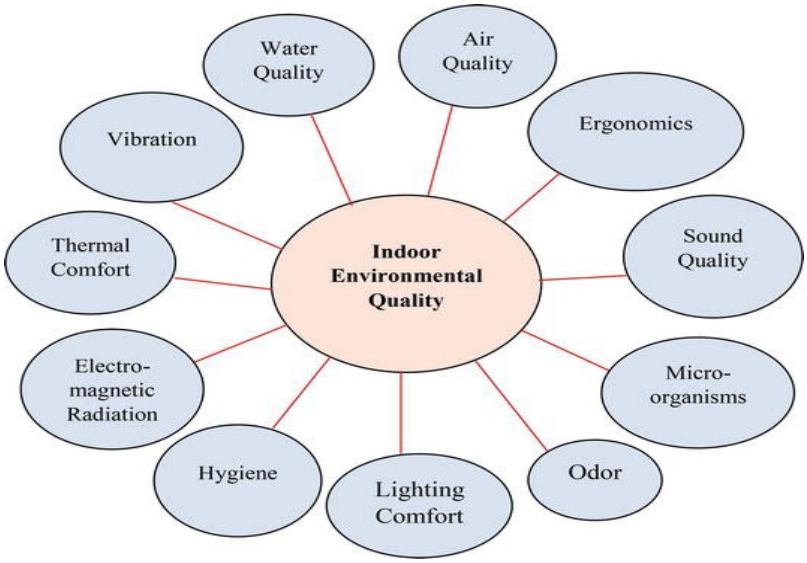
Indoor environmental quality (IEQ) and its effect on occupant thriving and comfort is a huge space of study. This paper presents a state-of-the-art concentrate through an expansive overview of the composition, by setting up joins among IEQs and inhabitant thriving and comfort. Extent of issues, for instance, weakened design condition, indoor air quality warm comfort, visual comfort, and acoustic comfort is considered in this paper. The complexity of the association between occupant comfort and thriving limits with IEQ is furthermore exacerbated as a result of the associations that these limits have with each other as well. In view of the audit of writing there it is set up that the plan of structures needs to consider tenant prosperity boundaries directly toward the start. Some great practices in this load of various regions have likewise been featured and archived in this paper. The information set up as a component of this paper would be useful for analysts, creators, specialists, and offices support engineers. This paper will likewise be of incredible advantage to analysts who attempt to embrace research around here and could go about as a decent beginning stage for them.

## Introduction

Human beings are always feeling comfortable in indoor environments because their nature is created in this way. The focus area will be indoor environmental quality and its relations with ventilation. The study has an objective to propose the new way forward to overcome the ventilation issue to improve indoor environmental quality by checking the relationship with ventilation with productivity, and comfort. A study was conducted in which links were established between indoor environmental quality and comforts of employees. Many issues were identified for example, debilitated structure disorder, indoor air quality warm solace, visual solace, and acoustic solace. To overcome the issues different solutions were highlighted for researchers, designers, and engineers. The most popular solution was to develop green buildings for improving the air quality. The other solution is enhancing ventilation to reduce air pollution. The air supply rates are the source of improving the airquality (Mohammad *et al*., 2021; Al horr*et al.*, 2016). The ventilation reduces sick building syndrome. The objective of this

examination is to survey diverse exploration on indoor natural quality to foster a connection between the boundaries which impacts wellbeing and efficiency in indoor climate possibly it is private climate or office climate. The base necessities to apply measures for indoor ecological quality assessment was likewise assessed in this article. The study aims to provide the comprehensive overview of research carried out on indoor air quality (Mujan*et al.*, 2019).

Any Building cannot be completed without good environmental quality. The building designs should meet the international standards and courts for implementation of indoor environmental quality. Separate guidelines have been developed for every factor of indoor environmental quality either its thermal, visual, acoustic etc. Still there is a need to create guidelines for multifactor so that, all factors can be catered through same document (Mahdavi *et al.*, 2020). Indoor ecological quality is ahead which has certain subheads inside it which incorporates indoor air quality (IAQ), lighting, warm solace, acoustics, drinking water, ergonomics, electromagnetic radiation, and many related variables has displayed in the figure beneath (Mujeebu, 2019).




The improvement in environmental quality can improve the quality of life for mankind. Different studies focused on the importance of relationship of indoor environmental quality with satisfaction of employee'sbecause it effects the employee health. Employees are the most reliable source for getting know how on what effect their health and what comfort they need (*Indoor Environmental Quality - an overview | ScienceDirect Topics*, no date).

The properties of indoor environmental quality are examined in much research. The researchers also examined the symptoms of sick building syndromes and measure taken to avoid them. In America, a lot of work has been done to examine the minimal accepted ventilation rate. The reasons for disorder condition are radon, asbestos, lead, carbon dioxide, formaldehyde, radon, asbestos, lead, carbon dioxide, formaldehyde (Mohammad and Khassawneh, 2022; Kubba, 2017).

The center of health design defines the evidence-based design for making decisions and outcomes of indoor environmental quality. This design helps the building and its employees to implement features that are important for health and productivity. This evidence-baseddesign has

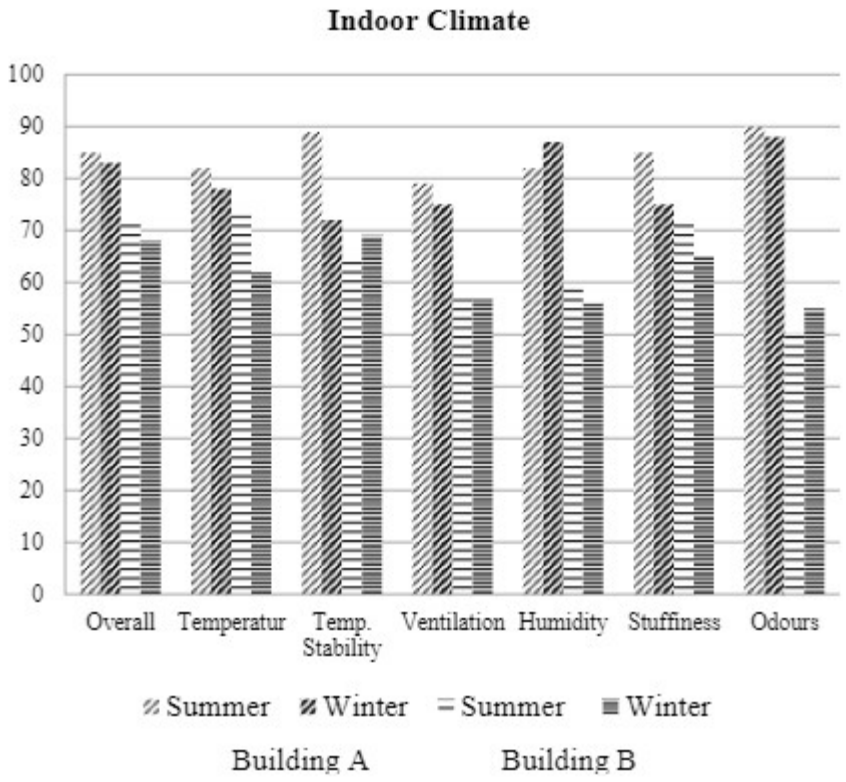
reduced cost and improve productivity. It became a cause of decreasing hospital stays of patients. The evidence-based designers collaborate with clients and develop solutions to meet client expectations and healthy environment (Bayer, 2015).

Qualitative research was conducted to find out the relation between indoor air environment and productivity of workers. The researchers considered qualitative research more elaborative than quantitative research. The efficiency rate due to improve IEQwas increased from 2.8% to 9.5%. similarly, numerous individuals keep up alterations in efficiency are very little and to be brought about by IEQ. IEQ is a source of increasing the employee commitment with their workplace it also forms a strong bond of employees with their management information system because of the increase in productivity (Abdou, no date).

Good indoor environmental quality puts a positive effect on health, productivity, and betterment of employees. It gives a substantial growth to the organization. Researchers have highlighted many strategies to provide high quality indoor environments. But it should be kept in mind there are many other factors that enhance employee's productivity (Paevere, 2018).

Indoor environmental quality is frequently focused during COVID-19 as the schools and buildings were ventilated properly to provide visual and acoustic comfort. COVID-19 has impacted the naturally ventilated schools and buildings less is compared to those which were not ventilated naturally (Kapoor *et al.*, 2021).

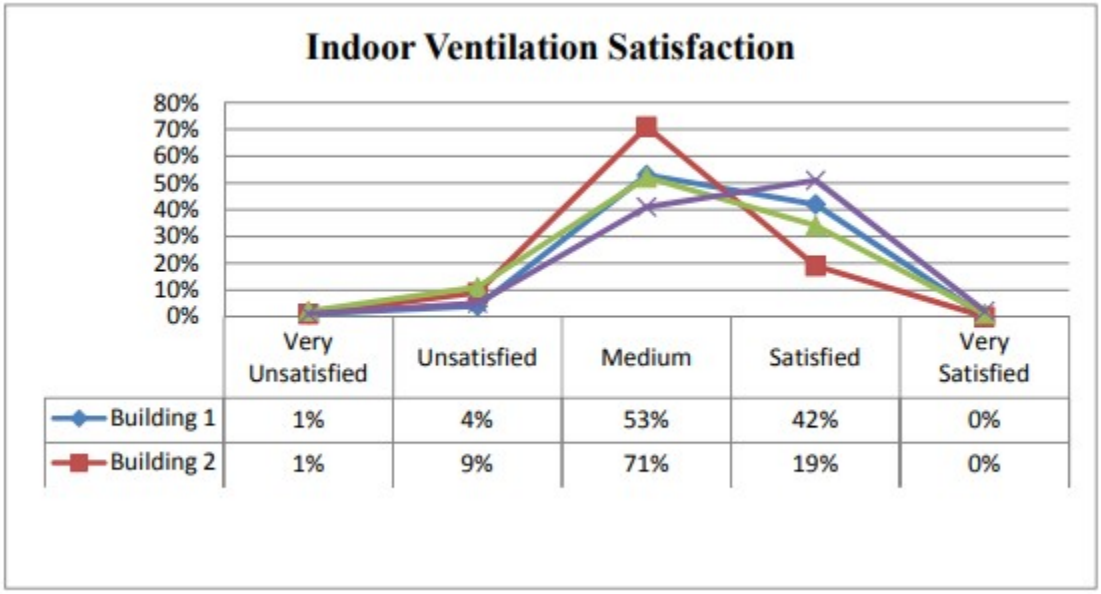
The satisfaction of employee with indoor environmental quality of offices is closely linked with employee comfort and productivity. If environmental quality is bad, it will negatively impact the employees' comfort and productivity. There are many reasons behind poor environmental quality and one of them is ventilation. The qualitative research was conducted which improved the comfort and productivity level of employees by maintaining good environmental quality. The relationship proves through qualitative study. The two buildings in Cairo were selected for evaluation. One was conventional building and other was green building which need LEED rating system. A bus occupant questionnaire was circulating in both buildings which shows that employee productivity and comfort can be increased through good design system(Al horr*et al.*, 2016).




Many authors discussed indoor pollution causes and the diseases due to this issue. One of the factors that impact more in poor air quality of buildings is presence of contaminates in air. These contaminates cause of many diseases and allergies. All these can be avoided through proper ventilation and filtration of buildings(Kubba, 2017).

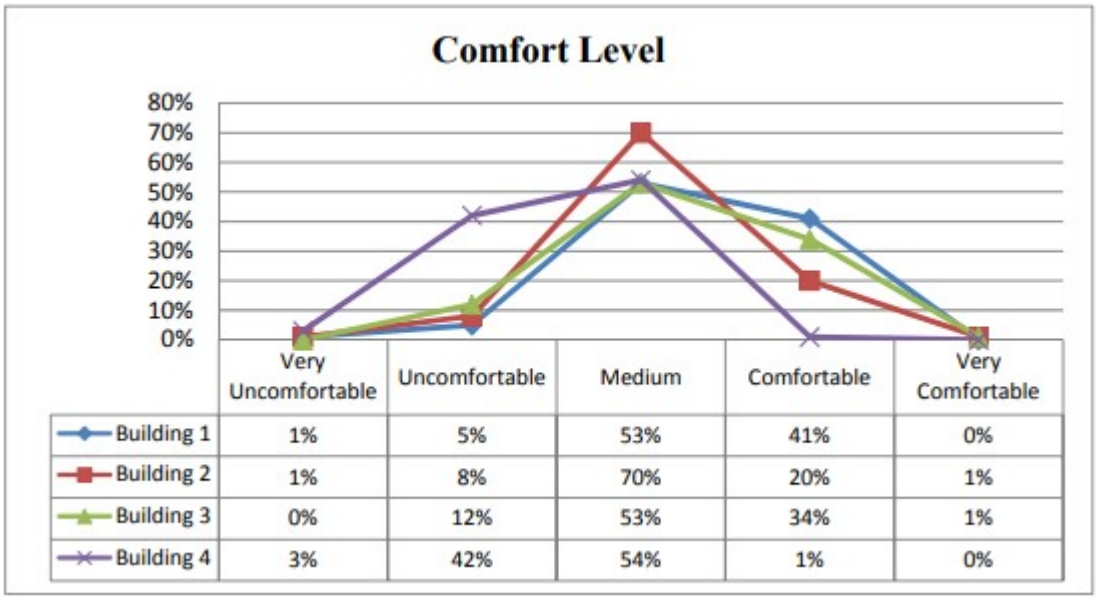
The above figure A is showing that insufficient ventilation creates pollution and B is showing that improper ventilation the second most cause of indoor pollution.

A study was conducted in KUALALUMPUR in different buildings (Kamaruzzaman and Sabrani, 2011) the below figure showed that mostly people are satisfied with the indoor ventilation of their buildings.



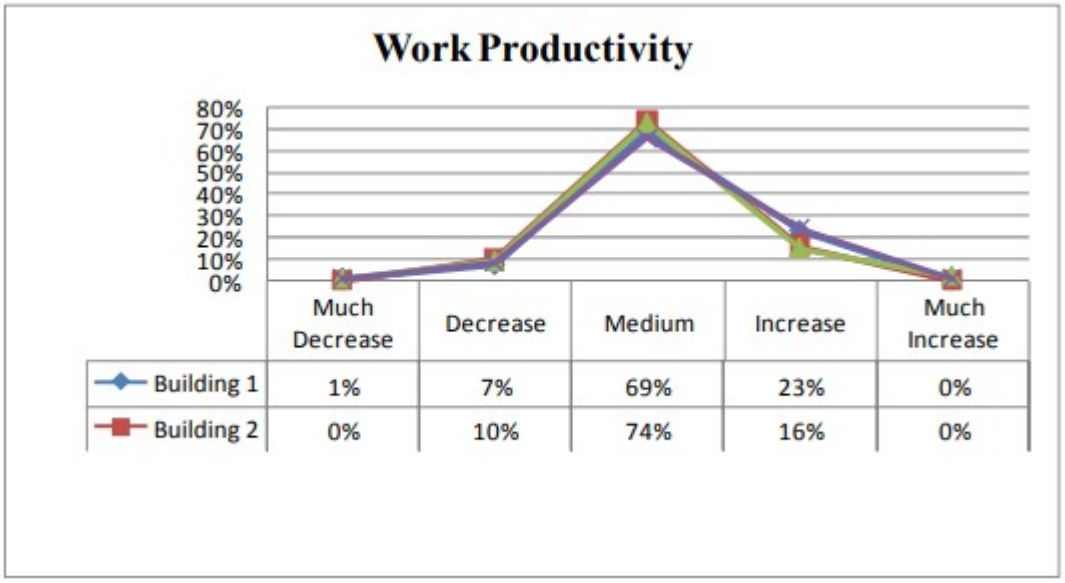

| | Very Unsatisfied | Unsatisfied | Medium | Satisfied | Very Satisfied |
|---|---|---|---|---|---|
| Building 1 | 1% | 4% | 53% | 42% | 0% |
| Building 2 | 1% | 9% | 71% | 19% | 0% |

Most of the employees also feel comfortable due to good ventilation maintained the indoor environmental quality.




| | Very Uncomfortable | Uncomfortable | Medium | Comfortable | Very Comfortable |
|---|---|---|---|---|---|
| Building 1 | 1% | 5% | 53% | 41% | 0% |
| Building 2 | 1% | 8% | 70% | 20% | 1% |
| Building 3 | 0% | 12% | 53% | 34% | 1% |
| Building 4 | 3% | 42% | 54% | 1% | 0% |

Neutral work productivity was also found in the buildings.




**Case Study**

(Kamaruzzaman*et al.*, 2019), applied an evaluation after completing the hiring process of employees. This method was implemented in the buildings of UK and Malysia to highlight the needs of the employeesaccording to their satisfaction and comfort levels with their building were evaluated. The case study was conducted through a questionnaire survey in which 25 organizations were involved over managing offices and buildings. The sample size for research was 115, which measured the satisfaction level of employees with respect to indoor environmental quality. The results shown that the indoor environment is based on lightning, quality of air, and aesthetics. These attributes were based on the 22 factors of indoor environment. Most of the respondents were provided satisfactory responses regarding their health condition. No serious issues were encountered to them (*Indoor environmental quality and LEED v4 | U.S. Green Building Council*, no date). However, for the employees it is necessary to have good environmental condition, health condition, circulation of air, ventilation, and freshness, in the building to ensure employee comfort and satisfaction. The contextual analysis gave an unmistakable picture with respect to the impression of representatives about the indoor climate and the issues which they are confronting (Lee, 2017). The LEED-ensured structures in America are assessed by the indoor natural quality. "LEED represents Leadership in energy and natural plan which is a US public normalize plan for building". It is reliant upon the idea of green structure plans. Seven IEQ models were contrasted and fulfillment and execution of representatives, LEED-guaranteed structures, and non-LEED confirmed structures. The seven models were characteristics of office design, office decorations, warm solace, indoor air quality, lighting, acoustics, and tidiness and upkeep. The outcomes showed the representatives of LEED-confirmed structures were more fulfilled against the given standards. The fulfillment level of representatives of non-LEED confirmed structures depended on office look and believes and

lightning. But the performance of employees of the LEED certified building are higher than non-LEED certified buildings (Lee and Kim, 2018).

For a business consideration UAE is the most favorite place but if indoor air quality is analyzed UAE needs to work a lot because the office buildings constructed in UAE are very higher with less indoor access. Although the buildings are energy efficient, but no fresh air can enter in buildings. Due to high indoor pollution in buildings occupants of Dubai are experiencing major skin diseases and different allergies. People uses different medicines to continue their work. An organization known as Sun Service is working to improve air quality in UAE('Protecting and Optimizing Indoor Air Quality in the GCC thanks to Green Building Rating Systems', 2020). Following steps are taken by UK and Malaysia for maintaining employee comfort and productivity to maintain indoor environmental quality.

1. Buildings of design to provide comfort to employees.
2. LEED rating systems were applied to measure the environmental quality of building.
3. Issues faced by employees are properly addressed.

**Case Study Comparison**

| Malaysian Case Study | UAE Case Study |
|---|---|
| Buildings of design to provide comfort to employees. | Buildings are higher and closed. |
| LEED rating systems were applied to measure the environmental quality of building. | No rating system has been applied for the betterment of environmental air quality. |
| Issues faced by employees are properly addressed. | Employees issues are addressed by giving medicines |
| Employees are satisfied | Employees are not satisfied. |

## Methods

The current study is a survey-based study. The survey was conducted from various sources such as books, journals, international standards, conference articles, and white papers which were centered around the boundaries of indoor natural quality. The accentuations simply given to warm solace, indoor air quality and ventilation, visual solace, and acoustic solace.The traditional way to increase ventilation to permit outdoor air to come inside and get exchanged with indoor air. Following steps should be taken in this regard.

1. Open windows and doors when weather is good.
2. Use air conditioners with open vent control to increase ventilation.
3. Use exhaust fans to remove contaminations from the room(US EPA, 2014).

4. Use HVAC equipment to maintain ventilation.
5. Place furniture in a way that air can pass easily.

**Recommendations**

- Indoor Environment quality can be achieved if proper grip on resources is maintained while construction and after constructing building.
- The best practices for indoor air quality can be shaken from standardized guide for designing and constructive buildings. The guide should be developed by experts and proper funding should be provided to them.
- With reference to the scientific findings of resource bank regarding indoor air quality. The effect of indoor air eminence on individuals can be improved and their wellbeing impact will be shown on their execution of work. These finding if properly implemented and proper funding is provided to them a wise impact on employee's growth will be observed.
- A cleaning and operational staff should not create problems while maintaining IEQ standards by using less expensive material as dry cleaners and on the other hand they should not use these materials in excessive amount and a balance should be maintained (*Enhance Indoor Environmental Quality (IEQ) | WBDG - Whole Building Design Guide*, no date).

**Discussion**

The undergone study has identified the direct and indirect relationship of indoor environmental quality with employee productivity with satisfaction and betterment. The indoor environmental quality is analyzed through various factors on which the indoor environmental quality is dependent. The major focus of the study was circled around employee's satisfaction and productivity. Indoor environmental quality put equal impact on the productivity of employee and the comfort for the residents. Although the focus of the research was around workplaces, but it cannot deny the importance of indoor environment of residential areas. This research opens new avenues of research for those who are ignoring the importance of indoor environment quality. Furthermore, in addition to employee productivity and wellbeing the impact of environmental quality can be checked with employee efficiency and behavioral change. This will set new examples to study the indoor effect with respect to students and different private businesses. This study has also highlighted the importance of green building framework.

**Conclusion**

This paper has led a review-based examination to distinguish the relationship of IEQ with its different components and their consolidated effect on representative fulfillment and efficiency. This review has featured the relationship of indoor ecological quality with worker's fulfillment, efficiency, and improvement. Their relationship is directly proportional if IEQ ill improve the employee performance will also improve. The human body is created to live inside, and average

human spent 90% of his life in indoor activities and act according to the indoor environment. Based on the current study the analysts and engineers need to focus on the issues that arise due to poor indoor environment and plan their construction according to the internally set standards. The green building frameworks do not always ensure the perfection of indoor environment other factors also contribute for improvement of IEQ. The construction of building houses and their rate of sustainability ensures the level of satisfaction which an individual will get by living inside the building. Planning is not sufficient to increase IEQ rather all stakeholders will be involved during each and every phase of plan execution.

**Reference**

Abdou, A. (no date) 'Correlation between Indoor Environmental Quality and Productivity in Buildings'. Available at: https://www.academia.edu/1013680/Correlation_between_Indoor_Environmental_Quality_and_Productivity_in_Buildings (Accessed: 17 May 2021).

Al horr, Y. *et al.* (2016) 'Impact of indoor environmental quality on employee's well-being and comfort: A review of the literature', *International Journal of Sustainable Built Environment*, 5(1), pp. 1–11. doi: 10.1016/j.ijsbe.2016.03.006.

Bayer, C. W. (2015) 'Indoor Environmental Quality indoor environmental quality (IEQ) and Health Improvement, Evidence-Based Design for', in Loftness, V. and Haase, D. (eds) *Sustainable Built Environments*. New York, NY: Springer New York, pp. 307–322. doi: 10.1007/978-1-4614-5828-9_604.

*Enhance Indoor Environmental Quality (IEQ) | WBDG - Whole Building Design Guide* (no date). Available at: https://www.wbdg.org/design-objectives/sustainable/enhance-indoor-environmental-quality (Accessed: 17 May 2021).

*Indoor Environmental Quality - an overview | ScienceDirect Topics* (no date). Available at: https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/indoor-environmental-quality (Accessed: 17 May 2021).

*Indoor environmental quality and LEED v4 | U.S. Green Building Council* (no date). Available at: https://www.usgbc.org/articles/indoor-environmental-quality-and-leed-v4 (Accessed: 17 May 2021).

Kamaruzzaman*et al.* (2019) *Effect of Indoor Environmental Quality (IEQ) to the Human Occupation Health and Performance in Buildings*. Available at: /paper/Effect-of-Indoor-Environmental-Quality-(IEQ)-to-the-Kamaruzzaman-Mahyuddin/70502fa6d339552170d8da82b3bb1a89baddd470 (Accessed: 17 May 2021).

Kapoor, N. R. *et al.* (2021) 'A Systematic Review on Indoor Environmental Quality in Naturally Ventilated School Classrooms: A Way Forward', *Advances in Civil Engineering*. Edited by A. Lampropoulos, 2021, pp. 1–19. doi: 10.1155/2021/8851685.

Khassawneh, O. (2018). *An Evaluation of the Relationship between Human Resource Practices and Service Quality: An Empirical Investigation in the Canadian Hotel Industry* (Doctoral dissertation, University of Gloucestershire).

Kubba, S. (2017) 'Indoor Environmental Quality', in *Handbook of Green Building Design and Construction*. Elsevier, pp. 353–412. doi: 10.1016/B978-0-12-810433-0.00007-1.

Lee, Y. S. (2017) 'Comparisons of Indoor Air Quality and Thermal Comfort Quality between Certification Levels of LEED-Certified Buildings in USA', *Indoor and Built Environment*, 20(5), pp. 564–576. doi: 10.1177/1420326X11409453.

Lee, Y. S. and Kim, S.-K. (2018) 'Indoor Environmental Quality in LEED-Certified Buildings in the U.S.', *Journal of Asian Architecture and Building Engineering*, 7(2), pp. 293–300. doi: 10.3130/jaabe.7.293.

Mahdavi, A. *et al.* (2020) 'Necessary Conditions for Multi-Domain Indoor Environmental Quality Standards', *Sustainability*, 12(20), p. 8439. doi: 10.3390/su12208439.

Mohammad, T., &Khassawneh, O. (2022). The Impact of Humor on Work Efficiency at Workplace: An Empirical Examination in Tourism and Hospitality Sector in The United Arab Emirates.

Mohammad, T., Darwish, T. K., Singh, S., &Khassawneh, O. (2021). Human resource management and organisational performance: The mediating role of social exchange. *European Management Review*, *18*(1), 125-136.

Mujan, I. *et al.* (2019) 'Influence of indoor environmental quality on human health and productivity - A review', *Journal of Cleaner Production*, 217, pp. 646–657. doi: 10.1016/j.jclepro.2019.01.307.

Mujeebu, M. A. (2019) *Introductory Chapter*, *Indoor Environmental Quality*. IntechOpen. doi: 10.5772/intechopen.83612.

Paevere, P. J. (2018) 'IMPACT OF INDOOR ENVIRONMENT QUALITY ON EMPLOYEES PRODUCTIVITY AND WELL-BEING IN OFFICE BUILDINGS', *Environment Design Guide*, pp. 1–9.