ERGONOMICS AND ENVIRONMENTAL RISK FACTORS: ENHANCING WORKPLACE HEALTH AND SAFETY

Yasmine N. Moussa[(1)]; Hossam A. Al Borombaly[(2)]; Moustafa H. Ragab[(3)]; Ahmed T. El-Awady[(1)]

1) Department of Environmental Engineering Sciences, Faculty of Graduate Studies and Environmental Research, Ain Shams University 2) Department of Architectural Engineering, Faculty of Engineering, Ain Shams University 3) Department of Environmental Medical Sciences, Faculty of Graduate Studies and Environmental Research, Ain Shams University.

ABSTRACT

This paper investigates environmental factors affecting employee health and performance in workplace environments. These factors are divided into two categories: environmental factors, including temperature, humidity, ventilation, lighting, and noise, which impact physical and mental comfort, and managerial and organizational factors, such as work organization, employee rotation, training, workspace design, and ergonomic practices, which ensure physical comfort during tasks.Using interviews, direct observations, and case studies, the study explores how these factors influence employee well-being and productivity. The findings reveal that an optimal work environment characterized by moderate temperature, adequate lighting, effective organization, and ergonomic practices significantly reduce health risks, such as fatigue and musculoskeletal pain, while enhancing productivity and focus. This paper concludes that a well-organized workplace, addressing both environmental and managerial factors, is essential for improving employee well-being and performance.

Keywords: Ergonomics, Workplace, Environmental Risk factor, Administrative Building, and Productivity.

INTRODUCTION

The workplace environment significantly affects employee performance, job satisfaction, and overall well-being. With the increasing complexity of global labor markets, employers must recognize that occupational health is not limited solely to preventing injuries or compliance with safety standards (Donley, 2021; Shammout, 2022). Instead, it encompasses a broader set of environmental and managerial and organizational factors that influence the long-term health and productivity of employees. These factors include physical aspects of the work environment such as temperature, humidity, ventilation, lighting, and

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noise as well as managerial and organizational practices, such as workflow organization, job rotation, employee training, and the provision of ergonomic interventions (OSHA, 2021; WHO, 2019).

Environmental conditions have been widely studied in occupational health literature due to their direct impact on employees' comfort and physical health. For instance, inappropriate temperature or poor lighting can lead to discomfort, reduced alertness, and decreased performance. High noise levels can contribute to stress, fatigue, and even hearing impairment over time.

Equally important are managerial factors that can either mitigate or exacerbate the effects of a suboptimal physical environment. Effective managerial practices such as equitable workload distribution, staff rotation to reduce repetitive strain, continuous training, and offering ergonomic tools can enhance employee resilience, reduce musculoskeletal disorders, and promote a culture of well-being (Gu et al., 2022; Elkarmouty, 2024).

Despite extensive research on individual environmental and managerial and organizational variables, there is a need for more integrated approaches that simultaneously consider both sets of factors. This holistic perspective is critical for developing comprehensive interventions that align physical workspace improvements with supportive organizational policies. Therefore, the objective of this paper is to systematically examine environmental and managerial and organizational risk factors, assess their combined effects on employee well-being, and propose evidence-based recommendations for enhancing workplace conditions Dul et al., 2014). To enhance workplace conditions, this paper suggests a combination of environmental and managerial solutions to optimize temperature control, ventilation, lighting, noise reduction, and stress management.

For temperature regulation, applying thermal insulation can help maintain consistent indoor temperatures, while utilizing heating systems in colder areas with even heat distribution ensures a comfortable work environment. Additionally, installing sensors to monitor and regulate temperatures within the optimal range enhances thermal stability.

Improving ventilation involves incorporating HEPA air purifiers to filter allergens and pollutants, designing spaces to maximize natural ventilation through operable windows and

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vents, and scheduling routine maintenance for ventilation and air conditioning systems to prevent the accumulation of dust, mold, and bacteria. Furthermore, installing indoor air quality sensors allows continuous pollutant monitoring, while adding air-purifying plants like spider plants or peace lilies naturally enhances air quality. Proper workspace design should ensure that air vents are not obstructed by furniture, allowing for unobstructed airflow (U.S. Environmental Protection Agency, 2023).

To optimize lighting, ensuring even distribution of artificial lighting across workspaces, maximizing natural light through adjustable curtains or blinds, maintaining functional lighting systems, and installing sensors that automatically adjust brightness based on natural light levels are recommended strategies Veitch (2012).

Noise control measures include installing soundproof ceilings and walls, using carpets and heavy curtains to absorb sound, selecting low-noise office equipment, and creating designated quiet areas for tasks requiring high concentration. Additionally, incorporating large indoor plants with sound-absorbing properties can further help in reducing noise levels.

To mitigate workplace stress, implementing managerial solutions is crucial. This includes equitable task distribution to prevent excessive workload, establishing schedules that integrate regular breaks to help employees relax and recharge, and utilizing time management software to efficiently plan tasks and balance work-rest cycles.

By integrating these environmental and managerial strategies, workplaces can enhance employee comfort, productivity, and overall well-being while minimizing occupational risks.

Given the substantial impact of environmental and managerial factors on employee well-being and productivity, it is crucial to develop an integrated approach that addresses both aspects simultaneously. This paper aims to bridge this gap by examining key workplace risk factors and proposing evidence-based strategies to create a healthier, more efficient work environment.

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MATERIALS AND METHODS

This section highlights the research methodology used to analyze the impact of environmental and managerial and organizational factors on employee health and performance. A mixed-methods approach combined quantitative measurements (temperature, humidity, lighting, and noise) with qualitative insights (surveys, interviews, and focus groups involving employees and management) Vimalanathan et al., (2014) (Haverinen-Shaughnessy 2015).

The study was conducted in a six-building administrative complex with a random sample of employees offering diverse perspectives. Quantitative data were analyzed using descriptive statistics and correlation methods, while qualitative data were examined through thematic analysis to identify key patterns and findings (Bryman, 2016; Creswell et al., 2018), as follows:

1) **Research Design:** A mixed-methods approach was employed, combining quantitative measurements of environmental factors with qualitative data gathered from employees and management personnel. This approach was chosen to capture both the measurable physical conditions and the subjective experiences of the workforce.
2) **Study Site and Sample:** The study was conducted in an administrative building (six buildings) that included offices, and open work areas located in an urban area. A random sample of employees was selected to participate in surveys and interviews. Additionally, interviews were conducted with management representatives to understand the organizational practices and policies.
3) **Data Collection Instruments:** This section describes the methods used for data collection regarding environmental conditions and managerial and organizational practices. Environmental factors were measured using various tools and instruments.

Temperature and humidity levels were monitored at multiple workstations using digital hygrometers and temperature sensors. Ventilation and air quality were assessed through air exchange rates using portable indoor air quality monitors to achieve thermal comfort, as illustrated in Figure (1).

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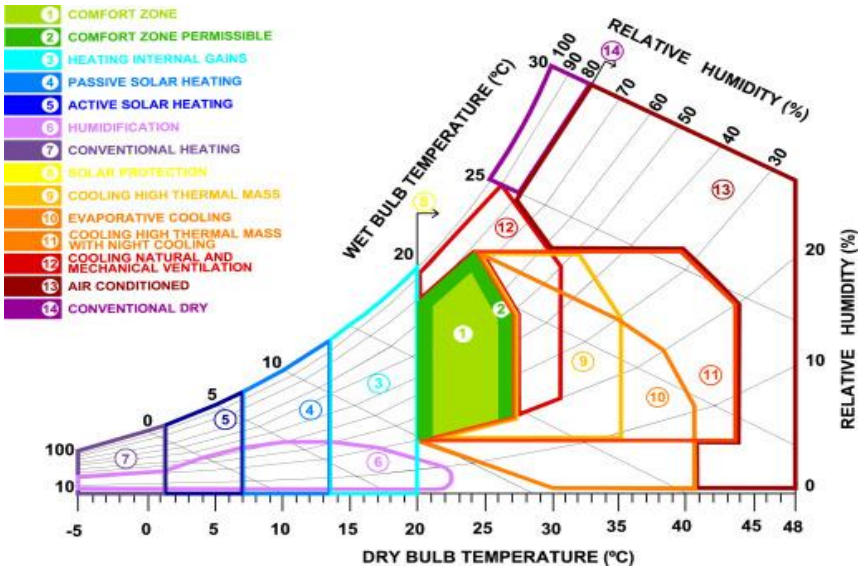

Figure 1. Bioclimatic Chart (Gupta & Dhobekar (2022).

Lighting conditions were evaluated by measuring illuminance levels with lux meters at desk height and in general areas. Additionally, noise levels were recorded during peak and off-peak periods using sound level meters to assess variations in workplace noise exposure, as illustrated in Figure (2).

Measurements were taken at multiple workstations to ensure accuracy and consistency. These assessments helped evaluate workplace conditions and their impact on employee comfort.

Figure 2. LUX meter and SOUND-LEVEL meter, in sequence.

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For managerial and organizational factors, data was collected through both group and individual interviews with employees to gather insights on organizational policies, perceived comfort, and suggestions for improving workplace conditions (The total number of employees is 600). Additionally, direct observations were conducted and analyzed, along with a review of medical records related to neck, lower back, and joint-related illnesses. These methods provided a comprehensive understanding of the factors influencing employee well-being and performance.

4) **Data Analysis:** Quantitative data (environmental measurements and annual disease records) were analyzed using descriptive statistics and correlation analyses, and the following Figure (3) presents aggregated samples of quantitative data, representing the environmental factors analyzed in the paper, including measurements of illuminance levels and recorded cases of ergonomics-related health diseases.

قياس شدة الإستضاءة الدور الأرضى

Office. N / Name :	Degree /Lux	Office. N / Name :	Degree /Lux	Office. N / Name :	Degree /Lux
Room A1 Projects	255/185	In front of the mincing machine	420	WorkStation Front Room A1	330
Room A2 Projects	450	The shipping dock	800	WorkStation Front Room A1	375
Room A3 Projects	420	Back door entrance	160	WorkStation Front Room A1	160
Room A4 Projects	490	front of photography	160	WorkStation Front Room A1	260
Room A5 Projects	450	Photography area	390/240/ 290/430	WorkStation Front Room A1	350
Room A6 Projects	430	Wael Salah Office	250	stairs	100
Bakr Abd Elaziz	1050/500	Kareem photography	190	stairs	85
Cafeteria	300/250	Mohamed Darwesh photography	190	Bathroom	180
The buffet	750	Hesham (Building)	260	Bathroom	250
The kitchen	800/900	Office DCC	310	Mr. Ibrahim Office	480
Back door	370	Office DCC	450	Mr. Mohamed Hafez Office	450
Mail	350/210	Building Affairs	270	corridor in front of the elevators	57
Main corridor in front of the elevators	37	Corridor Front buffet	45		

Statistics of back, neck and lower uterus pain

Division	mployee Nu	Name	Age	gnosis C	Diagnosis Name
Administration Division			59	M54.2	Cervicalgia
Administration Division			55	M54.2	Cervicalgia
Administration Division			48	M54.2	Cervicalgia
Administration Division			54	M54.2	Cervicalgia
Administration Division			39	M54.2	Cervicalgia
Administration Division			54	M54.5	Low back pain
Administration Division			58	M54.5	Low back pain
Administration Division			29	M54	Dorsalgia
Administration Division			58	M54.2	Cervicalgia
Administration Division			45	M54.2	Cervicalgia
Administration Division			45	M54.2	Cervicalgia
Administration Division			49	M54.2	Cervicalgia
Administration Division			51	M54.2	Cervicalgia
Administration Division			52	M54.2	Cervicalgia
Administration Division			50	M54.5	Low back pain
Administration Division			51	M54.5	Low back pain
Administration Division			54	M54.5	Low back pain
Administration Division			51	M54.5	Low back pain
Administration Division			53	M54.5	Low back pain
Administration Division			41	M54	Dorsalgia
Administration Division			42	M54	Dorsalgia
Administration Division			37	M54	Dorsalgia
Administration Division			41	M54.5	Low back pain
Administration Division			28	M54.5	Low back pain
Administration Division			55	M54	Dorsalgia
Administration Division			44	M54.2	Cervicalgia
Administration Division			48	M54.2	Cervicalgia
Administration Division			50	M54.2	Cervicalgia
Administration Division			45	M54.5	Low back pain
Administration Division			59	M54.5	Low back pain
Administration Division			56	M54.5	Low back pain
Administration Division			31	M54.5	Low back pain
Administration Division			54	M54.5	Low back pain
Administration Division			43	M54.5	Low back pain
Administration Division			51	M54	Dorsalgia
Administration Division			37	M54	Dorsalgia
Administration Division			45	M54.2	Cervicalgia
Administration Division			46	M54.2	Cervicalgia
Administration Division			36	M54.5	Low back pain
Administration Division			39	M54.5	Low back pain
Administration Division			49	M54.5	Low back pain

Figure 3. Environmental Measurements Aggregated Samples

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Qualitative data (interview transcripts and direct observations) were coded and thematically analyzed to identify recurring patterns and themes, and the following Figure (4) presents aggregated samples of qualitative data, which include direct observations from employees and building users that were analyzed in the paper.

Figure 4. Employees' Direct Observations Aggregated Sample

5) Ethical Considerations

All participants were informed of the research objectives and procedures, and informed consent was obtained. Anonymity and confidentiality were assured. The study complied with relevant ethical guidelines and institutional review board (IRB) requirements.

Based on the methodology above, each risk factor affecting employee comfort in the workplace was analyzed. Control measures whether engineering or administrative were then implemented to create a safe work environment free of injuries and musculoskeletal problems, thereby fostering a productive workplace, (International Organization for Standardization [ISO], 2018; LaDou, 2014).

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RESULTS

This section highlights the main findings of the six administrative buildings that were studied as case studies in different geographical areas, varying in nature, climate, and culture, to assess the extent of ergonomics application and measure employees' awareness of the surrounding ergonomic hazards. These buildings are from different regions worldwide, including:

For Foreign Countries, the buildings that were within the scope of this paper were **The Edge Headquarters** in Amsterdam (situated in the center of Amsterdam's Zuidas business district and designed by PLP Architecture in 2015) and **Torrey View Buildings** in the United States (situated in San Diego, California and designed by Flad Architects in 2024).

For Regional Countries, the buildings that were within the scope of this paper were **Dogus Technology Center** in Turkey (situated in Istanbul and designed by ERA Architects in 2014) and **Nestlé Waters Headquarters** in Lebanon (situated in Beirut and designed by Bernard Mallat Architects and Walid Zeidan in 2014).

For Local Communities in Egypt, the buildings that were within the scope of this paper were **Mountain View Head Office** in Egypt (situated in New Cairo and designed by Dar Al Maamar Group (DMG) in 2015) and **Engineering for Petroleum and Process Industries (Enppi)** in Egypt (situated in Nasr City, Cairo and designed by Architect Voy Madesky – Perkins and Will Group in 1987), as illustrated in Figure (5).

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Figure 5. Six Administrative Case Studies Buildings (Arch Daily, 2024).

While focusing on the impact of environmental and managerial and organizational factors on employee health and productivity at workplace in local Communities located in Egypt (Mountain View Head Office and Enppi), this section is related to the mentioned factors as follows:

1) Environmental factors

The previously mentioned thermal comfort conditions, including temperature and humidity levels, fall within the recommended ranges. However, certain workstations near windows experienced noticeable temperature fluctuations, resulting in discomfort reported by 15% of the employees surveyed. The thermal conditions in the workplaces studied revealed that indoor temperatures averaged 24°C in office environments and 26°C in manufacturing settings, with relative humidity levels ranging between 40-50%.

Lighting measured using a lux meter as previously explained. However, 20% of the employees who were surveyed showed uneven lighting distribution. This inconsistency

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caused glare on screens and paper documents, which negatively impacted visual comfort and productivity.

Noise levels in office environments were recorded at an average of 55 dB(A), measured using a sound-level meter as previously explained. These levels slightly exceeded the recommended range, potentially affecting employees' focus and comfort in these workspaces.

2) Managerial and Organizational Factors

Work organization and job rotation were evaluated through surveys, revealing that only 30% of employees experienced regular job rotation. Employees without job rotation reported higher levels of musculoskeletal discomfort and fatigue, whereas those with balanced work assignments expressed feeling more engaged and less physically strained.

Training and access to ergonomic tools also played a critical role in workplace conditions. 60% of employees believed they had received sufficient training in ergonomics and safe work practices. However, fewer than half of the surveyed employees reported having access to complete ergonomic toolsets, including adjustable chairs, monitor stands, and paper holders, as illustrated in Figure (6). Employees who utilized ergonomic equipment reported significantly lower rates of neck and shoulder pain, highlighting the importance of providing appropriate tools.

Figure (6): document holder, footrest and ergonomics mouse, in sequence.

Employee feedback on management practices indicated mixed responses. While many employees appreciated initiatives such as regular team meetings and the use of suggestion

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boxes, 25% felt that their feedback on environmental conditions, particularly regarding lighting and noise, was not adequately addressed by management. This highlights a gap in addressing workplace concerns that could impact employee well-being and satisfaction.

As shown in Table (1), the findings reveal key ergonomic patterns that significantly contribute to the enhancement of performance and productivity in workspaces, based on an analysis of six case studies, Derived from architectural visual observation and analysis of the building, both internally and externally.

Table (1). Case Studies comparative analysis

	BUILDING NAME / ERGONOMICS PATTERNS	THE EDGE HQ	TORREY VIEW BLDG.	DOGUS TECHNOLOGY CENTER	NESTLÉ WATERS HQ	MOUNTAIN VIEW HQ	ENPPI	TOTAL SCORE (18 POINTS)
1	Natural Ventilation							13
2	Natural Lighting							15
3	Noise							16
4	Training and Furniture							13
5	Sociability and Feedback							15
STRONG (3 points) MEDIUM (2 points) WEAK (1 point)								

The ergonomic patterns identified in the study are categorized based on their effectiveness. The most impactful patterns include building façades that effectively manage internal and external noise, creating a more comfortable environment for occupants. Following this, strong patterns such as the use of natural lighting, strategic color choices, and spaces designed to encourage sociability and feedback contribute significantly to comfort and productivity. Other patterns, including natural ventilation, employee training, and ergonomic furniture, also play a role in enhancing workplace conditions. These findings are further supported by figures that demonstrate the application of these patterns across the case studies, showcasing their positive impact on the overall work environment.

As illustrated in Figure (7) and Figure (8), which compare the six case studies across multiple factors, the analysis first focuses on environmental aspects, including natural

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ventilation, natural lighting, noise levels, and the architectural solutions implemented in the facades. Furthermore, it explores managerial and organizational elements, such as employee training and social dynamics.

And this comparison indicates that **The Edge Headquarters, Amsterdam**, which has received the BREEAM Award year 2016, excels in effective natural ventilation and lighting, along with well-designed façade treatments and noise reduction. Additionally, it places significant emphasis on managerial and organizational factors (employee training and social interactions).

On the other hand, **Torrey View Buildings, United States** shares many of Edge's advantages but relies entirely on mechanical ventilation, lacking natural airflow.

Meanwhile, **Dogus Technology Center, Turkey** benefits from good natural ventilation and lighting, while also considering social aspects and noise control. However, it lacks certain architectural solutions for its façades.

Conversely, **Nestlé Waters Headquarters, Lebanon** is the weakest in terms of workplace environment, requiring a comprehensive reassessment and immediate solutions to ensure a safe working place.

Regarding local Communities in Egypt, **Mountain View Head Office,** stands out for its efficient natural ventilation and well-managed façade treatments and noise control. However, it requires improvements in natural lighting and greater attention to managerial and organizational factors.

Similarly, **Engineering for Petroleum and Process Industries - Enppi** features good natural lighting, effective façade treatments, and noise control but needs enhancements in natural ventilation and better consideration of managerial and organizational factors.

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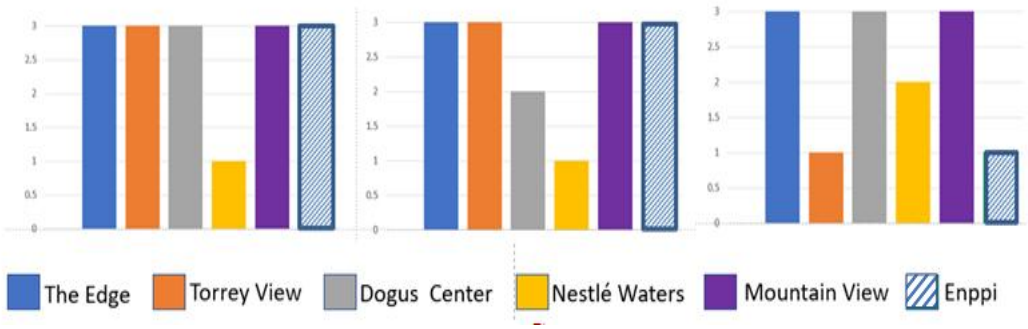

Figure (7). Comparison among different study cases in terms of ventilation, natural lighting, and noise levels.

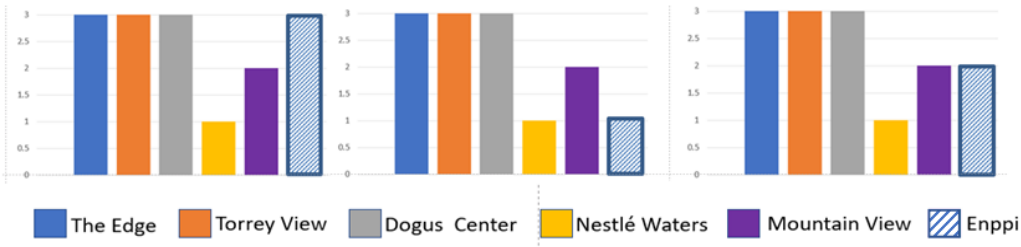

Figure (8). Comparison among different study cases in terms of Building's Facade, Training, and Sociability and Feedback.

DISCUSSION

This paper examines the impact of environmental and managerial factors on employee health and performance that has been extensively studied, with numerous findings supporting the idea that workplace conditions significantly affect productivity and well-being. Many studies align with this perspective, emphasizing the importance of optimizing environmental elements to enhance employee outcomes (Boyce et al., 2006; Lan et al., 2013). However, gaps persist in integrating individual differences and adapting to modern workplace models, highlighting areas for further research.

Environmental conditions such as temperature, lighting, and ventilation play a crucial role in shaping employee well-being. Research indicates that variations in temperature can influence cognitive performance and productivity, reinforcing the argument that maintaining

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optimal environmental settings is essential (Lan et al., 2013). Similarly, proper lighting enhances visual comfort and reduces fatigue, leading to improved work efficiency (Boyce et al., 2006). While these aspects are well-documented, some studies suggest that responses to environmental factors vary based on individual characteristics such as age, health status, and job nature (Ropponen et al., 2023). The importance of a personalized approach is evident, yet this perspective remains underexplored in existing discussions.

The methodology used in workplace studies significantly influences the reliability of findings. Many researchers argue that relying solely on interviews and observations introduces potential biases due to subjective perceptions. Combining qualitative insights with quantitative surveys enhances the accuracy of results by reducing respondent bias and providing a more objective assessment of workplace influences. Statistical modeling, for instance, has been shown to offer a comprehensive understanding of how various factors interact to affect employee performance (Haq, 2015). Incorporating both qualitative and quantitative methods could strengthen future research on workplace conditions.

Managerial practices play a critical role in shaping the work environment, yet their interaction with environmental factors is often overlooked. Studies have shown that flexible work arrangements, leadership support, and ergonomic policies can help mitigate environmental stressors (Shiri et al., 2022). For example, noise pollution is a common workplace issue that negatively impacts productivity, but strategic office design and remote work options can minimize its effects. The relationship between managerial strategies and environmental adjustments is essential in promoting employee well-being, making it an area worth deeper exploration.

The rise of remote and hybrid work models has introduced new challenges and opportunities for employee health and productivity. While remote work provides flexibility, it also presents risks such as isolation, digital fatigue, and ergonomic issues in home office setups.

Emerging technologies, including AI-driven workplace solutions, offer potential ways to enhance remote and hybrid work experiences by adapting lighting and ventilation to individual needs (Barbieri et al. (2024). Although research acknowledges the importance of

technology in workplace optimization, a more detailed discussion of hybrid work models and their long-term implications remains necessary.

Ergonomic training is a key factor in improving workplace safety and reducing injuries. Studies indicate that employees who receive proper ergonomic training experience fewer musculoskeletal disorders and report higher job satisfaction. Additionally, structured training programs enhance compliance with workplace safety regulations, leading to a healthier work environment. While existing research highlights the benefits of ergonomic training, exploring cost-effective methods for implementing such programs in resource-limited companies could further improve workplace safety outcomes (Faisting and Sato 2019).

Future research should focus on integrating advanced technologies and work-life balance strategies to create healthier work environments. AI-driven workplace optimization has the potential to enhance productivity by adjusting environmental factors in real time (Fiegler-Rudol et al.,2025). Additionally, work-life balance plays a significant role in moderating workplace stress, making it a crucial area for further exploration Wong et al. (2020). Addressing these aspects in future studies will provide a more comprehensive understanding of how environmental and managerial factors contribute to employee well-being and performance.

CONCLUSION

This section provides a summary of the key findings from the research. It highlights that both environmental and managerial and organizational factors are critical in influencing employee health, well-being, and productivity. Workplaces that prioritize ergonomic design and optimize environmental conditions such as temperature, lighting, ventilation, and noise have a significant positive impact on employee satisfaction. Furthermore, these improvements in the work environment also led to enhanced overall company performance. By addressing both the physical workspace and organizational practices, companies can create a more supportive and productive environment for their employees.

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RECOMMENDATIONS

This paper provided several recommendations to improve workplace conditions. First, enhancing workspace design by incorporating ergonomic principles is essential, including the use of adjustable desks, supportive seating, and optimal lighting to create a comfortable and efficient environment. Second, better environmental management is necessary, with employers encouraged to invest in climate control systems that maintain appropriate temperatures between 22-24°C, regulate humidity, and ensure proper ventilation system maintenance. Additionally, lighting conditions generally met the established standards of 300–500 lux, the recommended levels for office tasks. Noise levels should be maintained within the recommended range of 40-50 dB(A) for tasks requiring high concentration, as excessive noise may impact employees' focus and overall comfort in the workplace.

Regular employee training and awareness programs are also recommended to teach workers how to adopt ergonomic practices and manage stress effectively in the workplace. Furthermore, long-term monitoring of environmental conditions and employee well-being is critical to evaluate the effectiveness of implemented changes and ensure continuous improvement.

Lastly, integrating workplace safety policies that address both environmental and administrative considerations is vital. This involves regularly assessing and updating workplace conditions through employee feedback to create a safe, productive, and adaptive working environment.

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هندسة العوامل البشرية (الأرجونوميات) وعوامل الخطر البيئية: تعزيز صحة وسلامة مكان العمل

ياسمين نمر موسى[1]– حسام الدين حسن البُرمبلي[2]– مصطفى حسن رجب[3]– أحمد طارق العوضي[1]

1) قسم العلوم الهندسية البيئية، كلية الدراسات العليا والبحوث البيئية، جامعة عين شمس 2) قسم الهندسة المعمارية، كلية الهندسة، جامعة عين شمس 3) قسم العلوم الطبية البيئية، كلية الدراسات العليا والبحوث البيئية، جامعة عين شمس.

المستخلص

تناقش هذه الورقة العوامل البيئية التي تؤثر على صحة الموظفين وأدائهم في بيئات العمل. تنقسم هذه العوامل إلى فئتين :العوامل البيئية، التي تشمل درجة الحرارة، الرطوبة، التهوية، الإضاءة، ومستويات الضوضاء، والتي تؤثر على الراحة الجسدية والنفسية، والعوامل الإدارية والتنظيمية، مثل تنظيم العمل، تدوير الموظفين، التدريب، تصميم مكان العمل، والممارسات الأرغونومية التي تضمن الراحة أثناء أداء المهام. من خلال المقابلات والملاحظات المباشرة لدراسات الحالة، يستكشف البحث تأثير هذه العوامل على رفاهية الموظفين وإنتاجيتهم. أظهرت النتائج أن توفير بيئة عمل مثالية، تتسم بدرجات حرارة معتدلة، إضاءة كافية، تنظيم فعّال، وتطبيق ممارسات أرغونومية، يقلل بشكل كبير من المخاطر الصحية مثل الإرهاق وآلام العضلات، ويعزز الإنتاجية والتركيز. خلصت الورقة إلى أن تنظيم بيئة العمل بشكل جيد، مع معالجة العوامل البيئية والإدارية، أمر ضروري لتحسين رفاهية الموظفين وأدائهم.

الكلمات المفتاحية: الهندسة البشرية، عوامل الخطر البيئية، مبنى إداري، الإنتاجية