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An Empirical Study on Ergonomic Interventions on Electrical Engineer's Performance and Well-Being

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KEYWORDS

Electrical Engineers, Employee Productivity & Wellbeing, Ergonomic Office Design, Job Satisfaction, Workplace Ergonomics

ABSTRACT

Employee well-being and productivity has emerged as critical factors for organization success in today's fast-paced and technologically intensive work environments. The study examines the ergonomic office design and productivity and well-being of the electrical engineers. These professionals engage in complex task which involves long hours of work focus, physical precision and they are susceptible to work place related physical and cognitive stress. The study collected data form 178 electrical engineers through structured surveys for studying the impact of ergonomic work design on productivity and well-being of the professionals. Findings revealed ergonomic interventions significantly reduce muscular skeletal discomfort, fatigue and work place injuries thereby resulting in improved concentration, motivation and significant outcomes. The study also highlights benefits of ergonomically optimized environments with employee retention, higher job satisfaction and lower absenteeism. The importance of ergonomic training and education is also emphasized conveying that informed employees are better equipped to maintain proper posture, reduce physical strain, and enhance workflow efficiency.

The implications of this study extend beyond individual performance; they offer actionable insights for organizations seeking to build resilient, health-conscious workspaces that align with both human-centric design principles and corporate productivity goals. By promoting workplace ergonomics, companies can not only improve the occupational health of their electrical engineering teams but also create a sustainable model for long-term employee engagement and innovation. This research provides valuable recommendations for policymakers, HR practitioners, and facility managers to prioritize ergonomic design in technical workplaces, ensuring a balance between employee wellbeing and organizational effectiveness in an increasingly competitive global market..

1. INTRODUCTION

Workplace effectiveness and employee well-being are vital factors that influence organizational success in the rapidly changing and fast-paced industry of electrical engineering. Because they are responsible for the design, testing, and maintenance of intricate systems, electrical engineers frequently work in demanding settings where accuracy and creativity are crucial. However, if workplace design does not support ergonomic principles, the physical and cognitive demands of these positions can negatively impact overall well-being and productivity.

Ergonomics, which comes from the Greek words "ergon" (labor) and "nomos" (rules), is the study of how people interact with their workplace. Essentially, it aims to create work environments, equipment, and procedures that respect human potential and constraints. An ergonomically designed workspace can have a big impact on electrical engineers' productivity and job satisfaction because their jobs frequently call for prolonged concentration, dexterity when using technical equipment, and cooperation with cross-functional teams. On the other hand, poorly planned workstations can result in mental exhaustion,

repetitive strain injuries, and physical discomfort, which can ultimately impair performance and raise the possibility of mistakes

The Role of Ergonomics in Workplace Productivity:

The link between ergonomic improvements and greater job efficiency has been the topic of various research. Even modest ergonomic modifications can have a big influence in electrical engineering because there is extremely little opportunity for error. Ergonomic characteristics that might decrease physical strain and boost focus are anti-glare monitors, adjustable seats, proper workstation height, and sufficient lighting. Additionally, a more focused and creative environment can be established by using noise reduction measures and carefully positioning tools and equipment.

According to the study, ergonomic workplace design greatly improves psychological well-being in addition to physical suffering. Job satisfaction, engagement, and loyalty are more likely to be experienced by workers who feel supported by their employer. A well-designed workplace can be a crucial enabler of sustained high performance for electrical engineers, who frequently juggle challenging problem-solving assignments and severe deadlines.

In electrical engineering, ergonomics is vital for organizational performance as well as for individual productivity. Engineers working in ergonomically suitable conditions are less likely to suffer from burnout, weariness, and injuries—all of which promote turnover and absenteeism rates. Furthermore, by removing mental and physical hurdles to good teamwork, ergonomic workplace design may promote an inventive and collaborative culture.

Ergonomic workplace design also serves more basic objectives of fostering inclusivity and employee well-being in a time when businesses are growing more concerned with sustainability and corporate social responsibility. This can give electrical engineering organizations a competitive edge in luring and keeping top personnel and enhancing their standing as favorite employers.

The Impact of Ergonomic Workplace Design on the Productivity and Well-being of Electrical Engineers:

According to the study, electrical engineers' well-being and productivity are directly improved by ergonomic office design. The threat of musculoskeletal disorders, physiological discomfort, and weariness is all greatly lowered by well-designed workstations and equipment. As a result, engineers are more focused and efficient, which helps them to execute tough jobs more correctly and with less stress, therefore increasing production on both an individual and team level. The study also underlines how demographic characteristics, including age, work function, and experience, alter how ergonomic solutions are regarded and how effective they are.

Organizations may ensure inclusion and optimal performance across teams by identifying inherent differences and establishing unique ergonomic techniques that fulfill a range of needs. These outcomes give policymakers and companies vital information. Employers can lower absenteeism and turnover by providing tailored ergonomic solutions that encourage healthier, more engaged engineering teams. This information can be utilized by policymakers to support workplace policies that put technical workers' welfare first. When combined, these initiatives help to establish cultures that increase both company success and employee satisfaction.

Challenges in Implementing Ergonomic Designs:

Despite the obvious advantages, there are special problems in implementing ergonomic workplace design in the realm of electrical engineering. The range of activities engineers conduct, from desk-based design work to hands-on equipment testing, is one key impediment. Because of this variation, ergonomic solutions must be flexible and adaptable, which can be expensive and time-consuming to develop. Furthermore, corporations are not aware of or versed in ergonomic concepts, which could result in less-than-ideal designs that don't take into account the special requirements of engineering staff.

Scope and Significance of the Study

The ergonomics of workspace design for electrical engineers, especially those employed in offices, labs, and industries, constitute the main emphasis of this study. It will examine important ergonomic features such as lighting, noise levels, seating layouts, office layout, and tool and equipment design. This study is essential because it may offer practical guidance to facility managers, employers, and politicians on how to build workplaces that encourage well-being and productivity. The study can help with the following by addressing the particular requirements of electrical engineers:

i. Reducing musculoskeletal difficulties related to employment.

ii. Boosting cognitive function via boosting comfort and concentration.

iii. Improving overall work quality and job satisfaction.

iv. Creating an ergonomic design framework that can be utilized in various technical disciplines.

Objectives of the Study

1. To assess the role of ergonomic workplace among electrical engineers.

2. To examine the influence of ergonomically designed workstations for electrical engineers.

3. To determine the extent to which ergonomic workplace factors significantly influence the productivity of electrical engineers.

4. To evaluate the workplace design factors significance on the overall well-being of electrical engineers.

2. LIMITATIONS OF THE STUDY

It is crucial to understand the following limitations of this study notwithstanding its significance.

(i) Geographic Focus: Because the study will only look at a certain area or group of organizations, it may not take into consideration changes in workplace design norms and practices around the world.

(ii) Time Restrictions: Because of the short time frame, the study will concentrate on the immediate effects of ergonomic improvements rather than the long-term results.

(iii) External Factors: Aspects outside the study's control, such as personal habits, company

culture, and budgetary limits, may have an impact on the findings.

(iv) Technological Developments: Some conclusions may become less applicable in the future due to the fast changes in tools and equipment design.

3. LITERATURE REVIEW

Zadem, 2024, examined the convergence of ergonomic methods and mindful work design, which has been demonstrated to lessen physical discomfort and boost job satisfaction. This holistic approach emphasizes the relevance of aligning the working environment with employee requirements to enhance well-being, fulfillment, and productivity in current work contexts. Ergonomics focuses on tailoring workloads and workspaces to individual needs, decreasing musculoskeletal concerns, and promoting psychological wellness.

Zafir Khan Mohamed Makhbul, 2022, highlighted how vital ergonomic workplace aspects are to ensure workers can accomplish operations swiftly and successfully. Building dynamic human capital requires competitive and healthy people resources, which are heavily reliant on how employees see these issues. In today's brutally competitive global economy, inadequate employee health raises organizational expenses and lowers competitiveness. Organizations can better equip their workers to address evolving business and environmental issues by placing a stronger premium on workplace ergonomics.

Ana Colim, 2021, established that although it might be tough, including ergonomic concepts into collaborative workspace design is vital to boosting worker safety and well-being. This study uses a system that incorporates ergonomic concepts and physical workload evaluation to modify a manufacturing workplace with ergonomic problems. The method incorporated knowledge from standards, past research, and ergonomic methodologies with an emphasis on human-centered design. The framework, which will direct the implementation of a collaborative human-robot system that creates a balance between worker talents and production demands, was assessed using a laboratory prototype. Subsequent evaluations confirm the ergonomic enhancements made to the environment and measure how it affects employee and organizational performance.

Strasser, 2021, implied that in order to maximize work system performance and assure workplace safety, compatibility is key. Productivity may be increased, and occupational illnesses, repetitive strain injuries, and physiological strain can be decreased using ergonomic designs that take into account human physiological and cognitive skills. Research reveals that harmonizing technical design with human needs promotes optimal information processing, decreases mental stress, and enhances occupational safety. Furthermore, by balancing worker well-being and productivity, ergonomic improvements give financial benefits. This emphasizes how essential it is to combine ergonomic concepts with a comprehensive grasp of human functioning in order to build work systems that are both efficient and long-lasting.

Dr. Veena Christy, 2020, noted while badly organized workplaces can result in stress, tiredness, and health concerns such as musculoskeletal disorders and burnout, well-designed environments encourage employee engagement and learning. The purpose of cognitive ergonomics is to decrease the stress that occurs from people interacting with tasks and systems. According to research, applying ergonomic notions into work schedules, human-computer interaction, and workspace design can boost worker productivity and well-being. The significance of implementing ergonomic concepts into current workplaces is proven by the fact that ergonomically built workspaces and settings minimize stress, improve comfort, and increase total performance.

Rashid Heidarimoghadam, 2020, emphasizes that there is no one-size-fits-all solution to tackling problems like musculoskeletal illnesses (MSDs); ergonomics plays a significant role in boosting workplace productivity and health. Research indicates that larger outcomes may be accomplished by merging ergonomic training, workplace design, and employee interaction. Regular updates, continuing guidance, and modification of treatments to meet particular workplace standards are important for long-term effectiveness. Effective planning is critical for small and medium-sized firms due to challenges like absenteeism and a tiny workforce.

Tosi's 2019 study focuses on the design that is crucial for innovation due to its ability to satisfy the intricate requirements of individuals, industrial operations, and enterprises. Designers must achieve a balance among technological, organizational, and user needs collaborating with several teams, including engineers and marketing specialists. Individuals consider market demands, production timelines, pricing, and material availability, including furnishings. Focusing on the cultivation of innovative and user-centric solutions, the amalgamation of ergonomics with design has increased in importance. Ergonomics design synergizes to tackle modern challenges and drive progress across several industries, as proven by continuous research and experimentation.

Chandwani A, 2019 elucidated the research as the employees' lack of awareness regarding office matters. Extended static awkward positions, challenging postures, inadequately constructed seats, unsuitable equipment positioning intensified musculoskeletal issues, discomfort, and poor posture.. The absence of footrests was a prevalent reason. Noise generated anxiety and impeded concentration despite the internal environment and lighting being generally assessed as comfortable. An effectively crafted workspace design and proper ergonomic practices can enhance employee happiness and reduce health concerns. Further research is necessary to effectively tackle long-term challenges; nonetheless, comprehending workplace architecture, equipment arrangement, and environmental factors is crucial for cultivating healthier and more comfortable work environments.

Blanka Horvathova, 2019, indicates 78% of occupations in Slovakia are predominantly sedentary, suggesting that several positions in industrial companies involve limited physical activity. Extended sedentary behavior increases the likelihood of musculoskeletal disorders and diminishes performance. Majority of office chairs available in the market do not adequately meet the requisite standard requirements to ease the consequences of prolonged sitting. Dynamic chairs, which are derived from therapeutic balls, facilitate movement; yet, extended usage may still lead to strain.

Dessi Mufti, 2018, asserts that it is imperative to assess working posture to identify the hazards that personnel face while executing their responsibilities. Employees in occupations such as cake decorating and fabric cutting may include poor postures. Improper bending or sitting can lead to discomfort and perhaps long-term harm. Based on the risk levels determined by posture, musculoskeletal issues must be immediately averted. For instance, employees utilizing obsolete equipment or inferior facilities may experience discomfort in their wrists, neck, and back. Enhancing workspaces, including reconfiguring workstations designed to support employees' postures, can mitigate these risks while also enhancing comfort and productivity. This study underscores the significance of increased focus on ergonomics to prevent health issues and enhance productivity.

Peter Trebuna, 2017, underscores the financial losses endured by employers due to their in the context of ergonomics. Production may decline if ergonomic principles are violated. The legislation stipulates employers to furnish suitable working conditions that mitigate factors contributing to physiological and psychological stress. Legally mandated methods and tools must be employed to evaluate physical workplace attributes. Ergonomics, as a scientific discipline, focuses on optimizing interactions among personnel, their environment, and equipment to ensure efficiency and security.

Deouskar (2017) demonstrates that ergonomics can significantly enhance worker productivity in enterprises. To prevent burnout and cultivate lasting relationships with employees, organizations may create inclusive environments that emphasize mental and physical well-being. Research indicates that female employees may necessitate additional factors for psychological comfort compared to their male counterparts. To ensure that employees are satisfied, comfortable, and able to perform at their highest capacity, businesses should endeavor to foster work-life balance and enhance interpersonal relationships.

4. RESEARCH METHODOLOGY

The research employed a quantitative methodology, incorporating inferential analysis and descriptive investigation to evaluate the impact of ergonomic office design on electrical engineers well-being and productivity of professionals. A mobile-based Google Form survey designed to collect a wide array of viewpoints and experiences with ergonomic workplace design was the primary source of information. Given that the study primarily concentrated on firsthand responses provided by electrical engineers. Secondary data sources, including articles and information regarding electrical engineers found in search engines, were used. Individuals engaged in electrical engineering roles, including engineers, electricians, managers and supervisors were the focus of the study. Participants' ages varied from 18 to 60, yielding 178 valid responses. The study utilized a convenience sample method to ensure that the participants were intimately connected to its objectives. The collected data was analyzed using Microsoft Excel. Two-way ANOVA was used to assess the significance of ergonomic factors on the productivity and well-being of electrical engineers. Descriptive statistics was also used to emphasize significant trends and summarize the responses.

5. DISCUSSION

The study productivity and well-being of electrical engineers. Numerous substantial trends and insights were revealed by this comprehensive analysis, which was segmented into categories that underscore the importance of ergonomic interventions and professional responsibilities, demographics, and their associated outcomes.

1. Reduced discomfort and injury

Given that electrical engineering employment frequently involves repetitive tasks and prolonged periods of standing, utilizing ergonomic office design significantly reduces the likelihood of accidents. Chronic health issues can be mitigated by investing in adjustable desks and ergonomic chairs and other ergonomic furniture.

2. Ergonomically Engineered Workstations

An ergonomically designed desk enhances both efficiency and comfort. This has the potential to enhance engineers' comprehensive work experience and productivity by enhancing concentration, minimizing physical mitigating stress, and minimizing distractions stemming from discomfort.

3. Inadequate Ergonomic Design

Ineffective ergonomic practices elevate fatigue, discomfort, and the likelihood of injury, all of which may diminish productivity and job satisfaction. The results underscore the importance of financial expenditure involved. Developing suitable ergonomic solutions prevents adverse outcomes such as substantial staff attrition or an increase in absenteeism due to illness.

4. Mitigation of Fatigue and Strain

By mitigating the possible physical burden that engineering labor may impose, well-designed ergonomic approaches not only mitigate injuries but also enhance work-life balance. Engineers may endure extended hours with diminished fatigue when physical exertion is alleviated, which enhances time management and reduces disruptions to personal life from physical discomfort.

5. Decrease in absenteeism due to illness

An essential aspect of reducing absenteeism due to illness or injury is ergonomic design. Through promoting physical health, ergonomic work conditions can reduce the incidence of prevalent health issues that lead to absenteeism, thereby benefiting enterprise workforce by reducing healthcare costs and minimizing downtime.

6. Ergonomic Training & Education

The employees consider ergonomic training crucial, underscoring its significance of perceived role in preventing workplace injuries, minimizing physical discomfort, and enhancing overall productivity. This training equips workers with the knowledge to properly use ergonomic tools, adopt safe postures, and creates efficient workspaces, which in turn contributes to reduced absenteeism and improved job satisfaction. Ergonomic awareness isn't just an added benefit but a core component of professional development in technical roles. Ergonomic training and education are seen as significant drivers of worker well-being, efficiency, and long-term organizational success.

7. Employee Retention

A well-designed ergonomic workspace not only ensures physical comfort but also enhances productivity, emotional and psychological involvement. Comfortable environments promote satisfaction and a sense of value, which enhance enthusiasm, initiative, and commitment to the organization, resulting in employee retention.

8. Employment Contentment

Employee satisfaction with their employment is often correlated with motivation. Minimizing mitigating discomfort and fostering a healthy work environment engenders a sense of appreciation among employees, which enhances their motivation and determination to perform at their highest capacity. Ergonomics enhances overall workplace pleasure and indirectly fosters a more motivated workforce.

Principal Statistical Insights:

The study aims to evaluate the significance of different work place factors and impact levels on productivity and well-being outcomes using Two way ANOVA.

H1: The productivity of electrical engineers are significantly enhanced by ergonomic workplace design.

Source of Variation	Sum of squares	Df	Mean Square	F value	P-value
Rows	60.00	3	20.00	8.00	0.052
Columns	180.00	3	60.00	24.00	0.00002
Error	22.50	9	2.50		

Total	262.50	15			

Table No. 1 Anova results for Productivity

The two-way ANOVA results presented in the table examine the impact of various ergonomic factors - **Reduced Physical Discomfort, Ergonomically Designed Workstations, Engineer's Productivity, Cost-Effective Measures, and Poor Ergonomic Design** - on the productivity of electrical engineers. The rows represent different levels of perceived productivity impact, while the columns capture the specific ergonomic dimensions.

From the analysis, the **F-value for rows is 8.00**, with a **P-value of 0.052**. While this is slightly above the commonly used significance level of 0.05, it is marginal and suggests a near-significant influence of the different productivity impact levels. In contrast, the **F-value for columns** is **24.00,** with a **P-value of 0.00002**, which is well below the 0.05 threshold. This clearly indicates a statistically significant difference in engineer productivity across the various ergonomic factors.

These findings lend partial support to the hypothesis: *"The productivity of electrical engineers is significantly enhanced by ergonomic workplace design."* While the variation among the levels of impact (rows) is only marginally significant, the type of ergonomic intervention (columns) has a highly significant effect. Therefore, we can conclude that specific ergonomic features—especially those aimed at reducing discomfort and improving workstation design—play a critical role in enhancing productivity among electrical engineers.

H2: The well-being of electrical engineers are significantly enhanced by ergonomic workplace design.

Source of Variation	Sum of squares	Df	Mean Square	F value	P-value
Rows	160.00	3	53.33	15.24	0.0009
Columns	7061.68	3	2353.89	672.54	1.01E-10
Error	31.75	9	3.53		
Total					

Table No. 2 Anova results for Well-being

Table 2 results clearly indicate that ergonomic workplace design has a statistically significant impact on the well-being of electrical engineers. The analysis considered five critical factors - **Prevention of fatigue and strain, Reduction of sick days, Availability of office furniture, Ergonomic training and education, and Higher employee retention as** column variables. The well-being of electrical engineers showed a significant column effect ($p<0.0001$), indicating factors such prevents fatigue & strain, reduction of sick days, availability of office ergonomic office furniture, ergonomic training and education, higher employee retention are related to well-being of electrical engineers are meaningful. The findings strongly support the hypothesis: *"The well-being of electrical engineers is significantly enhanced by ergonomic workplace design."* The low error mean square (MS) value further suggests minimal unexplained variation, strengthening the reliability of the results. Overall, the study confirms that well-planned ergonomic interventions significantly contribute to reducing physical strain, minimizing absenteeism, improving comfort, and ultimately enhancing retention and well-being among electrical engineers.

6. CONCLUSION

This study underscores the significance of ergonomic workplace design for enhancement of productivity, well-being, and job satisfaction of electrical engineers. The findings indicate that ergonomic interventions substantially enhance long-term health outcomes and prevent injuries, helping alleviate bodily discomfort. The majority of engineers indicated that ergonomics had a positive influence on their professional experience, emphasizing enhanced work-life equilibrium, increased productivity, and a reduction in fatigue and strain. The statistical analysis underscores the significance of ergonomics in fostering productivity and a conducive workplace. Elevated degrees of comfort, motivation, and involvement are commonly represented by engineers employed in ergonomically designed work environments, such ultimately enhances productivity and reduces absenteeism. In conclusion, integrating ergonomic principles into the workplace fosters long-term health, occupational contentment, and psychological well-being alongside bodily comfort. Employers have the potential to enhance overall productivity, reduce healthcare costs, and improve employee retention by enhancing the workplace. The evidence from the study robustly endorses the implementation of ergonomic design as a strategic long-term investment that advantages both employers and employees

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