Occupational Safety, Health, and Ergonomics in Smes: A Conceptual Framework for Sustainable Work Performance

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ABSTRACT

Occupational safety and health (OSH) and ergonomics are critical elements in ensuring sustainable workforce productivity. This is especially true for small and medium-sized enterprises (SMEs). OSH focuses on identifying, assessing, and mitigating workplace hazards, while ergonomics ensures that tasks and environments are aligned with human capabilities to reduce strain and improve efficiency. Despite their importance, SMEs frequently encounter financial limitations, managerial capacity gaps, and low regulatory awareness, which make the implementation of OSH and ergonomic initiatives difficult. These barriers have drawn increasing concern as poor safety and ergonomics are strongly associated with health risks, reduced morale, and weaker competitiveness. Drawing from the Job Demands–Resources (JD-R) model and Socio-Technical Systems (STS) theory, this paper presents a conceptual study that integrates OSH and ergonomics within the SME context by examining the interrelationships between work organization, environmental conditions, posture and movement, productivity, and work performance. This paper also explores how digital technologies, Industry 4.0, and post- pandemic adjustments have reshaped approaches to workplace safety and ergonomics. By proposing a conceptual framework, the study contributes both theoretically and practically, offering SMEs pathways to enhance productivity while safeguarding employee well-being. The insights are expected to provide useful implications for policymakers, practitioners, and researchers committed to building safer, more adaptive, and sustainable workplaces in the SME sector.

Keywords: Occupational Safety and Health, Ergonomics, SMEs, Productivity, Work Performance, Sustainability

INTRODUCTION

The rapid transformation of work environments has intensified the need to prioritize occupational safety and health (OSH) in tandem with ergonomic practices. OSH seeks to protect the health and functional capacity of workers by systematically identifying, assessing, and preventing hazards in the workplace (International Labor Organization [ILO], 2021). Ergonomics complements this by applying scientific principles to reduce physical and cognitive strain, optimize task design, and ensure that workplace conditions support human performance (Davis & Kotowski, 2022).

Taken together, OSH and ergonomics provide a comprehensive approach to sustaining worker well-being, strengthening organizational productivity, and ensuring long-term resilience. Small and medium-sized enterprises (SMEs) are widely regarded as the backbone of economic growth and employment generation. In Malaysia, as in many developing countries, SMEs account for more than 90% of registered businesses (OECD, 2021). However, most of these enterprises lag behind in implementing systematic OSH and ergonomic practices. Barriers such as limited financial resources, insufficient managerial expertise, and weak

regulatory awareness constrain their ability to create safer and healthier work environments (Awang et al., 2023). Consequently, SME employees are more likely to experience occupational accidents, musculoskeletal disorders, and lower job satisfaction compared to those in larger organizations (Rahim et al., 2022). The COVID-19 pandemic further exposed the importance of safety and ergonomics by reshaping traditional work arrangements and amplifying psychosocial risks (Burke et al., 2021). At the same time, digital transformation and Industry 4.0 technologies ranging from sensor-based monitoring to data-driven risk assessment have opened new opportunities for SMEs to manage workplace hazards and improve ergonomic conditions (Firoozi et al., 2023). These shifts underscore the urgency of developing integrated frameworks that capture the dynamic interplay between OSH, ergonomics, and performance outcomes in SMEs. Against this backdrop, the present study offers a conceptual exploration of how OSH and ergonomics influence productivity and work performance in SMEs. By synthesizing insights from recent literature (2020–2025) and proposing a conceptual framework, the study seeks to bridge theoretical gaps while offering practical directions for SME managers, policymakers, and scholars striving to create safer, healthier, and more efficient workplaces.

LITERATURE REVIEW

Work Organization

Work organization encompasses the arrangement of tasks, schedules, and responsibilities in daily operations (Carayon & Smith, 2000). Earlier studies highlighted how job design, shift patterns, and supervisory roles shape safety outcomes and employee health (Hagberg et al., 1995). More recent research indicates that flexible work arrangements, participatory management, and digital monitoring tools not only enhance efficiency but also reduce psychosocial risks (Lee & Jeong, 2021). While these findings converge on the importance of organizational structures for safety, SMEs remain disadvantaged due to weak formal systems, long working hours, and limited supervisory support (Awang et al., 2023). A gap persists in the literature on scalable interventions that SMEs can realistically implement. Future research should examine which forms of participatory ergonomics or low-cost work redesign yield the greatest benefits, enabling SMEs to balance financial constraints with improved safety and productivity.

Environmental Factors

Environmental ergonomics considers both physical and psychosocial conditions such as noise, lighting, air quality, and temperature. Consensus exists across studies that poor environmental quality increases fatigue, stress, and lowers productivity (Ettner & Grzywacz, 2001). More recent evidence emphasizes the heightened relevance of indoor air quality and hygiene in the post-pandemic workplace (Cao et al., 2021). Digital technologies, such as sensor-based monitoring, present new opportunities for SMEs to evaluate compliance and improve safety in real time (Firoozi et al., 2023). However, studies often assume SMEs have equal access to these tools, overlooking persistent barriers such as cost and infrastructure gaps. There is little comparative evidence on the trade-offs between high-tech solutions and low-cost alternatives like improved ventilation systems or better lighting design. Future work should incorporate cost-benefit analyses that guide SMEs in selecting affordable interventions without compromising safety.

Posture and Movement

Improper posture and repetitive movement patterns remain significant causes of musculoskeletal disorders (MSDs), particularly in labor-intensive SMEs (Marras, 2000). Research continues to show that awkward postures, repetitive lifting, and static work positions are primary contributors to back pain and reduced productivity (Li et al., 2021). Ergonomically designed workstations, based on anthropometric data and task analysis, have been shown to alleviate these risks (Sander, 2014). Recent studies stress the importance of integrating ergonomic training and low-cost interventions, such as adjustable workstations and task rotation, which are particularly relevant for SMEs with limited resources (Hafeez et al., 2022). In addition, participatory ergonomics, where workers are directly involved in identifying risks and suggesting improvement has proven to be effective in reducing MSDs while fostering a stronger sense of ownership and

compliance among employees (Kogi, 2003). Technological innovations, such as wearable devices and sensor-based monitoring systems, also provide SMEs with affordable means to track posture and movement patterns in real time, offering opportunities for preventive interventions before injuries occur (Dodoo et al., 2024). Importantly, interventions should not only target physical strain but also address work-rest cycles and psychosocial demands, as prolonged fatigue and stress can exacerbate musculoskeletal risks. Taken together, these findings underscore that a combination of training, worker participation, low-cost redesign, and technology adoption provides the most practical pathway for SMEs to reduce MSDs, improve well-being, and sustain productivity despite financial and organizational constraints.

Productivity and Work Performance

Productivity and work performance are strongly influenced by the integration of OSH and ergonomics. Earlier studies established that good ergonomics practices improve efficiency, reduce errors, and increase profitability (Yeow et al., 2000; Kogi, 2003). Recent findings (2020–2025) reinforce this link, showing that ergonomic interventions enhance job satisfaction, reduce absenteeism, and contribute to long-term organizational sustainability (Dawal et al., 2020; Chen et al., 2023). For SMEs, where labor productivity directly affects survival and competitiveness, investments in ergonomics and safety practices are essential to sustaining performance in increasingly competitive markets. Cost-benefit models that compare upfront expenditures with long-term gains in productivity and reduced healthcare costs are rarely applied to SMEs, representing a significant area for future research.

Ergonomics Applications and Personal Protective devices (PPDs)

The use of ergonomic applications and personal protective devices (PPDs) is a fundamental aspect of workplace safety. Earlier studies (Rahman et al., 2000) reported widespread neglect of PPDs in SMEs, leading to high accident rates. Recent research indicates some improvement, with digital technologies enabling better design and monitoring of safety equipment (Nasir et al., 2021). However, adoption remains inconsistent in SMEs due to cost barriers and lack of enforcement (Awang et al., 2023). Ergonomic applications such as participatory ergonomics and lean workplace design have been identified as cost-effective methods for reducing workplace hazards while improving worker involvement and motivation (Hafeez et al., 2022). Participatory ergonomics and lean workplace design are repeatedly shown to be cost-effective strategies, but little comparative evidence exists across sectors and regions. More empirical studies are needed to test scalable models of PPD adoption that align affordability with safety, especially in developing economies.

Integration of OSH and Ergonomics in SMEs

When OSH and ergonomics are considered together, they create a holistic framework for safe and productive workplaces. Large firms often adopt global standards such as ISO 45001, but SMEs continue to face difficulties in aligning these practices with their day-to-day realities (ILO, 2021). Recent studies suggest that digitalization and Industry 4.0 tools can help close this gap by making compliance more achievable for resource-constrained firms (Firoozi et al., 2023; Chen et al., 2023). At the same time, the United Nations' Sustainable Development Goal 8 (Decent Work and Economic Growth) emphasizes the broader role of workplace safety in economic and social sustainability (United Nations, 2022). In this sense, integrating OSH and ergonomics into SME strategies is not only a matter of compliance but a pathway to long-term resilience and growth. Literature therefore lacks nuanced models that balance technological advancement with workforce readiness. Future studies should critically evaluate hybrid approaches combining low-cost ergonomic improvements with gradual digitalization that are both feasible and sustainable for SMEs.

Problem Statement

Small and medium-sized enterprises (SMEs) are widely acknowledged as engines of economic growth, contributing significantly to employment creation and industrial competitiveness. However, they consistently face challenges in implementing comprehensive occupational safety and health (OSH) and ergonomic

practices. Unlike larger enterprises, SMEs are constrained by limited financial resources, inadequate managerial capacity, and a lack of awareness of legal and regulatory requirements (Awang et al., 2023). Consequently, OSH and ergonomic initiatives are often perceived as secondary to operational priorities, leading to unsafe working conditions, musculoskeletal disorders, and lower levels of job satisfaction among employees (Rahim et al., 2022). The persistence of these issues highlights a critical gap in both theory and practice. While existing research has established the link between OSH, ergonomics, and productivity, most studies focus on large-scale organizations, with limited attention to SMEs, particularly in developing economies. Furthermore, although post-pandemic literature has emphasized digital technologies and Industry 4.0 applications in workplace safety, there is little evidence on how these advancements are integrated within SME contexts (Firoozi et al., 2023).

This absence of SME-specific frameworks weakens the ability of policymakers, researchers, and practitioners to design interventions that balance safety, health, and productivity. This study seeks to address these gaps by proposing a conceptual framework that integrates OSH and ergonomics into the dynamics of work organization, environmental conditions, posture and movement, and productivity. By doing so, it contributes both theoretical insights and practical strategies to help SMEs create safer and more productive workplaces.

Research Objectives

The study seeks to achieve the following objectives:

1. To examine the relationship between work organization, environmental factors, posture and movement, and work performance in SMEs.
2. To evaluate whether personal protective devices (PPDs) and ergonomic applications influence productivity and work performance.
3. To explore the relationship between productivity and overall work
4. To identify the most influential factors affecting work performance in
5. To propose strategies and design recommendations for improving work processes and ensuring sustainable SME performance.

Underpinning Theory

The Job Demands–Resources (JD-R) model (Bakker & Demerouti, 2007) provides a useful theoretical underpinning for understanding how occupational safety and health (OSH) and ergonomics influence work performance in SMEs. The model distinguishes between job demands, which are aspects of work that require sustained effort and are associated with physical and psychological costs, and job resources, which are the physical, psychological, or organizational supports that help employees meet demands, achieve goals, and stimulate growth. In the SME context, job demands often manifest in the form of poor work organization, inadequate environmental conditions, and repetitive or awkward postures, which can lead to fatigue, musculoskeletal disorders, and lower job satisfaction.

Conversely, job resources such as ergonomic applications, personal protective devices (PPDs), supportive management practices, and digital safety tools can buffer these demands, enhance motivation, and sustain productivity. The JD-R model highlights two simultaneous processes: the health impairment process, where excessive demands without adequate resources lead to strain and reduced performance, and the motivational process, where sufficient resources foster engagement, resilience, and higher productivity. In the proposed conceptual framework, productivity functions as the mediating link between demands and outcomes, while PPDs and ergonomic aids serve as moderating resources that shape the relationship between workplace conditions and work performance. By applying the JD-R lens, OSH and ergonomics can be framed not merely as compliance measures but as strategic resources that protect workers from strain while promoting motivation, engagement, and sustainable competitiveness in SMEs.

Another theory to support this study is the Socio-Technical Systems (STS) theory. The theory was first introduced by Trist and Bamforth (1951), emphasizes the interdependence of social and technical elements in

the workplace. It argues that organizational performance is optimized when both the social system (people, culture, leadership, and work practices) and the technical system (tools, equipment, technologies, and processes) are jointly designed to complement each other. In the context of SMEs, STS theory provides an important lens for understanding how occupational safety, health, and ergonomics cannot be managed effectively through technical interventions alone, such as machinery upgrades or digital monitoring, without considering the social aspects like worker participation, training, and safety culture. For example, ergonomic tools and personal protective devices (PPDs) are unlikely to achieve their intended impact if employees lack awareness, motivation, or managerial support. Similarly, investments in Industry 4.0 technologies may fail if not aligned with worker skills, attitudes, and organizational practices. By integrating STS into the conceptual framework, this study highlights the need for SMEs to strike a balance between human-centered approaches and technological solutions, ensuring that both dimensions reinforce each other to create safer, healthier, and more sustainable workplaces.

Conceptual Framework

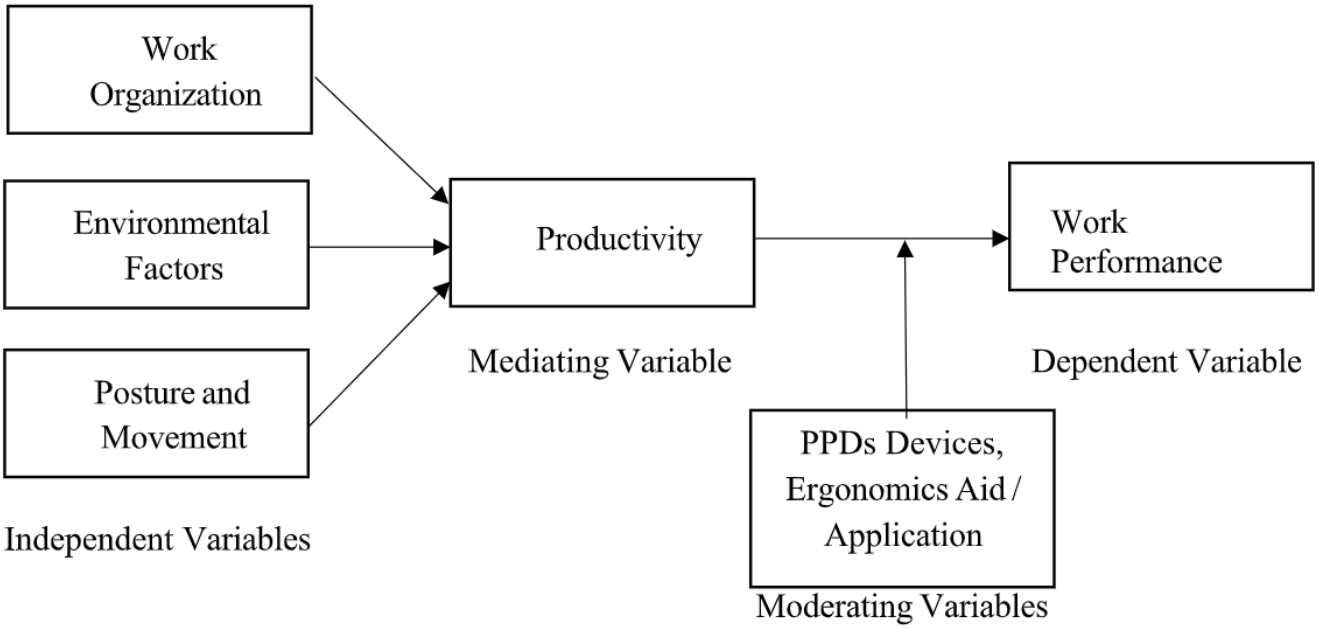

Figure 1.0: Conceptual Framework

The proposed conceptual framework integrates occupational safety and health (OSH) with ergonomic principles to explain their influence on productivity and work performance in small and medium-sized enterprises (SMEs). Drawing on prior research and recent developments, the framework identifies work organization, environmental factors, and posture and movement as the key independent variables shaping employee productivity and, subsequently, overall work performance. Work organizations encompass job design, scheduling, supervisory practices, and team dynamics, all of which directly affect both physical and psychological well-being. Environmental factors include physical conditions such as lighting, noise, air quality, and thermal comfort, as well as psychosocial elements that shape worker morale and efficiency. Posture and movement address ergonomic concerns such as repetitive strain, static postures, and heavy lifting, which are common in SMEs and strongly associated with musculoskeletal disorders.

Productivity is conceptualized as a mediating variable, representing the extent to which improvements in organizational and ergonomic conditions translate into measurable performance outcomes. Meanwhile, personal protective devices (PPDs) and ergonomic applications are positioned as moderating variables, shaping the strength and direction of the relationship between workplace conditions and performance. This framework emphasizes that OSH and ergonomics should not be treated as compliance driven obligations but as strategic enablers of competitiveness and sustainability within SMEs. It provides a theoretical basis for understanding how resource constrained enterprises can balance safety and productivity, particularly in the context of Industry 4.0 and post-pandemic workplace transformations.

Based on the objectives and the conceptual framework, the following testable hypotheses are proposed:

H1: Work organization, environmental factors, and posture and movement have a significant positive relationship with work performance in SMEs.

H2: Personal protective devices (PPDs) and ergonomic applications positively moderate the relationship between workplace factors (work organization, environmental conditions, posture and movement) and productivity.

H3: Productivity mediates the relationship between workplace factors and work performance in SMEs.

H4: Among workplace factors, posture and movement exert the strongest influence on work performance in SMEs.

H5: The adoption of integrated OSH and ergonomic practices significantly improves the sustainability of SME performance in competitive environments.

Significance of Study

This study offers practical guidance for SME managers, industry stakeholders, and policymakers. For SMEs, the framework highlights critical areas such as task design, environmental management, and ergonomic adjustments that directly affect worker performance. By adopting even low-cost ergonomic solutions and promoting consistent use of PPDs, SMEs can reduce accidents, improve morale, and strengthen productivity without imposing excessive costs. Policymakers may also draw on these insights to design targeted training, subsidies, and capacity building initiatives that are tailored to the needs of smaller firms.

From a scholarly perspective, this study enriches the literature on occupational safety, health, and ergonomics by contextualizing these issues within SMEs, a sector that remains underexplored compared to large organizations. The conceptual model contributes to theory by linking organizational, environmental, and ergonomic dimensions with productivity and performance in a structured manner. Moreover, by incorporating moderating and mediating variables, the study advances understanding of the mechanisms through which OSH and ergonomics influence outcomes in SMEs.

The study also connects global sustainability debates by aligning with the United Nations Sustainable Development Goal 8 (Decent Work and Economic Growth). By encouraging safer and healthier workplaces in SMEs, the framework underscores the dual role of OSH and ergonomics in improving worker well-being while contributing to economic resilience and national growth. In this sense, safety and ergonomics are framed not only as protective measures but as catalysts for sustainable industrial development.

DISCUSSION AND IMPLICATIONS

This conceptual study highlights the pivotal role of occupational safety and health (OSH) and ergonomic practices in shaping productivity and work performance within small and medium- sized enterprises (SMEs). The framework developed in this study reinforces the idea that SMEs, despite resource constraints, can achieve sustainable performance through strategic integration of OSH and ergonomics. One of the key insights from this study is that SMEs often face a trade-off between allocating resources to immediate operational needs versus investing in OSH and ergonomics. The framework suggests that this trade-off is a false dichotomy: even low-cost interventions, such as task rotation, participatory ergonomics, and simple workplace adjustments, can generate significant gains in productivity and employee well-being. This finding supports earlier calls for SMEs to view ergonomics not as a luxury, but as a cost-saving strategy that reduces absenteeism, turnover, and accidents while strengthening morale. On the other notes, although this study emphasizes physical aspects of ergonomics, the discussion also opens avenues for considering psychosocial dimensions, such as stress, job insecurity, and workload pressure. These issues are particularly salient in SMEs where workforces are smaller, roles are less specialized, and employees are more exposed to long working hours and multitasking demands. Cultural attitudes towards safety further shape OSH

implementation. In contexts where safety is perceived as secondary or optional, interventions must address not only systems but also mindsets. Leadership commitment and the cultivation of a safety culture emerge as crucial drivers of behavioral change in SME.

From a theoretical perspective, this study extends the understanding of occupational safety, health, and ergonomics in SMEs by applying the Job Demands–Resources (JD-R) model as an underpinning framework. The JD-R model posits that workplace conditions can be categorized into job demands, which require effort and may deplete employee well-being, and job resources, which buffer demands, stimulate engagement, and enhance performance (Bakker & Demerouti, 2007). In the context of SMEs, job demands are reflected in poor work organization, hazardous environmental conditions, and repetitive or awkward postures and movements. These demands increase the risk of strain, musculoskeletal disorders, and job dissatisfaction. At the same time, job resources such as ergonomic applications, personal protective devices (PPDs), training, and supportive supervisory practices serve as critical enablers that help workers manage strain, maintain health, and sustain productivity. By positioning productivity as a mediating variable, the framework emphasizes how improvements in ergonomic and safety conditions translate into tangible organizational outcomes. Moreover, the inclusion of PPDs and ergonomic applications as moderating variables aligns with the JD-R model's proposition that resources not only buffer the negative impact of demand but also enhance motivational processes. This dual pathway highlights that SMEs can achieve sustainable performance by strategically managing the balance between job demands and resources, even when financial and structural limitations exist. In addition, this study draws on the Socio-Technical Systems (STS) perspective, which emphasizes that organizational effectiveness depends on the alignment of both social (workers, culture, management practices) and technical (tools, technologies, ergonomic design) systems. By incorporating Industry 4.0 technologies, participatory ergonomics, and digital monitoring tools into the conceptual framework, this study acknowledges that safety and ergonomics in SMEs are not isolated technical issues but deeply embedded in broader organizational and cultural contexts. Taken together, the application of JD-R and STS theories enriches the conceptual framework by offering a multi-level explanation of how OSH and ergonomics affect SME outcomes. The JD-R model provides insight into the mechanisms linking demands, resources, and performance, while STS theory situates these mechanisms within the broader interaction of people, technology, and organizational structures. This theoretical integration contributes to the literature by contextualizing OSH and ergonomics in SMEs as both a human-centered and system-driven process, reinforcing the view that safety and health are strategic levers for resilience, sustainability, and competitiveness.

For policymakers in developing countries, enhancing OSH and ergonomics in SMEs requires policies that move beyond compliance and address structural constraints. Unlike larger firms, SMEs often lack both financial resources and institutional support to implement comprehensive safety programs. Direct subsidies or tax incentives for ergonomic equipment, personal protective devices, and digital safety tools could reduce financial barriers and encourage adoption. In addition, governments can establish national training programs tailored to SMEs, equipping workers and managers with the knowledge to implement low-cost yet effective interventions. Infrastructure gaps also play a central role in limiting SME adoption of Industry 4.0 technologies.Investments in digital infrastructure, such as affordable internet connectivity and shared digital monitoring platforms, can make advanced safety tools more accessible to smaller firms. To address cultural resistance, national campaigns that promote safety awareness and foster positive safety cultures are essential, particularly in industries where risk-taking behaviors are normalized. At a global level, aligning SME-oriented OSH policies with the United Nations Sustainable Development Goal 8 (Decent Work and Economic Growth) would reinforce the idea that workplace safety is not only a compliance issue but also a driver of inclusive economic development. Regional collaboration through industry associations, chambers of commerce, and cross-border networks could further strengthen SME capacity by sharing best practices and scalable intervention models. By embedding OSH and ergonomics into broader economic and social policies, governments can enhance both worker well-being and national competitiveness.

Since SMEs face significant financial limitations, cost-benefit analysis of ergonomic interventions are essential. Evidence suggests that even low-cost strategies such as task rotation, participatory ergonomics, and basic workstation redesign reduce musculoskeletal risks while improving productivity (Hafeez et al., 2022).

Yet, few studies quantify long-term savings from reduced absenteeism and turnover. Developing scalable intervention models that align affordability with safety would fill this gap and offer SMEs practical tools for decision-making. Despite the promise of Industry 4.0 technologies, barriers such as poor digital infrastructure, limited workforce training, and cultural resistance impede adoption in SMEs (Khoo, 2023). Many SMEs in developing countries operate in traditional sectors where awareness and readiness for digital solutions remain low. This suggests that digitalization strategies must be coupled with capacity-building programs and context-specific training to avoid widening inequalities between large firms and SMEs. Addressing these barriers would make Industry 4.0 interventions more realistic and implementable.

CONCLUSION

This paper advances the understanding of occupational safety, health, and ergonomics within SMEs by proposing a conceptual framework that links workplace conditions with productivity and work performance. By positioning productivity as a mediating variable and PPDs and ergonomic applications as moderating influences, the framework captures the complex dynamics between organizational, environmental, and ergonomic factors in resource-constrained enterprises. The findings suggest that SMEs, despite their financial and structural limitations, can enhance performance and competitiveness through incremental improvements in OSH and ergonomic practices. In the era of Industry 4.0 and post-pandemic recovery, digital tools and innovative practices offer new opportunities for SMEs to strengthen workplace safety while sustaining productivity.

The discussion underscores that while Industry 4.0 technologies offer transformative opportunities, their implementation in SMEs is constrained by digital infrastructure gaps, limited training, and cultural resistance. Rather than assuming seamless adoption, future strategies should focus on hybrid approaches that integrate incremental ergonomic improvements with gradual digitalization. The literature review highlights areas of consensus such as the positive effects of ergonomic interventions on productivity as well as persistent gaps, particularly regarding SMEs. Few studies assess the cost–benefit trade-offs of ergonomic and safety interventions, despite their importance for financially constrained firms. Addressing this gap through empirical analyses would strengthen the case for scalable, low-cost interventions that balance affordability with worker well-being.

Theoretically, this study enriches the body of knowledge on OSH and ergonomics in SMEs by integrating scattered insights into a coherent framework. Practically, it provides actionable guidance for SMEs, policymakers, and industry practitioners committed to fostering safer, healthier, and more productive workplaces. In conclusion, the proposed framework contributes to theory by integrating the Job Demands–Resources (JD-R) model and Socio-Technical Systems (STS) perspective, while offering practical pathways for SMEs to enhance performance under resource constraints. Future empirical studies are needed to test the proposed hypotheses across industries and regions, paying particular attention to developing economies where the challenges and opportunities are most pronounced. By combining theoretical rigor with practical relevance, this study positions OSH and ergonomics not as optional add-ons but as strategic drivers of sustainable performance in SMEs.

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