

Investigation on Spatial Design Quality for Furniture Manufacturing

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ABSTRACT: Despite ranking high in global furniture exports, the Malaysian furniture industry grapples with stagnant productivity and value-addition. Traditional production lines and uninspiring factory environments fail to engage and motivate employees, hindering growth potential. This research delves into the under-explored realm of strategic spatial design and the physical environment as potent tools for unlocking productivity gains in both production and workforce performance. This study meticulously examines specific factors to prioritize those with the most significant impact. The issue for this research mainly focuses on the lacking of design principles that affect the spatial design elements and physical environmental factors for furniture manufacturing. By analyzing the interplay between spatial design elements and physical environmental factors, this study aims to develop design principles that foster a productive, comfortable, and thriving workplace environment. Drawing insights from diverse precedent studies and employing a robust methodology, this research investigates the comparative impact of spatial design and the physical environment on Malaysian and overseas furniture manufacturing productivity. Research findings draw a distinct comparison between the Malaysian furniture industry and its foreign counterparts. In Malaysia, the focus predominantly centers on spatial design such as lean manufacturing, structural design and the availability of equipment, whereas overseas factories adopt a holistic approach that emphasizes both manufacturing efficiency and employee well-being. This research reveals that the furniture manufacturing for overseas industries provides a more comprehensive strategy which emphasizes on the spatial design and physical environment compared to Malaysia furniture industry.

Key Words: Spatial Design, Physical Environment, Furniture Manufacturing Productivity

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I. INTRODUCTION

Despite ranking among the top 15 global furniture exporters in the world [17], the Malaysian furniture industry exhibits concerning trends. From 2003 to 2019, its growth stagnated, indicating declining competitiveness [29]. Based on the Annual Manufacturing Survey, analysis reveals a dependence on increasing factor inputs for industrial growth, while labor and capital productivity remain stagnant or declining [20]. This suggests a worrying trend of decreasing value-addition and innovation within the industry. These observations necessitate a closer examination of the factors hindering the Malaysian furniture industry's progress and potential avenues for revitalization. In the price-driven furniture market, maximizing productivity reigns supreme as the ultimate weapon for competitive advantage [20]. One readily accessible path to this productivity prowess lies in the strategic manipulation of space through plant layout optimization. Plant layout design, the art of orchestrating physical facilities for seamless production flow, has long been recognized as a key driver of overall productivity and output [19]. Its essence lies in the careful placement of machinery, tools, raw materials, labors and accessories within the production process. As Lad et al (2016) perceptively observed, a well-conceived layout minimizing inter-process time and distance can unleash significant productivity gains. These studies underscore the pivotal role of spatial design in fueling the furniture manufacturing productivity. Far from mere aesthetics, spatial design encompasses the interplay of shapes, elements, colors, and light, shaping not just the physical landscape but also the human experience within it. By harnessing the power of space, we unlock a potent tool for propelling furniture manufacturing towards a future of amplified productivity and efficiency.

Driven by ever-increasing daily output targets, furniture manufacturers face relentless pressure to optimize their operations. Beyond individual worker effort, inherent limitations within traditional production lines constrain true productivity gains. Seeking solutions, a growing number of companies are turning to lean manufacturing, pioneered by Toyota, to systematically eliminate "waste" across the production process. This

waste encompasses not just excess material or inefficient movements, but also unnecessary lead times, defects, and overproduction. As Sharma (2020) highlights, successfully implemented lean manufacturing practices not only unlock significant productivity improvements, but also translate into reduced material handling costs, minimized waste generation, and even a decreased reliance on forklifts on the shop floor. Recognizing the untapped potential of lean manufacturing in furniture manufacturing, this research delves deeper into its application, specifically focusing on optimizing spatial design and production flow to unlock a sustainable path towards enhanced productivity and competitiveness. Employee productivity in factories is a complex interplay of factors beyond individual skill and machinery. While efficient methods, quality assurance, and material availability are crucial, recent research emphasizes the often-overlooked role of the physical environment [23]. Temperature, air quality, lighting, noise, and workplace design all subtly influence worker performance and output. This perspective is supported by research that highlights the ideal outcome: "correct specification garments delivered on time, within budget, and meeting customer expectations" [4]. Achieving this requires a holistic approach that extends beyond traditional manufacturing optimization. The spatial configuration of the factory, the sensory experience it creates, and its impact on employee well-being all become critical components in the equation of furniture manufacturing production efficiency. The tangible aspects of the environment, such as inadequate lighting, have demonstrated a correlation with diminished reading comprehension, increased clerical errors, and the onset of physical discomforts like headaches and eyestrain. Similarly, an unsuitable thermal environment, be it excessively hot or cold, has been associated with symptoms of lethargy, irritability, and a notable decline in concentration. Notably, the intrusion of noise within office spaces emerges as a significant disruptive force, yet the complexity lies in the preferences of workers, who exhibit an aversion to both excessive noise and absolute silence, posing a formidable challenge in regulation. The amalgamation of these workplace conditions yields substantial reductions in productivity, registering declines that may extend up to 85% [22].

Within the demands of furniture manufacturing, strategic spatial design emerges as a potent tool for unlocking productivity gains across both production and workforce. Optimizing spatial layouts to align with industry-specific needs and worker preferences becomes a critical driver of efficiency and productivity enhancement. This emphasis on spatial design transcends mere blueprint planning, extending into a multidisciplinary realm encompassing public, internal, and physical environments [16]. At its core, spatial design delves into the intricate relationship between space and its human occupants, striving to craft-built environments that not only facilitate production but also nurture the well-being and engagement of the workforce. The physical environment of a furniture factory is more than just the backdrop to employee activity; it directly impacts both efficiency and competitiveness while serving as a critical factor in employee health and well-being. This environment can be broken down into several key elements: ergonomics, exposure to chemicals and particles, noise and vibration, climate, lighting, and safety. Of paramount importance in any industry, particularly at the factory level, is employee safety. This concern is multifaceted, impacting both the individual well-being of employees and the overall success of the corporation. The harsh working conditions, necessitating constant vigilance from employees, often leads to preventable mishaps [14].

Despite ranking prominently in global furniture exports, Malaysia's furniture industry grapples with stagnant productivity and value-addition [20]. Uninspiring factory environments and monotonous production lines erode employee engagement and motivation, stifling the potential for growth. The implementation of sustainable design in the Malaysian furniture industry encounters challenges attributed to a lack of knowledge and awareness [26]. Recent researches point towards a compelling solution: optimizing spatial design and the physical environment have demonstrated a positive correlation towards employee well-being, engagement, and ultimately, productivity [16] [23]. Unfortunately, there is a lack of comprehensive research that investigates the specific impact of the spatial design and physical environment towards Malaysia furniture industry productivity. The existing challenges in the Malaysian furniture industry include a lack of awareness regarding the importance of spatial design and physical environment. While there is extensive research focusing on the implementation and development of lean manufacturing in the industrial context, the spatial design, as a crucial supporting variable, remains underexplored and inadequately developed [21]. The relentless pursuit of cost-cutting in Malaysian furniture manufacturing prioritizes resource inputs over investments in the physical working environment [17]. This negligence overlooks the crucial role environmental factors play in employee safety, health, and comfort – all vital components of a productive workforce. This poses a problem as there may be resistance or oversight in implementing necessary changes. To address this, it is essential to identify and communicate the key reasons why spatial design and physical environment are crucial for enhancing productivity. The current state of the industry lacks a detailed evaluation of specific spatial design and physical environment elements that can significantly improve furniture manufacturing productivity. The current understanding of design-oriented criteria in the furniture industry relies heavily on consumer preferences, which might be inadequate for comprehensive product development [27]. Thus, this issue will conduct a meticulous examination of specific spatial design and physical environment factors, aiming to identify and prioritize

elements crucial for enhancing productivity in furniture manufacturing. The research objective of this study is focusing on three main objectives which are to understand impact of spatial design and physical environment towards the furniture manufacturing productivity, identifying the reason of importance of spatial design and physical environment in furniture manufacturing, and evaluating spatial design and physical environment that can improve the furniture manufacturing productivity.

Therefore, this research delves into the under-explored realm of factory design as a strategic tool for enhancing employee productivity in the furniture manufacturing industry. By analyzing the interplay between spatial elements, environmental factors, and human psychology, this study aims to develop design principles that foster a productive, comfortable, and ultimately, thriving workplace environment.

II. LITERATURE REVIEW

The literature analysis focuses on critical terms related to spatial design and the physical environment in the context of augmenting productivity within furniture manufacturing. These keywords serve as the foundational information for this study, aiding in comprehending strategies and select facets of sustainable design, particularly within the Malaysian context. The following set of keywords to be explored pertains to "Understanding productivity enhancement in furniture manufacturing," as it plays a pivotal role in clarifying the study's aims. Ultimately, this study aims to shed light on essential elements contributing to enhanced productivity in furniture manufacturing.

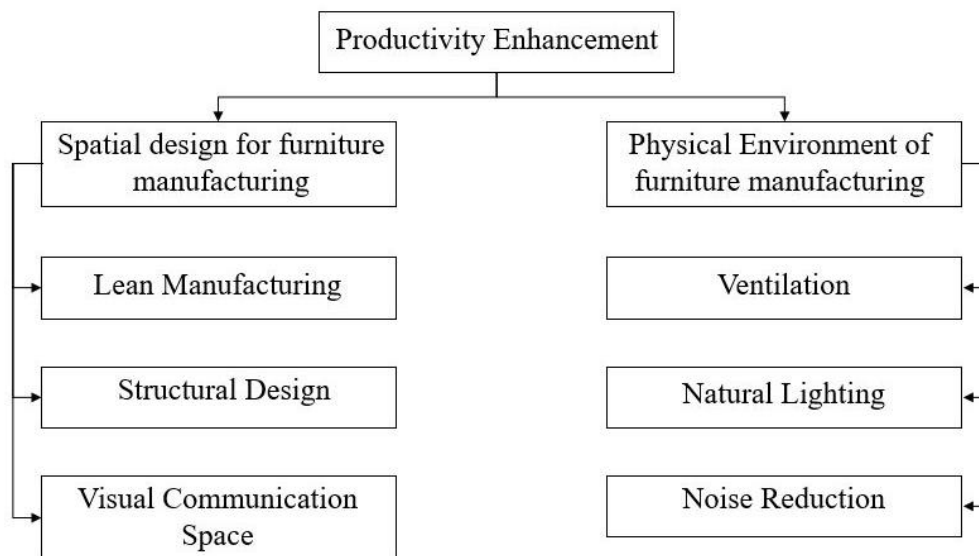


Fig. 1 The component of productivity enhancement

i) Spatial design for furniture manufacturing

Spatial design encompasses the planning, design, and management of spaces to create functional, aesthetically pleasing, and experience-enhancing environments. It goes beyond the typical definition of interior design by delving into the bigger picture: how people interact with, move through, and utilize a space. It focuses on the relationship between space and the user, aiming to create a built environment that enhances human experience [16].

Lean manufacturing primarily focuses on examining the influence of spatial design on human interaction within a production system and elucidating its correlation with production performance, specifically within the context of lean production. Incorporating lean manufacturing principles within wood manufacturing has the potential to yield a substantial 20-30% reduction in production costs, [9]. Achieving this involves streamlining production processes, curbing wastage, and enhancing overall productivity. This waste encompasses not just excess material or inefficient movements, but also unnecessary lead times, defects, and over production. The bustling chaos of a typical shop floor, with crammed tool cabinets, jumbled shelves, and unmarked walkways, makes it a constant struggle to keep tools, parts, and materials in order [11]. But for a furniture manufacturer in Chiang Mai, Thailand, the solution lies in lean manufacturing: utilizing space and time effectively. Their approach minimizes the time wasted searching for tools, materials, or information. Instead, their lean-inspired layout promotes a continuous flow of workers, materials, and information, transforming the chaotic into a well-oiled machine. Embracing a circular economy, closed-loop manufacturing is reshaping the

wood industry, promoting resource efficiency and environmental responsibility. This paradigm shift not only minimizes waste generation by repurposing wood by products like sawdust and scrap wood, but also optimizes resource utilization, leading to significant cost reductions. By transforming sawdust into biofuel pellets and scrap wood into innovative wood-based products, closed-loop manufacturing unlocks previously unrealized revenue streams while simultaneously enhancing brand sustainability and corporate social responsibility [13]. This synergistic approach not only resonates with eco-conscious consumers but also positions companies as industry leaders in environmental stewardship. As the wood industry embraces closed-loop principles, it paves the way for a thriving and sustainable future.

Embracing the dynamic nature of modern production, industrial structural design is evolving to prioritize retrofitting and expansion in buildings [10]. Gone are the days of rigid layouts; instead, imagine a modular grid system with inherent over-capacity, ready to accommodate future expansions and heavier equipment. Demountable walls and adaptable utilities become the building blocks, allowing for seamless reconfiguration of production lines and spaces. This future-proof approach minimizes downtime, maximizes operational productivity, and fosters a dynamic environment for innovation and technological advancements. By prioritizing configurability, industrial buildings transform from static structures into resilient platforms, ready to evolve alongside the ever-changing landscape of production. Injecting a dose of innovation and smart design, retrofitting breathes new life into aging industrial buildings, propelling them into the era of high efficiency and enhanced productivity [25].

Utilizing visual communication spaces within a furniture factory stands as a crucial element in spatial design, facilitating employee interaction and bolstering improvement processes. Visual communication also stands as a pivotal tool in augmenting safety within factory settings. Notably, safety signs and symbols serve as efficient means to swiftly convey hazards and safety protocols to employees. Studies indicate a significant impact, revealing that the utilization of such visual cues can potentially slash accidents and injuries by as much as 80%. Particularly in the manufacturing sector, visual communication plays a critical role in bolstering workplace safety. Research by Vigoroso (2020) and Furman (2023) underscores its efficacy in safety training and management. Vigoroso's study involving migrant farmworkers in Italy highlighted a substantial increase in satisfaction and comprehension through the utilization of visual safety training materials.

ii) Physical environment for furniture manufacturing

Research on the physical environment in factories has highlighted the significant impact of factors such as noise, light, and microclimate on work performance [3]. The studies reveal that these specific environmental factors have a substantial effect on employee performance. From reducing noise distractions to optimizing natural lighting levels and ensuring comfortable temperatures, smartly tweaking the physical environment can unlock a surprising boost in productivity and error-free work. This growing knowledge is prompting a shift in factory design, prioritizing worker comfort and well-being alongside productivity, ultimately leading to a win-win for both employees and businesses.

According to Factories and Machinery (Safety, Health and Welfare) Regulations 1970, where the means of natural ventilation is not adequate further means of natural or mechanical ventilation or both shall be provided (Regulation 25). The air in wood processing facilities isn't just sawdust-filled; it can harbor harmful pollutants that threaten both worker health and safety. Inadequate ventilation presents a significant threat, exposing workers to potentially harmful airborne chemicals and posing a fire hazard due to accumulated flammable dust and chemicals [5]. These risks necessitate the implementation of robust ventilation systems tailored to specific areas and activities. For high-risk zones with high levels of airborne pollutants, dedicated systems equipped with capture hoods or enclosures become indispensable, complementing essential safety measures like respirators. The benefits of good ventilation extend beyond health concerns, it's also about keeping workers safe, boosting productivity and creating a healthier, more comfortable working environment.

Traditional designs in industrial spaces like warehouses and factories historically prioritize functionality over improving the well-being of the workforce within these environments. However, recent advancements in technology and a heightened emphasis on workplace wellness present new possibilities for integrating daylighting techniques into these vast industrial settings [6]. Daylighting involves utilizing a combination of windows and artificial lighting to simulate natural sunlight, offering numerous benefits. As per the Factories and Machinery (Safety, Health and Welfare) Regulations 1970, it's prohibited to assign or allow work in any factory structure where the provision of natural light accounts for less than ten percent of the floor area (Regulation 29). Lighting within these spaces holds significance beyond employee productivity; it extends to safety measures and quality control standards. Enhanced lighting conditions enable the early detection of faults, errors, and potential hazards, allowing for timely intervention before they escalate into significant issues [1].

Multiple studies consistently affirm that diminishing noise levels within factory premises holds the potential to substantially elevate employee productivity [2] [12]. Their findings converge on the notion that reducing workplace noise fosters a more comfortable and efficient work atmosphere. Emphasizing the significance, Murphy (2017) stressed the implementation of noise control engineering and hearing loss prevention programs in manufacturing setups. Moreover, specifically highlighted the adverse effects of heightened noise levels on employee performance, especially within the health sector [12]. Collectively, these studies underscore the imperative need for deploying effective noise reduction strategies within furniture manufacturing to bolster employee productivity.

III. METHODOLOGY

In this study, a qualitative approach is utilized, involving the collection of extensive data, the identification of key themes within this data, and the organization of these findings into distinct segments. Considering the influence of spatial design and the physical environment on furniture manufacturing productivity, qualitative observations emerge as a viable means of data collection. This methodology enables researchers to delve deeper into understanding how the spatial design and impact of the physical environment interact with manufacturing productivity and employee engagement. Several precedent studies were referenced in this particular study, all emphasizing spatial design and physical environments, utilizing a combination of quantitative and qualitative methodologies in their research. This research intends to gain an in-depth understanding of the phenomenon by actively engaging in the environment where it unfolds. Employing site visits, the research team can directly observe and interact with both participants and their immediate surroundings. Utilizing a blend of textual descriptions and visual representations effectively portrayed the situation, allowing the researcher to present the findings in a visually compelling manner, thereby enriching the comprehension of the research outcomes. This approach facilitates the gathering of intricate details through diverse methods like interviews, discussions, and the capture of visual data in the form of pictures.

This study concentrates on investigating three specific overseas furniture factories, and two local furniture factories. Those buildings operate as a furniture manufacturing industry. The methodology employed for this research entails a thorough examination of these factories and their impact on employee and manufacturing productivity within the furniture industry. The selection of these particular buildings enables researchers to closely scrutinize the spatial design and physical environments, amenities, and facilities in the industry. Structured observations served as the methodology for data collection, referencing the spatial design and physical environment variables identified in the literature review. This method aimed to facilitate precise and targeted data collection, focusing specifically on the implementation of these variables within factory environments. To comprehensively address the primary research objectives, five precedent studies were undertaken. The initial phase involved studying three furniture factories overseas, while the subsequent phase analysed two local furniture factories. This comparative approach allowed for a thorough examination of how these variables were applied and differed across various factory settings

Overseas:



Precedent study 1:
Schaerholzbau
Grossdietwil Furniture
Factory



Precedent Study 2:
BC Passive Furniture
Factory



Precedent Study 3:
Raagin Karman Furniture
Factory

Local:



Precedent Study 1: LB Furniture Sdn Bhd



Precedent Study 2: Euro Design Furniture Factory

Fig. 2 Five precedent study selected from overseas and local factory design

From the previous research, a few independent variables in this study are chosen that facilitate the spatial design and physical environment of furniture manufacturing, while the dependent variable is the productivity enhancement experienced by the employee and manufacturing process. The spatial design and physical environment encompasses various aspects of air quality, lighting, noise, workplace design, etc. These factors have the potential to significantly impact productivity in the employee and manufacturing process.

Variables	Independent Dimension	Dependent Features
Spatial Design	Lean Manufacturing	Reduce inefficient movement
		Reduce excess wastage
	Structural Design	Future expansion
	Visual Communication	Improve interaction
Safety purpose		
Physical Environment	Natural Lighting	Enhance psychological health
		Energy saving
	Ventilation	Reduce health risk
	Noise	Comfortable environment

Table 1: The variables of the independent dimension and dependent features.

IV. RESULT AND DISCUSSION

Research findings reveal a distinct comparison between the Malaysian furniture industry and its foreign counterparts. The evaluation of each precedent study considers factors such as Lean Manufacturing, Structural Design, Visual Communication, Natural Lighting, Ventilation, and Noise, considering them.

Buildings Variables	Precedent 1: Schaerholzbau Grossdietwil Furniture Factory	Precedent 2: BC Passive Furniture Factory	Precedent 3: Raagin Karman Furniture Factory	Precedent 4: LB Furniture Sdn Bhd	Precedent 5: Euro Design Furniture Factory
Lean Manufacturing	✓	●	✓	✓	●
Structural Design	●	●	●	✓	✓
Visual Communication	✓	✓	✓	●	✓
Natural Lighting	✓	✓	✓	✓	●
Ventilation	✓	✓	✓	●	●
Noise	✓	✓	✓	●	●

Table 2: Comparative Findings of Precedent Studies.

Precedent Studies	Finding	Total Score
Precedent 1: Schaerholzbau Grossdietwil Furniture Factory	<p>⚙️ Precedent Study 1</p> <p>A radar chart with six axes: Lean..., Noise, Ventilat..., Natural..., Visual..., and Structur... The scale ranges from 0 to 1. The chart shows scores of 1 for Lean..., 0.5 for Noise, 0 for Ventilat..., 0 for Natural..., 0 for Visual..., and 0 for Structur...</p>	Precedent 1 adheres to 5/6 required variables
Precedent 2: BC Passive Furniture Factory	<p>⚙️ Precedent Study 2</p> <p>A radar chart with six axes: Lean..., Noise, Ventilat..., Natural..., Visual..., and Structur... The scale ranges from 0 to 1. The chart shows scores of 1 for Lean..., 0.5 for Noise, 0 for Ventilat..., 0 for Natural..., 0 for Visual..., and 0 for Structur...</p>	Precedent 2 adheres to 5/6 required variables
Precedent 3: Raagin Karman Furniture Factory	<p>⚙️ Precedent Study 3</p> <p>A radar chart with six axes: Lean..., Noise, Ventilat..., Natural..., Visual..., and Structur... The scale ranges from 0 to 1. The chart shows scores of 1 for Lean..., 0.5 for Noise, 0 for Ventilat..., 0 for Natural..., 0 for Visual..., and 0 for Structur...</p>	Precedent 3 adheres to 5/6 required variables
Precedent 4: LB Furniture Sdn Bhd	<p>⚙️ Precedent Study 4</p> <p>A radar chart with six axes: Lean..., Noise, Ventilat..., Natural..., Visual..., and Structur... The scale ranges from 0 to 1. The chart shows scores of 1 for Lean..., 0.5 for Noise, 0 for Ventilat..., 0 for Natural..., 0 for Visual..., and 0 for Structur...</p>	Precedent 4 adheres to 3/6 required variables
Precedent 5: Euro Design Furniture Factory	<p>⚙️ Precedent Study 5</p> <p>A radar chart with six axes: Lean..., Noise, Ventilat..., Natural..., Visual..., and Structur... The scale ranges from 0 to 1. The chart shows scores of 1 for Lean..., 0.5 for Noise, 0 for Ventilat..., 0 for Natural..., 0 for Visual..., and 0 for Structur...</p>	Precedent 5 adheres to 2/6 required variables

Table 3: Comparative Finding of Precedent Studies.

i. Lean Manufacturing

Overseas	Local
The overseas furniture factory demonstrates a lean manufacturing approach, primarily due to meticulous manufacturing process planning from the initial design phase. Each machine's layout is strategically organized to adhere to an optimized flow, minimizing unnecessary worker movement and spatial wastage. This deliberate arrangement ensures an efficient workflow, eliminating redundancies and maximizing the effective use of available space within the facility.	Furniture factories in Malaysia are often constructed without prior planning regarding the optimal placement of goods and corresponding machinery sizes. The absence of preliminary studies before construction leads to haphazard arrangements within these factories. Consequently, the positioning of machines within the building must be more intentional, resulting in an irregular and ad-hoc layout.

ii. Structural Design

Overseas	Local
Overseas furniture factories emphasize their corporate image, recognizing its potential to establish credibility and foster customer loyalty. Consequently, these factories are meticulously designed to mirror and embody the company's identity. The structures are purposefully built to reflect the brand's essence, often employing challenging designs to alter or modify.	In Malaysia, factories are typically regarded simply as functional spaces, emphasizing cost-saving measures by utilizing more affordable building structures. However, opting for these cost-effective structures not only offers economic benefits but also facilitates easier modifications or improvements in the future.

iii. Visual Communication

Overseas	Local
Overseas furniture factories emphasize their corporate image, recognizing its potential to establish credibility and foster customer loyalty. Consequently, these factories are meticulously designed to mirror and embody the company's identity. The structures are purposefully built to reflect the brand's essence, often employing challenging designs to alter or modify.	In Malaysia, factories are typically regarded simply as functional spaces, emphasizing cost-saving measures by utilizing more affordable building structures. However, opting for these cost-effective structures not only offers economic benefits but also facilitates easier modifications or improvements in the future.

iv. Natural Lighting

Overseas	Local
Planned factory construction and a focus on environmental quality frequently prioritize incorporating high-quality natural lighting in buildings. This emphasis reflects the priority of overseas factories on superior natural lighting due to its numerous advantages, including enhancing employee productivity and reducing electricity consumption. Additionally, these factories capitalize on this by integrating solar energy systems to harness and optimize natural light sources.	In Malaysia, factory designs have limited emphasis on enhancing natural lighting. During the design phase, lighting provisions are often merely installed to meet specified requirements. Consequently, these openings, if present, may not adequately illuminate the entire factory space, leading to a reliance on artificial lighting to compensate for insufficient natural light sources.

v. Ventilation

Overseas	Local
Sophisticated machines in the factory are complemented by a mechanical ventilation system, ensuring workers can operate machinery without encountering disruptions from wood dust, chemicals, and other particles. This setup significantly impacts	Factories in Malaysia rely heavily on worker expertise to manage tasks involving dust and chemicals. Dedicated machinery or specific rooms for handling wood dust and chemicals are often needed in these settings. As an alternative approach,

manufacturing productivity and safeguards employees' health by minimizing their exposure to potentially harmful substances.	these factories have implemented new initiatives, such as installing exhaust fans and additional ventilation systems, to enhance overall ventilation within the workspace.
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vi. Noise

Overseas	Local
High-quality building structures are often equipped with soundproofing features. Overseas factories that prioritize their image also prioritize the well-being of their employees by offering comfortable office spaces. This focus on employee health ensures a conducive environment for uninterrupted daily work.	When buildings are constructed using cheaper and thinner materials, they may lack adequate soundproofing. As a result, noise can easily pass through these structures, causing disturbances for workers trying to focus on their tasks. Prolonged exposure to such noise levels can permanently damage the workers' hearing. This situation affects their work and poses long-term health risks, underscoring the importance of soundproofing in maintaining a conducive and safe working environment.

V. CONCLUSION

Research findings reveal a distinct comparison between the Malaysian furniture industry and its foreign counterparts. In Malaysia, the focus predominantly centres on spatial design such as lean manufacturing, structural design and the availability of equipment, whereas overseas factories adopt a holistic approach that emphasizes both manufacturing efficiency and employee well-being. This contrast underscores a critical oversight in Malaysian factories, neglecting the essential correlation between the physical work environment such as natural lighting, ventilation, noise, employee health, and overall engagement. Consequently, this places Malaysian factories at a disadvantage in the global competitive landscape. As a solution to narrow this gap and propel the industry forward, a transformative shift in mindset becomes imperative. Adopting a human-centric approach that places equal importance on worker well-being alongside production optimization is no longer merely an option but an essential strategic move.

The comparative analysis between the Malaysian furniture industry and its international counterparts underscores a significant disparity in approach. While Malaysia primarily concentrates on spatial design, overseas industries adopt a more comprehensive strategy, emphasizing both spatial design and physical environment for manufacturing efficiency and employee well-being. This disparity reveals a critical oversight within Malaysian factories, overlooking the integral link between the physical work environment, employee health, and overall productivity. To bridge this gap and enhance competitiveness, an essential shift in mindset is imperative. Embracing a human-centric approach that values employee well-being on par with production optimization is no longer an elective choice but a strategic necessity. This transformative shift is pivotal for Malaysian furniture industries to establish and sustain their competitiveness in the global market, enabling enduring success and global recognition.

In conclusion, this study serves as a catalyst for ongoing discourse, emphasizing that the physical environment of spatial design is not a fixed entity but a dynamic, evolving experiment necessitating continuous refinement, adaptation, and innovation. It is a collective call to action, urging stakeholders to actively participate in the dynamic journey toward productive furniture factory design. This work envisions a transformation where a furniture factory transcends being a mere industrial space to become a workplace that prioritizes the well-being of every individual, including workers. Through fostering an environment that cares for the workforce, it is poised to act as a driving force for positive change, ultimately contributing to enhanced factory productivity and outcomes.

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