Industrialised Building System (IBS) In Construction Technology towards Ergonomics for Safety and Health

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ABSTRACT

The Malaysian construction industry has increasingly used the Industrialised Building System (IBS) as part of construction technology to improve efficiency, quality, and sustainability. This research aims the effects of construction technology innovation on onshore fabrication projects in Malaysia, focusing specifically in steel framing system on advancements in ergonomics, occupational safety, and work-life balance. The research examines the use of Industrialised Building Systems (IBS) encompassing mechanized production processes, automated material handling systems, and modular steel fabrication techniques. These technologies diminish reliance on physical labour, minimize repetitive motions, and restrict workers' exposure to hazardous site activities. Moreover, fabrication in regulated production settings improves quality control and operational efficiency relative to traditional on-site construction techniques. This study used a qualitative single case study methodology to investigate the effects of construction technology innovation design on ergonomics, occupational safety, and work–life balance in onshore fabrication projects in the Malaysian construction sector. This case study examines an onshore fabrication project, selected according to their technical adoption, project scale, and significance to onshore fabrication operation. Data was gathered via semi-structured interviews with project managers, engineers, safety officers, and fabrication workers, in addition to an examination of project paperwork and safety records. Interview data were utilized to get practitioners' viewpoints on alterations in workload, safety performance, and work–life balance after the adoption of novel technology focused on labor processes, material handling techniques, equipment utilization, and workstation design to assess ergonomic conditions and safety protocols. The data gathered were analyzed thematically. Moreover, the implementation of technology-driven operational workflows enhances job scheduling, minimizes overtime demands, and optimizes labor resource management. These enhancements positively affect employees' physical health, fatigue levels, and overall job satisfaction, hence promoting a healthier work–life balance. The results demonstrate that the deliberate and systematic application of IBS technologies in Malaysia yields quantifiable enhancements in safety performance and productivity, while concurrently fostering sustainable worker behaviors. This study asserts that ongoing IBS innovation in construction technology is crucial for Malaysia's construction sector with national modernization efforts and long-term labor welfare goals.

Keywords: Construction Technology: IBS; Ergonomics; Occupational Safety and Health; Onshore Fabrication

INTRODUCTION

The construction industry is globally recognized as one of the most labour-intensive and high-risk sectors due to its dependence on manual labour, repetitive work processes, and hazardous working environments. Workers are frequently exposed to physical strain, unsafe conditions, and extended working hours, which contribute to occupational injuries, musculoskeletal disorders, and reduced work–life balance (HSE, 2020; Lingard & Rowlinson, 2005). Traditional construction methods involve extensive on-site fabrication, heavy lifting, and manual material handling, increasing ergonomic risks and compromising worker safety and health. In Malaysia, the Industrialised Building System (IBS) has been introduced as a strategic solution to modernize construction practices and enhance productivity, safety, and sustainability. IBS refers to a construction method where building components are manufactured in controlled environments using mechanized and automated processes before being transported and assembled on-site (CIDB, 2010). The Malaysian government has actively promoted IBS

through the IBS Roadmap and Construction Industry Transformation Programme (CITP) to reduce reliance on foreign labour, improve construction efficiency, and enhance worker safety (CIDB, 2016).Technological advancements in IBS, particularly in steel fabrication and modular construction, have significantly improved ergonomic conditions and safety performance. Mechanized production systems reduce repetitive manual work, while automated material handling systems minimize physical strain and injury risks (Pan et al., 2012). Furthermore, fabrication in controlled environments enhances quality control and reduces exposure to hazardous construction site conditions. Despite the increasing adoption of IBS in Malaysia, there remains limited qualitative research examining its impact on ergonomics, occupational safety, and worker well-being in onshore fabrication projects. Therefore, this study aims to investigate how IBS technology influences ergonomic conditions, occupational safety, and work–life balance among workers in Malaysian onshore fabrication projects.

LITERATURE REVIEW

Industrialised Building System (IBS) in Malaysia

Industrialised Building System (IBS) is defined as a construction method involving the prefabrication of building components in a controlled environment, followed by transportation and installation on-site (CIDB, 2010). IBS includes precast concrete systems, steel framing systems, modular systems, and prefabricated components. IBS has been widely promoted in Malaysia to improve construction productivity, quality, and sustainability. According to CIDB (2016), IBS reduces construction time, improves quality consistency, and minimizes material wastage. Additionally, IBS reduces dependency on manual labour and enhances construction efficiency through mechanization and automation. The use of IBS in steel framework fabrication provides significant advantages, including precision manufacturing, improved structural quality, and faster assembly. Automated fabrication processes improve dimensional accuracy and reduce construction errors, contributing to overall project efficiency (Pan et al., 2012).

Ergonomics in Construction

Ergonomics refers to the scientific discipline concerned with understanding human interactions with work systems and designing work environments to improve safety, efficiency, and comfort (International Labour Organization, 2019). Poor ergonomic conditions in construction often result in musculoskeletal disorders, fatigue, and reduced productivity. Traditional construction methods expose workers to repetitive lifting, bending, and awkward postures, increasing injury risks (Gibb & Isack, 2003). The adoption of IBS improves ergonomic conditions by introducing mechanized material handling systems, reducing manual labour, and improving workstation design. Mechanization and automation reduce repetitive strain and improve worker comfort, contributing to improved productivity and worker well-being (Pan et al., 2012).

Occupational Safety and Health in IBS Construction

The construction industry has a high rate of occupational accidents due to hazardous working environments, including working at heights, heavy machinery operation, and manual handling tasks (HSE, 2020). IBS improves safety by transferring fabrication activities from construction sites to controlled factory environments. Controlled environments allow better safety supervision, standardized work processes, and reduced exposure to environmental hazards (Blismas & Wakefield, 2009). Mechanized systems reduce direct worker interaction with dangerous equipment, lowering accident risks. Furthermore, standardized manufacturing processes improve safety compliance and reduce workplace injuries, contributing to improved overall safety performance (CIDB, 2016).

Technology Innovation and Work–Life Balance

Technological innovation plays a critical role in improving construction efficiency and worker well-being. IBS reduces construction duration, improves workflow efficiency, and minimizes overtime requirements (Pan et al., 2012). Improved working conditions and reduced physical strain enhance worker satisfaction, reduce fatigue, and promote better work–life balance (Lingard & Francis, 2004). Technology-driven operational workflows

improve scheduling efficiency and optimize labour resource management, contributing to improved worker welfare.

METHODOLOGY

This study adopts a qualitative single case study approach to examine the impact of IBS technology on ergonomics, occupational safety, and work–life balance in onshore fabrication projects in Malaysia. A qualitative approach was selected to obtain detailed insights into workers' experiences and perceptions regarding IBS implementation. A single onshore fabrication project was selected based on its adoption of IBS technology, project scale, and relevance to modern fabrication practices. The selected project involved steel framework fabrication using mechanized production systems and modular construction techniques. Data were collected through semi-structured interviews with key stakeholders, including Project Managers, Engineers, Safety Officers and Fabrication Workers. These participants were selected due to their direct involvement in fabrication operations and IBS implementation on steel framing system. In addition to interviews, project documentation and safety records were reviewed, including Safety reports, Operational procedures and Productivity reports. Information was analyzed using thematic analysis (Braun & Clarke, 2006). This method involved identifying recurring themes related to ergonomics, safety, productivity, and work–life balance. The thematic analysis enabled the identification of patterns and relationships between IBS innovation technology towards ergonomics worker well-being.

FINDINGS AND DISCUSSION

Improved Ergonomic Conditions

The findings indicate that IBS technology significantly improved ergonomic conditions. Mechanized lifting equipment and automated material handling systems reduced manual lifting and repetitive tasks. Workers reported reduced fatigue and physical strain. Improved workstation design and organized fabrication environments enhanced worker comfort and efficiency. These findings are consistent with previous studies that highlight the ergonomic benefits of prefabrication and mechanized construction (Gibb & Isack, 2003).

Enhanced Occupational Safety Performance

The study found that IBS significantly improved safety performance. Fabrication in controlled environments reduced exposure to hazardous site conditions such as working at heights and unsafe terrain. Safety officers reported fewer workplace accidents and improved safety compliance. Automation and mechanization reduced direct worker interaction with hazardous equipment, lowering injury risks. These findings support previous research indicating that IBS improves construction safety (Blismas & Wakefield, 2009).

Increased Productivity and Efficiency

IBS technology improved production efficiency by streamlining fabrication processes. Mechanized systems increased precision, reduced errors, and improved workflow efficiency. Project managers reported faster production rates, reduced delays, and improved overall project performance. These findings align with CIDB (2016), which identified IBS as a key driver of construction productivity improvement.

Improved Work–Life Balance and Worker Well-being

IBS implementation reduced physical fatigue and minimized overtime requirements. Improved scheduling and workflow management allowed workers to maintain better work–life balance. Workers reported improved job satisfaction, reduced stress levels, and enhanced overall well-being. These findings support previous research indicating that improved working conditions contribute to better worker welfare (Lingard & Francis, 2004).

Discussion

The findings demonstrate that IBS technology plays a critical role in improving ergonomics, safety, productivity, and worker well-being. The transition from traditional labour-intensive methods to mechanized fabrication significantly reduces physical strain and injury risks. IBS also supports sustainable construction practices by

improving worker safety and operational efficiency. The adoption of IBS aligns with Malaysia's national construction modernization goals and supports long-term workforce sustainability.

CONCLUSION

This study confirms that the implementation of IBS technology significantly improves ergonomic conditions, occupational safety, and work–life balance in onshore fabrication projects in Malaysia. Mechanized production systems and controlled fabrication environments reduce manual labour, minimize injury risks, and improve working conditions. IBS also enhances productivity, reduces overtime demands, and improves worker well-being. The findings highlight that IBS technology is essential for improving construction safety, productivity, and sustainability in Malaysia. Continued adoption of IBS is crucial to support national construction modernization efforts and improve worker welfare. Future research should include multiple case studies and quantitative analysis to further validate the long-term benefits of IBS technology across different construction sectors. Future research will include multiple case studies with different project types to enhance the generalizability of the findings. For research method will adopting a mixed-method approach that integrates qualitative interviews with quantitative safety performance indicators, such as accident rates, absenteeism, and productivity metrics, would strengthen the empirical robustness of the research.

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Conflict of Interest

Authors declare that there is no conflict of interest regarding the publication of the paper.

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