# Workforce Skill Challenges in IBS Project Implementation in Rural Area Sabah & Sarawak: A Systematic Analysis

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## ABSTRACT

The paper aimed to evaluate workforce skill deficiencies, benchmark project management challenges causing delays, identify organizational and logistical factors influencing IBS adoption, deconstruct management-delay relationships, and compare mitigation strategies in rural Malaysian Borneo contexts. A systematic analysis of qualitative and quantitative studies focusing on rural Sabah and Sarawak was conducted, emphasizing workforce competency, management practices, and delay factors. Findings reveal pervasive local workforce skill gaps, including limited technical knowledge and motivation, compounded by reliance on foreign labour and insufficient training programs. Management challenges such as poor communication, fragmented teams, inadequate supervision, and contract issues significantly contribute to project delays. Logistical constraints, including limited local manufacturing and infrastructure deficits, exacerbate delays and increase costs. Organizational support mechanisms, notably government incentives, training initiatives, and readiness frameworks, are critical yet underutilized in rural settings. Integrating these findings highlights the multifactorial nature of IBS implementation delays, underscoring the need for integrated workforce development and management competency enhancement tailored to rural contexts. The finding informs theoretical frameworks and practical interventions aimed at improving IBS project delivery and reducing delays in Sabah and Sarawak's rural construction sectors.

**Keyword:** Workforce skill, Industrial Building System (IBS), rural Sabah, rural Sarawak, Project Implementation, delay

## INTRODUCTION

Research on workforce skill project management challenges in the implementation of Industrialized Building System (IBS) in Sabah and Sarawak rural areas has emerged as a critical area of inquiry due to its implications for construction efficiency, quality, and economic development. Since the 1960s, Malaysia has promoted IBS to address housing demand and improve construction productivity, with notable projects in urban West Malaysia demonstrating benefits such as faster completion and safer sites (Wong & Lau, 2015) (Alawag, et al., 2021). However, the adoption of IBS in rural areas, particularly in East Malaysia's Sabah and Sarawak, remains limited, with the construction sector still dominated by conventional methods (Wan Ahmad, 2025) (Wong & Lau, 2015) (Hadi, Muhamad, & Othman, 2017). The construction industry contributes significantly to Malaysia's GDP, with the government policy in IBS use in public projects worth over RM10 million, yet rural development still lags behind urban area (Wong & Lau, 2015) (Alawag, et al., 2021). This disparity underscores the social and economic importance of addressing IBS implementation challenges in these regions (Ali, Abas, Affandi, & Abas, 2018) (Bohari, Mahat, & Kipli, 2012). Malaysia Auditor General Report 2024 highlight the school development project delay under Ministry of Education (MoE) are critical problematic and affect to student academic performance and safety for the school communities (Wan Ahmad, 2025).

The specific problem addressed is the persistent delays and management difficulties in IBS projects in rural Sabah and Sarawak, attributed largely to workforce skill deficiencies and project management issues (Nasir, Nawi, Rahim, Bahaudin, & Tapa, 2015) (Jabar, Ismail, & Aziz, 2018). Despite government incentives and policy frameworks, studies reveal a lack of skilled labor, inadequate knowledge transfer, and logistical constraints as major barriers (Hadi, Muhamad, & Othman, 2017) (Ali, Abas, Affandi, & Abas, 2018) ( (Tamrin, Nawi, & Nifa,

2015). Existing research predominantly focuses on urban West Malaysia or contractor perspectives, leaving a gap in understanding the nuanced challenges faced in rural East Malaysia, especially from a project management and workforce skill standpoint (Wong & Lau, 2015) (Samsi, et al., 2024) (Khor S.-C. , Tiang, Abdullatef, & Wai, 2021). Controversies exist regarding the cost-effectiveness and readiness of IBS adoption, with some studies emphasizing high initial costs and resistance to change, while others highlight potential long-term benefits (Wong & Lau, 2015) (Ali, Abas, Affandi, & Abas, 2018) (Masram, Yassin, Shafii, & Murugappah, 2024). The consequences of this knowledge gap include continued project delays, cost overruns, and underutilization of IBS benefits in rural areas (Nasir, Nawi, Rahim, Bahaudin, & Tapa, 2015) (Shafie, 2020).

The conceptual framework for this review integrates the definitions of IBS as a prefabrication and offsite construction method emphasis mechanization and minimal onsite work (Wong & Lau, 2015) (Alawag, et al., 2021), workforce skill as the competency and motivation of labor essential for IBS productivity (Mohsen, Yunus, Handan, Kasim, & Hussain, 2019) (Khor S.-C. , Tiang, Abdullatef, & Wai, 2021) and project management challenges incorporated coordination, supervision, and communication issues that contribute to delays (Jabar & Ismail, 2018) (Ismail, Aziz, & Aziz, 2014). These concepts are interrelated, as workforce skills directly impact project management effectiveness, which in turn influences IBS implementation success (Kamar K. M., 2011) (Jabar et al., 2018). This framework guides the systematic examination of how workforce and management factors affect IBS adoption in rural Sabah and Sarawak (Wan Ahmad, 2025).

The purpose of this systematic review is to identify and analyze workforce skill and project management challenges that contributing to delays in IBS implementation in rural Sabah and Sarawak. It aims to fill the research gap by focusing on rural contexts and integrating multiple stakeholder perspectives, thereby providing actionable insights for policymakers, contractors, and academics. This review adds value by synthesizing dispersed findings and highlighting critical factors that hinder IBS adoption, ultimately supporting improved project outcomes and regional development (Wong & Lau, 2015) (Hadi, Muhamad, & Othman, 2017) (Soo-Cheen, Wai-Yew, Abdullatef, & Soon-Han, 2021).

The review methodology involves a comprehensive literature search of peer-reviewed articles, government reports, and industry studies focusing on IBS in Malaysia, with inclusion criteria emphasizing rural implementation and workforce-related challenges. Analytical frameworks include thematic synthesis and critical appraisal of management and skill-related factors. The findings are organized to address workforce competencies, project management issues, and their combined impact on IBS project delays in rural Sabah and Sarawak (Wong & Lau, 2015) (Samsi, et al., 2024) (Jabar & Ismail, 2018).

## Purpose And Scope of The Review

### Statement of Purpose

The objective of this report is to identified the existing research on workforce skill project management challenges in the implementation of Industrialized Building System (IBS) in Sabah & Sarawak rural areas, focusing on management problems that contributing to delays. This review is important because IBS implementation in rural Sabah and Sarawak faces unique challenges distinct from urban context, particularly in where workforce competency and project management practices that directly affect project timelines. By consolidating insights from diverse studies, this report aims to inform academic discourse and guide future research and policy interventions to enhance IBS project delivery and reduce delays in these underexplored rural settings.

### Objectives

The main goal of this research is to understand why IBS projects in rural Sabah and Sarawak often face delays. It specifically looks at the gap in workforce skills and the unique challenges project managers encounter in these remote areas. By examining the logistical and organizational hurdles that make IBS difficult to adopt, the study connects how management decisions directly affect project timelines. Finally, it compares different strategies used to solve these problems, offering clear insights into which solutions work best for rural construction.

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# METHODOLOGY OF LITERATURE SELECTION

## Transformation of Query

By systematically expanding a broad research question into several targeted queries, below were the transformed queries we formed from the statement of propose:

- Workforce skill project management challenges in the implementation of Industrialized Building System (IBS) in Sabah & Sarawak rural areas, focusing on management problems contributing to delays
- Investigating management challenges and delay factors in the implementation of Industrialized Building System (IBS) in rural construction projects of Sabah and Sarawak
- Exploring skill shortages and organizational strategies in overcoming project management challenges for the implementation of Industrialized Building System (IBS) in rural Sabah and Sarawak

## Search Strategy and Query Formulation

To ensure a comprehensive retrieval of literature relevant to the implementation of Industrialized Building Systems (IBS) in rural Sabah and Sarawak, a systematic search strategy was employed. The search process was designed to capture the intersection of three core conceptual clusters, it is (A) The Construction Method (IBS and off-site manufacturing), (B) The Problem Domain (Workforce skills, project management, and delays), and (C) The Geographic Context (Rural East Malaysia).

Table 1: Summary Table for Methodology Section

| | **Search Component** | **Keywords Used** |
|---|---|---|
| **A.** | **The Construction Method (IBS and off-site manufacturing)** | Industrialised Building System, IBS, Prefabrication, Modular, MMC, Off-site manufacturing |
| **B.** | **The Problem Domain (Workforce skills, project management, and delays)** | Project Management, Workforce skill, Labour shortage, Delays, Time overrun, Barriers, Challenges |
| **C.** | **The Geographic Context (Rural East Malaysia)** | Sabah, Sarawak, East Malaysia, Rural, Malaysia |
| | **Search Field** | Article Title, Abstract, and Keywords (TITLE-ABS-KEY) |

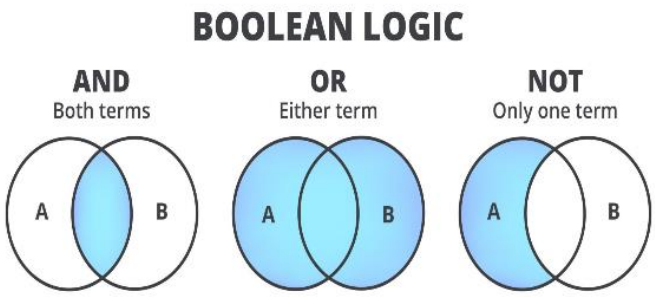


Figure 1: The Boolean search operators are AND, OR and NOT are used

## Keyword Identification and Boolean Logic

The original research question was deconstructed into specific keywords and synonyms to capture variations in terminology across different journals. Boolean operators (AND, OR) were utilized to construct robust search

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strings. The OR operator was used to combine synonyms within each concept to maximize sensitivity (e.g., "Industrialised" OR "Prefabricated"), while the AND operator was used to intersect the three concepts to ensure precision. Wildcards (e.g., Skill*, Industrial*) were employed to capture word variations such as "skills," "skilled," "industrialised," or "industrialized."

The following search strings were developed and applied across comprehensive academic databases (Scopus and Google Scholar):

**Primary Search String (Specific Focus):**

*("Industrialised Building System" OR "IBS" OR "Prefabricated construction" OR "Off-site construction")* **AND** *("Project management" OR "Workforce skill*" OR "Labour shortage" OR "Delay*" OR "Competenc*")** **AND** *("Sabah" OR "Sarawak" OR "East Malaysia" OR "Borneo" OR "Rural area*")*

**Secondary Search String (Broader Scope):**

To ensure studies focusing on "rural Malaysia" generally—which are highly applicable to the Sabah/Sarawak context—were not missed, a broader query was also executed: *("IBS" OR "Modern Method of Construction") AND ("Rural construction" OR "Remote area") AND ("Malaysia" OR "Developing countr*")*

**Transformation of Query and Screening**

The broad research question was expanded into targeted search statements to ensure both niche and jargon-specific studies were retrieved. This phase involved running the transformed queries and applying initial Inclusion and Exclusion Criteria.

**Citation Chaining (Snowballing Technique)**

To overcome the limitations of keyword-based searching, a "Citation Chaining" method was applied to the 26 core papers to identify foundational and emerging research. This rigorous chaining process identified an additional **156 papers**, resulting in a total pool of **182 candidate papers** for screening. This initial database search yielded **26 core papers**.

**Relevance scoring and sorting**

Titles and abstracts were screened against the specific research objectives specifically looking for evidence linking workforce competency and management practices to project delays (Wan Ahmad, 2025). We take our assembled pool of 182 candidate papers (26 from search queries + 156 from citation chaining) and impose a relevance ranking so that the most pertinent studies rise to the top of our final papers table. We found 179 papers that were relevant to the research query. Out of 179 papers, 50 were highly relevant.

| Criterion | Inclusion Criteria | Exclusion Criteria |
|---|---|---|
| **Topic/ Scope** | Studies focusing on **Industrialized Building System (IBS)**, prefabrication, or off-site construction combined with **project management**, **workforce skills**, or **delays**. | Studies focusing purely on structural engineering properties (e.g., concrete strength testing), architectural aesthetics, or chemical composition without management/workforce context. |
| **Geographic Context** | **Primary:** Studies situated in **Sabah** and **Sarawak** (East Malaysia) or rural Borneo contexts.<br><br>**Secondary:** Studies from general **Malaysia** or developing countries that specifically address | Studies from developed nations (e.g., UK, Singapore) unless used strictly for theoretical comparison, or studies focused exclusively on high-density urban logistics (e.g., Klang Valley high-rise) with no rural applicability. |

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|---|---|---|
| | **rural logistics** or **workforce shortages** applicable to the research gap. | |
| **Problem Focus** | Papers discussing **delay factors**, **skill shortages**, **logistics**, **contractor readiness**, or **management competency**. | Papers discussing IBS solely from a sustainability/green rating perspective or design software tutorials (unless related to BIM management/collaboration). |
| **Document Type** | Peer-reviewed journal articles, conference proceedings, and reputable industry reports (e.g., CIDB). | Opinion pieces, non-peer-reviewed blogs, or duplicates. |
| **Language** | English and Malay (if applicable). | Non-English papers where translation is not available. |
| **Timeline** | Studies published between **2009 and 2024** to capture the evolution from early barriers to modern digital integration[5]. | Outdated studies (pre-2009) that do not reflect current IBS technologies or government policies. |

Table 2: Inclusion and Exclusion Criteria. Adapt from (Wan Ahmad, 2025)

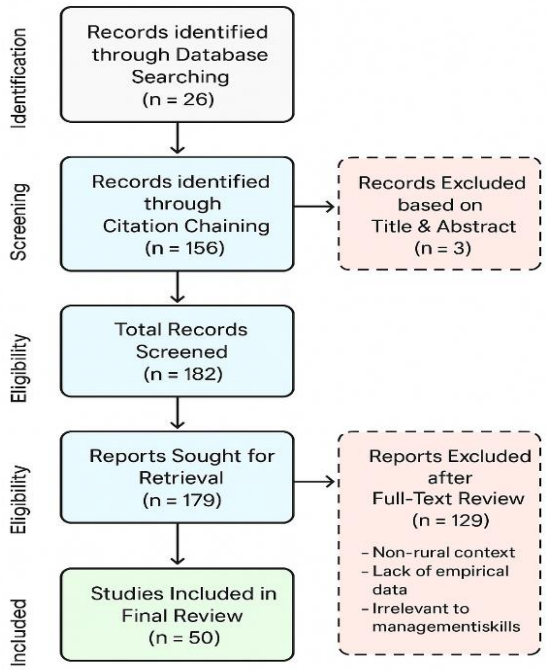


Figure 2: PRISMA Flow Diagram illustrating the literature selection process by Author

## RESULTS & FINDING

### Descriptive Summary of the Studies

This section explains the research landscape of the literature on workforce skill project management challenges in the implementation of Industrialized Building System (IBS) in Sabah & Sarawak rural areas, focusing on management problems that contributing to delays based on 50 most relevant journals. The studies mainly employ qualitative and quantitative methods, including surveys, interviews, and case studies, with a strong geographic focus on rural Sarawak and Sabah, as well as broader Malaysian contexts. This comparative analysis is crucial for addressing the research questions by analysis knowledge on workforce skill gaps, management issues,

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organizational support, and mitigation strategies specific to IBS adoption in rural Malaysian construction projects. Based on 50 most relevant papers, the matrix was developed as below;

| Study | Workforce Skill Level | Management Challenge Types | Delay Factors Impact | Organizational Support Mechanisms | Mitigation Strategies Effectiveness |
|---|---|---|---|---|---|
| (Wong & Lau, 2015) | Low local IBS technical knowledge and experience | Logistics, lack of local manufacturers, resistance to change | Delays due to flooding and material unavailability | Limited local IBS manufacturers, high logistics costs | Emphasis on modular system benefits and manpower handling |
| (Hadi, Muhamad, & Othman, 2017) | Skill deficiencies among SMEs contractors | Infrastructure and logistics problems, payment methods | Delays linked to logistics and financial constraints | Government incentives and infrastructure support needed | Government role in incentives and infrastructure improvement |
| (Samsi, et al., 2024) | G7 contractors show low readiness and skill gaps | Logistical challenges and high IBS costs | Delays caused by lack of readiness and manufacturer scarcity | Limited local manufacturers and high costs hinder adoption | Calls for further research on readiness improvement |
| (Abdullah & Nasir, 2024) | Human factors affecting supply chain integration | Human-related delays in supply chain and project execution | Project delays linked to organizational human factors | Organizational human factors critical for project flow | Framework development to improve human factor management |
| (Yusof, Jabar, Nawawi, & Nawi, 2024) | Workforce skill shortages and collaboration issues | Teamwork and procurement challenges | Delays due to disputes, miscommunication, and payment issues | Need for improved collaboration and procurement processes | Preliminary survey suggests teamwork improvement strategies |
| (Kaur, et al., 2024) | Lack of skilled workers as a major barrier | Supervision and adaptation to design changes | Delays linked to high initial costs and workforce skill gaps | Strategies include balancing supply and demand, innovation | Factory production optimization and eco-friendly innovation |
| (Khor S. C., Tiang, Abdullatef, & Wai, 2023) | Strong correlation between motivation, education, and skills | Workforce performance factors impacting IBS productivity | Delays linked to workforce skill and motivation levels | Monetary incentives and education improvements proposed | Enhancing workforce incentives and academic levels |
| (Razak, Khoiry, Badaruzzama | Low workforce collaboration | Poor collaboration and | Delays due to poor planning and | Framework for DfMA adoption to | Adoption of DfMA and BIM |

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| n, Hussain, & Zain, 2023) | and technology adoption | low technology use | process integration | improve readiness | for sustainable construction |
| (Alawag, Alaloul, Baarimah, Musarat, & Al-Mekhlafi, 2023) | Poor TQM adoption and awareness among firms | Reluctance to implement TQM, poor communication | Delays linked to lack of quality management systems | TQM drivers identified to improve project outcomes | Adoption of TQM drivers to overcome implementation issues |
| | Low awareness of TQM benefits in IBS projects | Lack of teamwork and quality management | Delays due to inefficient processes and poor safety | Increased awareness of TQM benefits recommended | TQM implementation to improve efficiency and satisfaction |
| (Al-Aidrous, Shafiq, Al-Ashmori, Al-Mekhlafi, & Baarimah, 2022) | Need for extended training for local labor | Communication and planning challenges | Delays linked to poor project location evaluation | Policies and incentives critical for IBS adoption | Early planning and standardized design adoption emphasized |
| (Saberi, Zulkifli, Zainuddin, & Saidin, 2022) | High skilled labor requirement and technology gaps | High initial cost and financing issues | Delays due to raw material price fluctuations | Financing and technology support needed | Addressing cost and technology barriers for contractors |
| (Jalil & Shaari, 2022a) | Skill gaps in procurement and contract management | Payment mechanism and delivery time issues | Delays caused by payment disputes and litigation | Contractual clarity and payment enforcement needed | Solutions for procurement and contract management issues |
| (Jalil & Shaari, 2022b) | Lack of skilled supervision during installation | Supervision cost and handling difficulties | Delays due to defective installation and lack of monitoring | Mandatory supervision and clearer method statements | Regulated supervision and constant monitoring proposed |
| (Flora, 2022) | Poor workmanship linked to equipment and coordination | Miscommunication and poor coordination | Delays caused by labor negligence and equipment issues | Improved communication and equipment suitability needed | Addressing workmanship and coordination to reduce delays |
| (Delfani & Ibrahim, 2021) | Coordination challenges among design professionals | Intensive coordination causing bottlenecks | Delays due to design rework and communication gaps | Smart technology and innovation recommended | Enhancing professional communication and reducing rework |

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|---|---|---|---|---|---|
| (Soo-Cheen, Wai-Yew, Abdullatef, & Soon-Han, 2021) | Motivation and education strongly affect productivity | Workforce motivation and skill level issues | Delays linked to workforce competency and motivation | Monetary incentives and education improvements proposed | Improving workforce incentives and academic qualifications |
| (Mohsen, Yunus, Handan, Kasim, & Hussain, 2019) | Skilled labor with IBS awareness improves outcomes | Low knowledge and skills among local workers | Delays linked to unskilled labor and foreign workforce reliance | Encouraging local skilled labor participation | Enhancing knowledge transfer and local workforce skills |
| (Mohammed, 2016) | Skilled workers essential for timely project delivery | Lack of skilled labor and knowledge gaps | Delays due to insufficient skilled workforce | Promoting local skilled labor to reduce foreign dependency | Recommendations for skill enhancement and awareness |
| (Shafie, 2020) | Skilled craftsmen shortage and management gaps | Lack of special managers and weak communication | Delays due to storage and skilled labor costs | Management improvements and skilled labor incentives | Early preparation and management strategies suggested |
| (Nasir, Nawi, Rahim, Bahaudin, & Tapa, 2015) | Poor expertise and communication among stakeholders | Poor communication and ineffective team alliance | Delays caused by client behavior and financial issues | Improved stakeholder communication and management | Addressing financial and communication factors to reduce delays |
| (Ali, Abas, Affandi, & Abas, 2018) | Lack of knowledge and skilled workers impede uptake | Knowledge gaps and workforce shortages | Delays linked to workforce and knowledge deficiencies | Increased facilities and incentives recommended | Enhancing R&D and workforce training proposed |
| (Yusof, Jabar, Nawawi, & Nawi, 2024) | Shortage of professionals experienced in modular systems | Logistical complexities and resistance to change | Delays due to cost and compliance challenges | Policy and procedural improvements needed | Addressing resistance and logistical issues for adoption |
| (Rakan K. Albalawi, Paul M. Goodrum, & Taylor, 2023) | Multiskilled workers have higher competency levels | Competency measurement among single and multiskilled | Delays linked to skill level and experience | Training multiskilled workers to improve competency | Multiskilling as a strategy to enhance workforce skills |
| (Ismail, Aziz, & Aziz, 2014) | Project managers require | Extra roles and competencies needed for IBS projects | Delays linked to management competency gaps | Competency framework development | Enhancing project manager skills for IBS success |

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|---|---|---|---|---|---|
| | specific IBS competencies | | | for project managers | |
| (Lee, Abdullah, Q., Gui, & Whyte, 2021) | Contractor perception of IBS readiness varies | Management and logistical challenges perceived | Delays linked to readiness and management issues | Need for improved contractor readiness and support | Enhancing contractor awareness and readiness |
| (Alaghbari, 2012) | Workers' skills and experience affect IBS speed | Multiple factors causing delays in construction projects | Delays due to workforce skills and equipment use | Improved training and technology adoption needed | Addressing workforce skills to improve construction speed |
| (Bohari, Mahat, & Kipli, 2012) | Contractors in Sarawak lack IBS exposure | Low awareness and volume limit IBS use | Delays linked to economic scale and exposure | Increased training and exposure programs needed | Promoting IBS awareness and economic viability |
| (Baharuddin et al., n.d.) | Lack of skills and knowledge hinder IBS formwork use | Financial and policy barriers affect implementation | Delays due to cost and enforcement issues | Government policy enforcement and incentives needed | Addressing knowledge and financial barriers |
| (Baharuddin, Bahardin, Zaidi, Lokman, & Nawi, 2016) | Knowledge and awareness gaps in IBS formwork | Financial and incentive challenges | Delays linked to policy enforcement and costs | Policy enforcement and promotion recommended | Enhancing awareness and financial support |
| (Jabar & Ismail, 2018) | Management challenges in pre-, during, post-construction | Phase-specific management issues causing delays | Delays due to poor planning and coordination | Improved contractor preparedness and management | Categorizing challenges to improve handling |
| (Tarang, Mohammad, Nizam Akbar, & Mohamed, 2025) | Internal knowledge transfer and capital challenges | External political and market challenges | Delays linked to payment and political instability | Strategic business planning and government support | Addressing internal and external business challenges |
| (Jabar et al., 2018) | Project managers need evolving roles and competencies | Additional competencies beyond generic projects | Delays linked to management skill gaps | Career development support for project managers | Enhancing project manager capabilities |
| (El-Abidi et al., 2019) | Critical success factors include | Strategy, funding, and process challenges | Delays linked to process inefficiencies | Funding and strategic support critical | Prioritizing CSFs for smooth IBS implementation |

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| | | | | | |
|---|---|---|---|---|---|
| | people and process | | | | |
| (Kamar, 2011) | Contractor transformation requires training and skills | Organizational strategy and soft issues | Delays due to lack of readiness and skills | IT and continuous improvement as enablers | Holistic approach to contractor readiness |
| (Hashim, Muntath, Othman, & Musa, 2024) | Workforce competency reduces construction waste | Poor labor skills increase waste and delays | Delays linked to errors and poor supervision | IBS reduces waste through better workforce skills | Emphasizing workforce training to reduce waste |
| (Jaffar & Lee, 2020) | Knowledge and expertise critical for IBS success | Communication and management factors | Delays linked to payment and integration issues | Government policies and training support needed | Addressing multiple factors for performance improvement |
| (Jabar I. l., Ismail, Aziz, & Janipha, 2013) | Construction managers need additional IBS competencies | Competency gaps in managing IBS projects | Delays linked to management inefficiencies | Competency development for managers recommended | Enhancing management skills for IBS projects |
| (Nawi, Azman, Osman, Radzuan, & Yaakob, 2017) | Poor integration among stakeholders causes delays | Fragmentation and communication barriers | Delays due to lack of team integration | Integrated team approaches recommended | Promoting collaboration to reduce delays |
| (Kamar, Alshawi, & Hamid, 2012) | Training, leadership, and cost management critical | Supply chain and procurement challenges | Delays linked to readiness and experience | IT and continuous improvement as enablers | Benchmarking best practices for readiness |
| (Alawag, et al., 2022) | Workforce skill shortages and innovation gaps | Innovation and management challenges | Delays linked to technology adoption | Research and development support needed | Future research to address workforce and innovation gaps |
| (Alawag, et al., 2021) | Skilled manpower shortages and foreign labor reliance | Barriers include cost and productivity issues | Delays linked to workforce and enforcement gaps | Early planning and enforcement recommended | Enhancing skilled labor and policy enforcement |

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| | | | | | |
|---|---|---|---|---|---|
| (Amin, et al., 2017) | Workforce skill and knowledge barriers | Fragmentation and sustainability challenges | Delays due to fragmentation and low adoption | Government encouragement and policy support | Addressing barriers to increase IBS adoption |
| (Salahuddin, 2010) | Worker and machinery factors affect time performance | Financial, material, and worker challenges | Delays linked to financial and material issues | Improved management and planning needed | Enhancing factors to improve time performance |
| (Mohamad, Zawawi, & Nekooie, 2018) | Low acceptance and awareness among practitioners | Problems in implementation and management | Delays linked to awareness and acceptance issues | Strategies to improve awareness and implementation | Promoting acceptance and addressing problems |
| (Tamrin, Nawi, & Nifa, 2016) | Readiness factors include knowledge, ability, planning | Lack of readiness among industry players | Delays linked to readiness and planning gaps | Focus on knowledge and planning improvements | Enhancing readiness to improve IBS uptake |
| (Hobees, et al., 2021) | FM challenges include quality and maintenance skills | Management and quality challenges | Delays linked to maintenance and management issues | Efficient FM practices needed | Improving FM to support IBS project success |
| (Tamrin, Nawi, & Nifa, 2015) | Readiness obstacles include awareness and cost issues | Planning and supply chain challenges | Delays linked to readiness and supply chain | Readiness improvement critical | Addressing readiness to increase IBS implementation |
| (Alia, Bohari, & Kipli, 2011) | Contractors lack IBS knowledge and exposure | Low awareness limits IBS adoption | Delays linked to knowledge and exposure gaps | Training and informative programs needed | Strengthening contractor knowledge and exposure |
| (Masram, Yassin, Shafii, & Murugappah, 2024) | Workforce supervision and logistics challenges | Site supervision and monitoring issues | Delays linked to supervision and logistics | Improved site monitoring recommended | Enhancing supervision to reduce delays |

Base on matrix above, we summarizing all the finding as below;

**Workforce Skill Level**

30 studies found that workforce skill deficiencies, (Wong & Lau, 2015) (Mohsen, Yunus, Handan, Kasim, & Hussain, 2019) (Khor S.-C. , Tiang, Abdullatef, & Wai, 2021). Several studies emphasize the importance of multiskilling and competency development among workers and project managers to improve IBS outcomes

(Ismail, Aziz, & Aziz, 2014) (Jabar, Ismail, & Aziz, 2018). A recurring theme is the reliance on foreign labor due to insufficient local skilled workers, highlighting the need for local workforce development (Mohsen, Yunus, Handan, Kasim, & Hussain, 2019) (Mohammed, 2016) (Alawag, Alaloul, Baarimah, Musarat, & Al-Mekhlafi, 2023). Monetary incentives and educational improvements are frequently proposed to enhance workforce motivation and skill levels (Khor S.-C. , Tiang, Abdullatef, & Wai, 2021) (Soo-Cheen, Wai-Yew, Abdullatef, & Soon-Han, 2021).

**Management Challenge Types**

28 studies identified key management challenges including poor communication, ineffective team integration, logistical difficulties, and lack of specialized management roles (Hadi, Muhamad, & Othman, 2017) (Nasir, Nawi, Rahim, Bahaudin, & Tapa, 2015) (Nasir, Nawi, Rahim, Bahaudin, & Tapa, 2015) (Nawi, Azman, Osman, Radzuan, & Yaakob, 2017). Fragmentation of project teams and inadequate supervision during installation are common issues causing delays (Jalil & Shaari, 2022b) (Jabar & Ismail, 2018) (Nawi, Azman, Osman, Radzuan, & Yaakob, 2017). Payment mechanisms and contract management problems also contribute to management challenges (Jalil & Shaari, 2022b) (Shafie, 2020). Several studies highlight the need for improved planning, coordination, and leadership to address these challenges (Al-Aidrous, Shafiq, Al-Ashmori, Al-Mekhlafi, & Baarimah, 2022) (Kamar, Alshawi, & Hamid, 2012).

**Delay Factors Impact**

32 studies report that delays in IBS projects are often caused by workforce skill gaps, logistical constraints, poor communication, and financial issues ( (Wong & Lau, 2015) (Saberi, Zulkifli, Zainuddin, & Saidin, 2022) (Nasir, Nawi, Rahim, Bahaudin, & Tapa, 2015). Environmental factors such as flooding and material unavailability also contribute to project timeline extensions (Wong & Lau, 2015). Delays are exacerbated by inadequate supervision, defective workmanship, and design coordination problems (Jalil & Shaari, 2022b) (Flora, 2022) (Delfani & Ibrahim, 2021). Financial constraints, including high initial costs and payment disputes, are significant delay factors (Jalil & Shaari, 2022a) (Salahuddin, 2010).

**Organizational Support Mechanisms**

25 studies emphasize the critical role of government incentives, policies, and infrastructure development in facilitating IBS adoption and workforce readiness (Hadi, Muhamad, & Othman, 2017) (Ali, Abas, Affandi, & Abas, 2018) (Tamrin, Nawi, & Nifa, Key factors of readiness in the implementation of industrialised building system (IBS), 2016). Organizational human factors and effective facilities management are important for smooth project execution (Abdullah & Nasir, 2024) (Hobees, et al., 2021). Support mechanisms such as training programs, knowledge transfer, and readiness frameworks are frequently recommended (Al-Aidrous, Shafiq, Al-Ashmori, Al-Mekhlafi, & Baarimah, 2022) (Tamrin, Nawi, & Nifa, Industrialised building system in construction projects: a study on readiness., 2015) (Tamrin, Nawi, & Nifa, 2016). Challenges include limited local IBS manufacturers and weak enforcement of policies (Wong & Lau, 2015) (Ali, Abas, Affandi, & Abas, 2018).

**Mitigation Strategies Effectiveness**

27 studies propose strategies including enhanced training, monetary incentives, improved supervision, and adoption of quality management systems like TQM to address workforce and management challenges (Khor S. C., Tiang, Abdullatef, & Wai, 2023) (Alawag, et al., The Implementation of the Industrialized Building System in the Malaysian Construction Industry—a Comprehensive Review, 2021) (Jalil & Shaari, Installation IBS Components in Malaysian Housing Projects; The Difficulties and Solutions, 2022b). Frameworks integrating design for manufacturing and assembly (DfMA) and building information modeling (BIM) are suggested to improve collaboration and reduce delays (Razak, Khoiry, Badaruzzaman, Hussain, & Zain, 2023). Government-led initiatives focusing on incentives, infrastructure, and policy enforcement are seen as vital for successful IBS implementation (Hadi, Muhamad, & Othman, 2017) (Ali, Abas, Affandi, & Abas, 2018). Focus on early planning, standardized design, and integrated team approaches are effective in mitigating delays (Al-Aidrous, Shafiq, Al-Ashmori, Al-Mekhlafi, & Baarimah, 2022) (Nawi, Azman, Osman, Radzuan, & Yaakob, 2017).

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**Critical Analysis and Synthesis**

The literature on workforce skill and project management challenges in implementing Industrialized Building System (IBS) in rural Sabah and Sarawak reveals a various landscape of issues and potential solutions. A recurring theme is the significant gap in workforce competency and the logistical constraints unique to rural settings, which contribute to project delays. While many studies provide valuable insights into barriers such as lack of skilled labor, lack of management practices, and supply chain inefficiencies, there is a notable shortage of comprehensive empirical data specifically focused on rural contexts. Furthermore, the methodologies employed vary widely, with qualitative case studies and controlling surveys, which sometimes limits the generalizability of findings. Despite these limitations, the research collectively underscores the critical need for targeted strategies to enhance workforce skills and project management competencies to improve IBS adoption and reduce delays in these rural regions.

| **Aspect** | **Strengths** | **Weaknesses** |
|---|---|---|
| Workforce Skill Deficiencies | Several studies robustly identify the lack of skilled local labor as a primary barrier to IBS implementation, emphasizing the need for enhanced training and education programs tailored to rural contexts. The correlation between workforce motivation, education, and productivity is well established, providing a clear direction for workforce development. | Many studies rely on self-reported data from contractors or professionals, which may introduce bias and overlook the perspectives of the labor workforce itself. There is limited quantitative data measuring actual skill levels or competency benchmarks, particularly in rural Sabah and Sarawak, reducing the precision of workforce assessments. |
| Project Management Challenges | Research highlights the complexity of managing IBS projects due to the integration of conventional and industrialized methods, requiring specialized competencies among project managers. The identification of additional roles and competencies needed for IBS project managers is a strength, offering a foundation for competency frameworks. | The predominance of qualitative interviews with small sample sizes limits the generalizability of findings. There is a lack of longitudinal studies tracking the impact of enhanced management competencies on project timelines and outcomes in rural settings. Moreover, the unique logistical challenges in rural areas are often underexplored in management-focused studies. |
| Logistical and Supply Chain Constraints | Studies effectively document the logistical difficulties in rural IBS projects, such as distance from manufacturers, poor infrastructure, and transportation challenges, which increase costs and cause delays. The recognition of supply chain issues as a critical factor provides a comprehensive view of external constraints affecting project delivery. | While logistical challenges are acknowledged, there is limited empirical analysis quantifying their direct impact on project delays. Few studies propose or evaluate specific logistical solutions tailored to rural Sabah and Sarawak, leaving a gap in actionable strategies. |
| Organizational and Human Factors | The role of organizational human factors, including communication, teamwork, and leadership, is well addressed, with frameworks proposed to improve supply chain integration and project performance. The emphasis on Total Quality Management (TQM) as a potential driver for overcoming IBS implementation | Despite recognizing human factors, many studies focus on urban or general Malaysian contexts, with insufficient attention to rural-specific organizational dynamics. The adoption of TQM and other frameworks remains low, and studies often lack empirical validation of these approaches in rural IBS projects |

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| | challenges adds depth to the organizational analysis. | |
| Strategies for Improvement and Readiness | Several papers propose comprehensive strategies including government incentives, enhanced training, improved planning, and adoption of digital technologies like BIM and DfMA to boost IBS readiness and implementation success. The identification of critical success factors and readiness elements provides a strategic roadmap for stakeholders. | Many proposed strategies are conceptual or based on limited case studies, with few rigorous evaluations of their effectiveness in rural settings. There is a tendency to generalize findings from urban or West Malaysian contexts without sufficient adaptation to the unique challenges of Sabah and Sarawak rural areas. |
| Research Methodologies | The use of mixed methods, including qualitative interviews, surveys, and case studies, allows for rich, contextual insights into IBS challenges and workforce issues. Some studies employ robust statistical analyses to identify critical factors influencing IBS adoption. | The predominance of qualitative and cross-sectional designs limits causal inference and longitudinal understanding. Sample sizes are often small and geographically limited, reducing representativeness. There is a notable lack of experimental or intervention-based studies to test proposed solutions. |
| Focus on Rural Contexts | A few studies specifically address rural IBS implementation in Sabah and Sarawak, highlighting unique challenges such as poor infrastructure and limited local manufacturing. These contributions fill an important gap by contextualizing IBS challenges beyond urban centers. | Despite these contributions, rural-focused research remains sparse and often anecdotal. Many studies extrapolate findings from urban or West Malaysian contexts, which may not fully capture the complexities of rural IBS projects in Sabah and Sarawak. There is a need for more targeted, empirical research in these underexplored areas. |

**Thematic Review of Literature**

The literature on workforce skill and project management challenges in implementing Industrialized Building System (IBS) in Sabah and Sarawak's rural areas reveals several recurrent themes. Key issues include workforce skill deficiencies, management and project delays, organizational and logistical constraints, and strategies for overcoming these barriers. The studies highlight the importance of specialized competencies, readiness, and integrated management practices tailored to rural contexts. Additionally, challenges such as supply chain logistics, financial constraints, and stakeholder perceptions intersect with workforce and management issues to exacerbate project delays and affect IBS adoption.

| **Theme** | **Appears In** | **Theme Description** |
|---|---|---|
| Workforce Skill Deficiencies and Competency Gaps | 18/50 Papers | A predominant theme concerns the lack of skilled and knowledgeable workforce, especially local labor, which undermines IBS implementation in rural Sabah and Sarawak. Studies emphasize the need for enhanced training, motivation, and multi-skilling to improve productivity and reduce reliance on foreign labor (Khor S.-C. , Tiang, Abdullatef, & Wai, 2021) (Soo-Cheen, Wai-Yew, Abdullatef, & Soon-Han, 2021) (Mohsen, Yunus, Handan, Kasim, & Hussain, 2019) (Mohammed, 2016) (Tamrin, Nawi, & Nifa, Industrialised building system in construction projects: a study on readiness., 2015). Workforce education and incentives are critical for overcoming skill gaps, which directly impact project quality |

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| | | and timelines (Mohsen, Yunus, Handan, Kasim, & Hussain, 2019) (Mohammed, 2016) (Khor S. C., Tiang, Abdullatef, & Wai, 2023). |
| Project Management Challenges and Causes of Delays | 16/50 Papers | Management problems such as poor coordination, ineffective communication, lack of specialized project managers, and weak supervision are key contributors to project delays in IBS projects. Delays stem from both pre-construction and construction phases, necessitating improved management competencies and integration of processes (Wong & Lau, 2015) (Saberi, Zulkifli, Zainuddin, & Saidin, 2022) (Shafie, 2020) (Nasir, Nawi, Rahim, Bahaudin, & Tapa, 2015) (Jabar & Ismail, 2018) (Jabar I. l., Ismail, Aziz, & Janipha, 2013)The complexity of combining IBS with conventional methods intensifies the demand for competent project managers (Ismail, Aziz, & Aziz, 2014) (Jabar, Ismail, & Aziz, Managing IBS Project: The evolving roles and competencies of project manager, 2018). |
| Organizational and Logistical Constraints | 14/50 Papers | Organizational readiness and logistical issues, including limited local IBS manufacturers, infrastructure challenges, procurement difficulties, and supply chain fragmentation, impede IBS uptake in rural areas. These constraints result in cost overruns and schedule disruptions (Hadi, Muhamad, & Othman, 2017) (Samsi, et al., 2024) (Jalil & Shaari, Exploring the Hurdles and Solutions in Procuring IBS Components for Malaysian Housing Projects, 2022a) (Ali, Abas, Affandi, & Abas, 2018) (Bohari, Mahat, & Kipli, 2012) (Tarang, Mohammad, Nizam Akbar, & Mohamed, 2025). Poor supply chain integration and inadequate financial support exacerbate implementation difficulties (Abdullah & Nasir, 2024) (Jalil & Shaari, Installation IBS Components in Malaysian Housing Projects; The Difficulties and Solutions, 2022b) (Tarang, Mohammad, Nizam Akbar, & Mohamed, 2025) |
| Strategies and Critical Success Factors for IBS Adoption | 12/50 Papers | Several studies identify critical success factors involving early planning, training, government incentives, teamwork, and technological integration as essential to enhance IBS adoption. Emphasis on total quality management (TQM), design for manufacturing and assembly (DfMA), and multidisciplinary collaboration aim to improve project delivery and reduce delays (Alawag, Alaloul, Baarimah, Musarat, & Al-Mekhlafi, 2023) (Alawag, Alaloul, Liew, Musarat, & Baarimah, 2023b) (Al-Aidrous, Shafiq, Al-Ashmori, Al-Mekhlafi, & Baarimah, 2022) (El-Abidi et al., 2019) (Kamar K. M., 2011) (Kamar, Alshawi, & Hamid, 2012). Strategic frameworks and competency models for project managers are proposed to address unique IBS demands (Ismail, Aziz, & Aziz, 2014) (Jabar, Ismail, & Aziz, 2018). |
| Stakeholder Perceptions and Resistance to Change | 9/50 Papers | Resistance to change and negative perceptions among stakeholders, including contractors and developers, affect IBS acceptance. High initial costs, lack of exposure, and misconceptions about IBS benefits are common barriers in rural regions (Wong & Lau, 2015) (Kaur, et al., 2024) (Mohamad, Zawawi, & Nekooie, 2018) (Alia, Bohari, & Kipli, 2011). Addressing these through awareness programs and policy incentives is vital for improving readiness (Mohamad, Zawawi, & Nekooie, 2018) (Tamrin, Nawi, & Nifa, 2015) (Alia, Bohari, & Kipli, 2011). |

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| Supervision and Workmanship Quality Issues | 7/50 Papers | The quality of IBS workmanship, especially during installation, is compromised by insufficient skilled supervision and poor communication among teams. This leads to defects, rework, and further delays (Flora, 2022) (Jalil & Shaari, 2022a) (Masram, Yassin, Shafii, & Murugappah, 2024). Mandating supervision and clear method statements are recommended solutions to mitigate installation challenges (Jalil & Shaari, 2022a) |
| Supply Chain and Procurement Challenges | 6/50 Papers | Challenges in procuring IBS components, including payment disputes, contract breaches, and logistical barriers, directly contribute to project delays. These issues cause interruptions in component delivery and litigation risks, undermining timely project completion (Jalil & Shaari, 2022a) (Baharuddin, Bahardin, Zaidi, Lokman, & Nawi, 2016). Emphasis on improved payment mechanisms and contract clarity is suggested (Jalil & Shaari, 2022a) |
| Readiness and Knowledge Transfer Among Industry Players | 6/50 Papers | The general lack of industry readiness, poor knowledge transfer, and insufficient exposure to IBS technologies are frequently cited. Readiness encompasses knowledge, ability, and planning, which are foundational for successful IBS implementation, especially in less urbanized areas (Tamrin, Nawi, & Nifa, 2016) (Tamrin, Nawi, & Nifa, 2015) (Alia, Bohari, & Kipli, 2011). Continuous training and government facilitation are crucial to improving readiness levels (Hadi, Muhamad, & Othman, 2017) (Tamrin, Nawi, & Nifa, 2015) |
| Quality Management Practices and TQM Implementation | 5/50 Papers | Adoption of total quality management (TQM) in IBS projects remains low despite its potential to enhance communication, reduce costs, and improve satisfaction. Reluctance among local firms to integrate TQM systems limits quality improvements and project success. Addressing this requires management commitment and awareness of TQM benefits (Alawag, Alaloul, Baarimah, Musarat, & Al-Mekhlafi, 2023) (Alawag, Alaloul, Liew, Musarat, & Baarimah, 2023b). |
| Technological Integration and Innovation | 4/50 Papers | Integration of advanced technologies like Building Information Modelling (BIM) and Design for Manufacturing and Assembly (DfMA) principles is identified as a means to enhance IBS efficiency and sustainability. However, low adoption rates and lack of collaboration hamstring these innovations in rural contexts (Razak, Khoiry, Badaruzzaman, Hussain, & Zain, 2023) (Alawag, et al., 2022). Frameworks to support digital construction are being proposed for future advancements (Razak, Khoiry, Badaruzzaman, Hussain, & Zain, 2023) |

Table 3: Theme review matrix for the studies

**Chronological Review of Literature**

The literature on workforce skill and project management challenges in implementing Industrialized Building System (IBS) in Sabah and Sarawak rural areas has evolved over the years with increasing focus on specific barriers and success factors. Early studies explored general IBS adoption challenges and workforce competency deficits, often cantered on urban contexts. Over time, research began addressing unique rural logistical constraints, manufacturer scarcity, and management competency in project delays. Recent works emphasize integrated management strategies, human factor improvements, and competency frameworks tailored to rural and Malaysian contexts, highlighting the importance of organizational readiness and supply chain management.

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| Year Range | Research Direction | Description |
|---|---|---|
| 2009–2012 | Foundational IBS Adoption and Early Barriers | Initial research identified IBS as a promising method to improve construction quality, cost, and safety but highlighted limited adoption due to lack of experience, traditional practices, and workforce skill deficiencies. Studies focused on general barriers such as poor exposure to IBS, limited contractor readiness, and the need for training and awareness, especially in less urbanized areas like Sarawak. |
| 2013–2015 | Project Management Competencies and Delay Factors | Research expanded to investigate project management challenges, delay factors, and the critical role of competent managers for IBS projects. Studies analyzed the complexity of integrating IBS with conventional methods, emphasizing the necessity for skilled project managers and highlighting communication and coordination gaps as contributors to project delays. |
| 2016–2018 | Workforce Skill Enhancement and Management Challenges | Focus shifted towards identifying and enhancing workforce skills essential for IBS implementation, with quantitative approaches assessing contractor perspectives. Research also explored management challenges including supply chain constraints, financial issues, and organizational readiness, with increased attention to the role of government policies and incentives in supporting IBS uptake. |
| 2019–2021 | Critical Success Factors and Organizational Readiness | Studies concentrated on identifying critical success factors, organizational readiness, and the development of frameworks to improve IBS adoption. Emphasis was placed on team integration, collaboration, and training needs while addressing persistent barriers such as high initial costs, lack of skilled labor, and limited local manufacturing, particularly in rural settings. |
| 2022–2024 | Human Factors, Supply Chain, and Strategic Management Models | Recent works focus on human resource management, supply chain integration, and strategic approaches to overcome IBS implementation challenges. Research highlights include addressing workforce motivation, competency evaluation, total quality management adoption, and digital and sustainable construction frameworks. These studies propose actionable strategies for improving project delivery times and reducing delays in rural IBS projects in Sabah and Sarawak. |

Table 4: Evolution of IBS studies in Malaysia

**Agreement and Divergence Across Studies**

The reviewed literature displays considerable consensus on the significant workforce skill deficiencies and management challenges impacting IBS implementation in rural Malaysian contexts, especially Sabah and Sarawak. Many studies emphasize logistical constraints, lack of skilled labor, and organizational readiness as critical delay factors. Nonetheless, divergences arise regarding the efficacy of mitigation strategies and the extent of governmental and organizational support, with some studies highlighting proactive policy roles while others underscore persistent gaps in enforcement and incentive structures. These differences often stem from varying research methodologies, geographic focus (urban vs rural), timeframes, and stakeholder perspectives, including contractors, project managers, and workforce.

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| Comparison Criterion | Studies in Agreement | Studies in Divergence | Potential Explanations |
|---|---|---|---|
| Workforce Skill Level | Numerous studies concur that skill deficiencies among local labor significantly hinder IBS project success and contribute to delays, emphasizing the need for enhanced training and motivation, especially in rural Sarawak and Sabah (Wong & Lau, 2015) (Khor S. C., Tiang, Abdullatef, & Wai, 2023) (Soo-Cheen, Wai-Yew, Abdullatef, & Soon-Han, 2021) (Mohsen, Yunus, Handan, Kasim, & Hussain, 2019) (Mohammed, 2016) (Ali, Abas, Affandi, & Abas, 2018) (Alia, Bohari, & Kipli, 2011). The correlation between education, motivation, and productivity is also widely acknowledged (Khor S. C., Tiang, Abdullatef, & Wai, 2023) (Soo-Cheen, Wai-Yew, Abdullatef, & Soon-Han, 2021). | Some papers highlight the development and implementation of multiskilling and competency measurement strategies that show promise, suggesting a path beyond basic skill deficits (Rakan K. Albalawi, Paul M. Goodrum, & Taylor, 2023). However, the readiness to adopt such advanced workforce measures is uneven across regions (Samsi, et al., 2024) (Tamrin, Nawi, & Nifa, 2015). | Agreement is driven by consistent evidence of skill gaps from contractor and workforce perspectives. Disparity happen due to differences in technological adoption levels, regional focus (rural vs urban), and whether studies include advanced competency frameworks or focus solely on basic skill shortages. |
| Management Challenge Types | There is strong consensus that IBS projects face complex management challenges including poor communication, inadequate supervision, fragmented team integration, and insufficient project-specific managerial competencies, all contributing to delays (Flora, 2022) (Shafie, 2020) (Ismail, Aziz, & Aziz, 2014) (Jabar, Ismail, & Aziz, 2018) (Nawi, Azman, Osman, Radzuan, & Yaakob, 2017). The need for specialized project managers with IBS competencies is emphasized (Ismail, Aziz, & Aziz, 2014) (Jabar, Ismail, & Aziz, 2018) | Some studies differ in the weight assigned to specific challenges. For example, urban-focused studies stress design and incentive issues more, whereas rural studies underscore infrastructural and logistical management problems (Wong & Lau, 2015) (Hadi, Muhamad, & Othman, 2017) (Masram, Yassin, Shafii, & Murugappah, 2024). Also, the role and implementation of Total Quality Management (TQM) as a solution vary in reported effectiveness (Alawag, Alaloul, Baarimah, Musarat, & Al-Mekhlafi, 2023) (Alawag et al., 2023) (Alawag, Alaloul, Liew, Musarat, & Baarimah, 2023b) | Variation arises due to differences in project location (rural vs urban), scope (public vs private), and methodological focus (qualitative interviews vs quantitative surveys). The diversity of IBS project scales and management maturity levels also affects findings. |

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|---|---|---|---|
| Delay Factors Impact | Studies commonly identify workforce skill shortages, logistical difficulties, inadequate supply chains, and financial constraints as primary delay contributors in rural IBS implementation (Wong & Lau, 2015) (Hadi, Muhamad, & Othman, 2017) (Saberi, Zulkifli, Zainuddin, & Saidin, 2022) (Jalil & Shaari, 2022b) (Shafie, 2020) (Nasir et al., 2015) (Alaghbari, A. Kadir, Salim, & Ernawati, 2007). Poor communication and coordination among stakeholders are consistently highlighted (Flora, 2022) (Nasir, Nawi, Rahim, Bahaudin, & Tapa, 2015) (Jabar & Ismail, 2018) (Nawi, Azman, Osman, Radzuan, & Yaakob, 2017). | Some research points to less emphasis on workforce skills and more on systemic organizational issues or external political-economic factors causing delays (Tarang, Mohammad, Nizam Akbar, & Mohamed, 2025). Contrastingly, a few studies note that despite recognized challenges, IBS adoption in some urban areas proceeds efficiently, suggesting delay factors are context-dependent (Hashim, Muntath, Othman, & Musa, 2024) (Masram, Yassin, Shafii, & Murugappah, 2024). | The differences largely reflect the geographic and contextual focus, with rural areas facing compounded infrastructural and manpower issues. Studies with a broader national or urban perspective may understate local rural challenges or highlight different delay causatives. |
| Organizational Support Mechanisms | There is agreement that organizational support, including government incentives, training programs, and infrastructure development, is vital for successful IBS adoption and workforce readiness (Hadi, Muhamad, & Othman, 2017) (Al-Aidrous, Shafiq, Al-Ashmori, Al-Mekhlafi, & Baarimah, 2022) (Ali, Abas, Affandi, & Abas, 2018) (El-Abidi et al., 2019). The role of policy and incentives is often described as critical but insufficiently enforced (Ali, Abas, Affandi, & Abas, 2018) (Tamrin, Nawi, & Nifa, 2015) (Tamrin, Nawi, & Nifa, 2016). | Divergences exist in the perceived effectiveness of these mechanisms; some studies report proactive government involvement and visible improvements (El-Abidi et al., 2019 (Mohamad, Zawawi, & Nekooie, 2018), whereas others indicate weak policy implementation, lack of enforcement, and insufficient financial support inhibit progress (Hadi, Muhamad, & Othman, 2017) (Tarang, Mohammad, Nizam Akbar, & Mohamed, 2025) (Alawag, et al., 2021) | Differences stem from evolving policy landscapes over time, regional disparities in infrastructure and support availability, and varying stakeholder perceptions. Studies conducted in different periods or regions may capture different policy impact phases. |
| Mitigation Strategies Effectiveness | Many studies suggest strategies such as enhanced training, stricter supervision during IBS component installation, improved communication and collaboration among project stakeholders, and adoption of TQM and DfMA frameworks | However, there is limited empirical evidence on long-term success of these strategies, with some studies highlighting persistent resistance to change, cost barriers, and logistical constraints undermining their effectiveness (Wong & | Discrepancies arise due to differences in study designs—some focus on theoretical frameworks and expert opinions, others on field data. Additionally, rural contexts may have unique challenges not fully addressed by existing |

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| | to overcome workforce and management challenges (Abdullah & Nasir, 2024) (Razak, Khoiry, Badaruzzaman, Hussain, & Zain, 2023) (Alawag, Alaloul, Liew, Musarat, & Baarimah, 2023b) (Jalil & Shaari, 2022b) (Delfani & Ibrahim, 2021) (Ismail, Aziz, & Aziz, 2014) (Jabar, Ismail, & Aziz, 2018). There is consensus on the need for integrated approaches and innovation to improve IBS project delivery (Yusof, Jabar, Nawawi, & Nawi, 2024) (El-Abidi et al., 2019) (Kamar K. M., 2011). | Lau, 2015) (Yusof, Jabar, Nawawi, & Nawi, 2024) (Masram, Yassin, Shafii, & Murugappah, 2024). The applicability and success of strategies often vary between rural and urban settings (Kaur, et al., 2024) (Masram, Yassin, Shafii, & Murugappah, 2024). | strategies developed primarily in urban settings. |

Table 5: Matrix of Agreement & Divergence across studies

**Theoretical And Practical Implications**

The findings reinforce the critical role of workforce skills and project management competencies in the successful implementation of IBS, particularly in rural contexts such as Sabah and Sarawak. This supports existing theories that emphasize human capital and managerial capabilities as pivotal to construction innovation adoption (Mohsen, Yunus, Handan, Kasim, & Hussain, 2019) (Ismail, Aziz, & Aziz, 2014) (Jabar, Ismail, & Aziz, 2018). The evidence suggests that IBS projects require specialized competencies beyond conventional construction management, highlighting the need for tailored theoretical frameworks addressing IBS-specific challenges.

The literature reveals that organizational readiness, including knowledge, ability, and planning, is a foundational theoretical construct influencing IBS adoption. This aligns with readiness theory in innovation diffusion, where lack of preparedness among stakeholders impedes technology uptake (Tamrin, Nawi, & Nifa, Industrialised building system in construction projects: a study on readiness., 2015) (Tamrin, Nawi, & Nifa, 2016). The findings extend this theory by identifying specific readiness factors relevant to rural Malaysian contexts, such as limited local manufacturers and logistical constraints.

The recurring theme of resistance to change and negative stakeholder perceptions challenges the assumption that technological advantages alone drive IBS adoption. This underscores the importance of integrating behavioral and socio-cultural theories into IBS implementation models to account for human and organizational resistance (Wong & Lau, 2015) (Ali, Abas, Affandi, & Abas, 2018) (Yusof, Jabar, Nawawi, & Nawi, 2024).

The role of integrated project management approaches, including total quality management (TQM) and team integration, emerges as a theoretical imperative to overcome fragmentation and coordination issues inherent in IBS projects (Alawag, Alaloul, Baarimah, Musarat, & Al-Mekhlafi, 2023) (Jabar, Ismail, & Aziz, 2018) (Nawi, Azman, Osman, Radzuan, & Yaakob, 2017). These findings support systems theory perspectives that advocate for holistic and collaborative management frameworks in complex construction environments.

The evidence also challenges traditional labor theories by highlighting the effectiveness of multiskilling strategies to enhance workforce competency and address labor shortages in IBS projects (Rakan K. Albalawi, Paul M. Goodrum, & Taylor, 2023). This suggests a theoretical shift towards flexible and adaptive workforce models in construction management literature.

The critical success factors identified, such as early planning, effective communication, and training, corroborate established project management theories but contextualize them within the unique demands of IBS in rural Malaysia, thereby enriching the theoretical discourse with localized empirical insights (Al-Aidrous et al., 2022) (El-Abidi et al., 2019) (Kamar, 2011).

**Practical Implications**

For industry practitioners, the findings emphasize the urgent need to invest in workforce development programs that enhance IBS-specific skills, including technical training and multiskilling initiatives. This is particularly crucial in rural Sabah and Sarawak, where skill shortages and lack of exposure to IBS technology are pronounced (Khor S. C., Tiang, Abdullatef, & Wai, 2023) (Mohsen, Yunus, Handan, Kasim, & Hussain, 2019) (Rakan K. Albalawi, Paul M. Goodrum, & Taylor, 2023). Enhancing workforce competency can directly reduce project delays and improve quality outcomes.

Policymakers should prioritize the establishment of local IBS manufacturing facilities and improve logistical infrastructure to address supply chain bottlenecks that contribute to project delays in rural areas (Wong & Lau, 2015) (Hadi, Muhamad, & Othman, 2017) (Jalil & Shaari, 2022b). Government incentives and financial support mechanisms are vital to stimulate local industry readiness and reduce reliance on costly imports.

The adoption of integrated management practices such as TQM and enhanced team collaboration should be promoted within IBS projects to mitigate coordination failures and improve project delivery timelines (Alawag, Alaloul, Baarimah, Musarat, & Al-Mekhlafi, 2023) (Alawag, Alaloul, Liew, Musarat, & Baarimah, 2023b) (Jabar, Ismail, & Aziz, 2018). Training programs for project managers and supervisors on these methodologies can enhance overall project performance.

Practical strategies to overcome resistance to change include stakeholder engagement initiatives and awareness campaigns that highlight the benefits of IBS, tailored to the socio-cultural context of rural communities (Wong & Lau, 2015) (Ali, Abas, Affandi, & Abas, 2018)( (Yusof, Jabar, Nawawi, & Nawi, 2024). This can foster more positive perceptions and greater acceptance of IBS technologies.

The implementation of mandatory supervision during IBS component installation is recommended to prevent workmanship defects and subsequent delays, addressing a critical practical challenge identified in the literature (Jalil & Shaari, 2022b) (Flora, 2022). Clear method statements and continuous monitoring can enhance installation quality and project efficiency.

Finally, the integration of digital technologies such as Building Information Modeling (BIM) and Design for Manufacturing and Assembly (DfMA) frameworks offers practical pathways to improve planning, coordination, and sustainability in IBS projects, aligning with national Construction 4.0 initiatives (Razak, Khoiry, Badaruzzaman, Hussain, & Zain, 2023). Adoption of these technologies can facilitate better project control and reduce time overruns in rural IBS implementations.

**Limitations of The Literature**

| Area of Limitation | Description of Limitation | Papers which have limitation |
|---|---|---|
| Geographic Bias | Many studies focus mostly on urban areas or specific regions such as West Malaysia, limiting the external validity of findings when applied to rural Sabah and Sarawak. This geographic concentration restricts understanding of unique rural challenges. | (Wong & Lau, 2015) (Hadi et al., 2017) (Samsi et al., 2024) (Kaur et al., 2024) (Ali et al., 2018) (Bohari et al., 2012) |
| Small Sample Sizes | Several studies rely on limited sample sizes or few respondents, which constrains the generalizability of results and may introduce sampling bias. This methodological constraint weakens the robustness | (Hadi, Muhamad, & Othman, 2017) (Ali, Abas, Affandi, & Abas, |

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| | of conclusions drawn about workforce and management challenges. | 2018) (Lee, Abdullah, Q., Gui, & Whyte, 2021) |
| Stakeholder Perspective Imbalance | Research often emphasizes views from contractors, managers, or consultants, neglecting the labor workforce perspective. This imbalance limits comprehensive insight into workforce skill challenges and may overlook critical grassroots issues affecting project delays. | (Khor S. C., Tiang, Abdullatef, & Wai, 2023) (Soo-Cheen, Wai-Yew, Abdullatef, & Soon-Han, 2021) |
| Lack of Longitudinal Data | The predominance of cross-sectional designs restricts understanding of how workforce skills and management challenges evolve over time, affecting the ability to infer causality or long-term impacts on IBS project delays. | (Samsi, et al., 2024) (Saberi, Zulkifli, Zainuddin, & Saidin, 2022) (Nasir, Nawi, Rahim, Bahaudin, & Tapa, 2015) |
| Limited Focus on Rural Context | Despite the unique challenges in rural Sabah and Sarawak, few studies explicitly address these contexts, reducing the applicability of findings to these underexplored areas and limiting targeted policy recommendations. | (Wong & Lau, 2015) (Hadi, Muhamad, & Othman, 2017) (Samsi, et al., 2024) (Shafie, 2020) |
| Overemphasis on Technical Factors | Many studies concentrate on technical or process-related issues, often underrepresenting organizational, cultural, and human factors that significantly influence IBS adoption and project management effectiveness, thus limiting holistic understanding. | (Kamar K. M., 2011) (Kamar, Alshawi, & Hamid, 2012) (Alawag, et al., 2021) |
| Insufficient Exploration of Management Competencies | There is a scarcity of detailed investigation into specific project management competencies required for IBS projects, which weakens the ability to develop targeted training and competency frameworks to mitigate delays. | (Ismail, Aziz, & Aziz, 2014) (Jabar, Ismail, & Aziz, Managing IBS Project: The evolving roles and competencies of project manager, 2018) (Jabar I. l., Ismail, Aziz, & Janipha, 2013) |
| Inconsistent Methodologies | Variability in research methods, including qualitative, quantitative, and mixed approaches with differing instruments, limits comparability across studies and may affect the consistency and reliability of synthesized findings. | (Abdullah & Nasir, 2024) (Alawag, Alaloul, Baarimah, Musarat, & Al-Mekhlafi, 2023) (Alawag, Alaloul, Liew, Musarat, & Baarimah, 2023b) |

**Gaps and Future Research Directions**

Base on the studies, there some gap needs to explore for the future research. The gap was essential to define to get better picture on effect of the skills in strengthen the IBS implementation in rural area.

| Gap Area | Description | Future Research Directions | Justification | Research Priority |
|---|---|---|---|---|
| Quantitative assessment of workforce skill | Existing studies largely rely on qualitative or self-reported data with limited quantitative measurement of actual | Conduct empirical studies using standardized skill assessment tools to quantitatively measure | Quantitative data is essential to precisely target training programs and improve workforce readiness, which is | High |

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|---|---|---|---|---|
| levels in rural IBS projects | workforce competencies in rural Sabah and Sarawak. | workforce competencies and identify specific skill gaps in rural IBS projects. | currently under-documented in rural contexts (Wong & Lau, 2015) (Khor S. C., Tiang, Abdullatef, & Wai, 2023) (Mohsen, Yunus, Handan, Kasim, & Hussain, 2019). | |
| Longitudinal evaluation of project management competency impact | There is a lack of longitudinal studies tracking how enhanced project management competencies affect IBS project timelines and outcomes in rural areas. | Design longitudinal studies to monitor the effect of targeted project management training on IBS project performance and delay reduction over time in rural Sabah and Sarawak. | Understanding causal relationships over time will validate competency frameworks and inform effective management interventions (Ismail, Aziz, & Aziz, 2014) (Jabar, Ismail, & Aziz, 2018). | High |
| Tailored logistical solutions for rural IBS supply chains | While logistical challenges are acknowledged, few studies propose or empirically evaluate specific solutions adapted to the unique rural infrastructure and manufacturer scarcity in Sabah and Sarawak. | Develop and test innovative supply chain models and logistics strategies specifically designed for rural IBS projects, including local manufacturing incentives and transport optimization. | Addressing rural-specific logistical barriers is critical to reducing delays and cost overruns unique to these regions (Wong & Lau, 2015) (Hadi, Muhamad, & Othman, 2017) (Wong & Lau, 2015) (Hadi et al., 2017) (Samsi, et al., 2024). | High |
| Empirical validation of organizational human factor frameworks in rural IBS | Existing frameworks addressing human factors and TQM adoption are mostly conceptual or urban-focused, lacking empirical validation in rural IBS projects. | Implement and evaluate organizational human factor improvement frameworks and TQM drivers in rural IBS projects to assess their effectiveness in reducing delays. | Empirical validation will ensure these frameworks are practical and effective in rural settings with distinct organizational dynamics (Abdullah & Nasir, 2024) (Alawag, Alaloul, Baarimah, Musarat, & Al-Mekhlafi, 2023) (Alawag, Alaloul, Liew, Musarat, & Baarimah, 2023b) | Medium |
| Effectiveness of digital technologies (DfMA, BIM) in rural IBS adoption | Although digital frameworks like DfMA and BIM are proposed, their adoption and impact on collaboration and delay mitigation in rural IBS projects remain underexplored. | Conduct pilot projects integrating DfMA and BIM in rural IBS construction to evaluate their influence on workforce collaboration, planning accuracy, and project timelines. | Digital tools could transform rural IBS implementation but require evidence of feasibility and benefits in these contexts (Razak, Khoiry, Badaruzzaman, Hussain, & Zain, 2023) (Al-Aidrous, Shafiq, Al- | Medium |

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|---|---|---|---|---|
| | | | Ashmori, Al-Mekhlafi, & Baarimah, 2022). | |
| Local workforce development versus foreign labor reliance | The persistent reliance on foreign labor due to local skill shortages is noted, but strategies to effectively transition to a skilled local workforce in rural areas are insufficiently studied. | Investigate comprehensive local workforce development programs, including multiskilling and incentive schemes, and measure their impact on reducing foreign labor dependency in rural IBS projects. | Enhancing local skills is vital for sustainable IBS adoption and reducing project delays linked to labor issues (Mohsen, Yunus, Handan, Kasim, & Hussain, 2019) (Mohammed, 2016) (Alawag, et al., 2021). | High |
| Impact of financial and payment mechanisms on IBS project delays | Payment disputes and financial constraints are frequently cited delay factors, yet detailed analyses of payment mechanisms and their reform in rural IBS projects are limited. | Analyze current payment and contract management practices in rural IBS projects and develop improved mechanisms to ensure timely payments and reduce litigation-related delays. | Financial management improvements can directly mitigate delays and improve contractor-manufacturer relationships (Jalil & Shaari, 2022b) (Shafie, 2020) (Nasir, Nawi, Rahim, Bahaudin, & Tapa, 2015). | Medium |
| Integration of stakeholder communication and team collaboration | Poor communication and fragmentation among project stakeholders cause delays, but integrated team approaches tailored to rural IBS projects are underdeveloped. | Design and test communication protocols and integrated team models that enhance collaboration among rural IBS stakeholders, including contractors, manufacturers, and local authorities. | Effective integration is essential to overcome fragmentation and improve project delivery in rural contexts (Nawi, Azman, Osman, Radzuan, & Yaakob, 2017) (Yusof, Jabar, Nawawi, & Nawi, 2024). | High |
| Context-specific readiness frameworks for rural IBS implementation | Readiness factors such as knowledge, ability, and planning are identified, but existing frameworks lack adaptation and validation for rural Sabah and Sarawak conditions. | Develop and validate readiness assessment tools and improvement strategies customized for rural IBS stakeholders, considering local infrastructure and workforce characteristics. | Tailored readiness frameworks will better prepare rural industry players and reduce implementation delays (Tamrin, Nawi, & Nifa, 2015) (Tamrin, Nawi, & Nifa, 2016). | High |
| Empirical studies on the effectiveness of government | Government incentives and policies are recognized as critical but their actual impact | Conduct impact evaluations of existing government programs and pilot new policy | Evidence-based policy adjustments are necessary to optimize support for rural IBS projects and | Medium |

| | | | | |
|---|---|---|---|---|
| incentives and policies | on rural IBS adoption and workforce skill enhancement is under-researched. | interventions aimed at boosting rural IBS uptake and workforce development. | address persistent barriers (Hadi, Muhamad, & Othman, 2017) (Ali, Abas, Affandi, & Abas, 2018) (Tamrin, Nawi, & Nifa, 2016). | |

## CONCLUSION

The existing body of literature consistently highlights that workforce skill insufficiency are a principal barrier to the effective implementation of Industrialized Building Systems (IBS) in the rural areas of Sabah and Sarawak. A significant lack of local technical knowledge, motivation, and formal training among workers undermines productivity and increases reliance on foreign labor, which in turn affects project timelines and quality outcomes.

The literature underscores the importance of developing multiskilled workers and enhancing project managers' competencies, suggesting that targeted training programs and competency frameworks are critical to closing these skill gaps. Moreover, workforce motivation and educational improvements, including monetary incentives, emerge as essential factors to boost workforce performance and commitment within IBS projects. Based on the systematic analysis and recent 2026 construction sector developments, the following suggestions aim to bridge the gap between theoretical IBS frameworks and practical rural implementation.

Management challenges also play a central role in contributing to delays, with poor communication, fragmented team integration, and insufficient specialized management roles frequently cited. In rural contexts, these challenges are compounded by logistical constraints such as inadequate infrastructure, limited local manufacturing capacity, and complex supply chains, which elevate costs and disrupt material availability. Adopt innovative, standardized design concepts to lower initial capital costs and simplify installation for less experienced rural workforces. The interaction between organizational human factors such as leadership, supervision, and teamwork and these logistical issues exacerbates project inefficiencies and delays. Make certified IBS supervision mandatory for all rural government projects. Regulating supervision during installation can significantly reduce common 2025 delays related to poor workmanship.

Payment mechanism complexities and contract management difficulties further intensify project risks, pointing to the need for improved planning, coordination, and leadership in IBS project management. Promote project-based joint ventures or "vertical integration" models where SME contractors in Sabah and Sarawak partner with established IBS manufacturers to share technical risks. Revised Payment Frameworks, transition from conventional "progress payment" to systems that allow for payment upon material arrival at off-site casting facilities. This addresses the cash-flow difficulties that frequently stall rural contractors in 2026. Customized Rural Incentives: Urge the government to provide enhanced, "impartial" incentives specifically for IBS projects in high-poverty or geographically isolated districts like Baram or Beluran.

Organizational support mechanisms, particularly government incentives, policy enforcement, and infrastructure development, are recognized as pivotal enablers for IBS adoption. However, the literature reveals that enforcement is often weak, and local manufacturing capacity insufficient, limiting the effectiveness of these supports in rural areas. Frameworks and quality management systems like Total Quality Management (TQM), alongside digital technologies such as Building Information Modelling (BIM) and Design for Manufacturing and Assembly (DfMA), are proposed as valuable strategies to improve collaboration, supervision, and overall project readiness. Early planning, standardized designs, and integrated team approaches are repeatedly recommended to mitigate delays and enhance project delivery. Digital Literacy Integration: Incorporate basic Construction 4.0 digital training—such as mobile-based site monitoring and simple BIM viewing to empower the local workforce with 2026 technology standards.

Establish Mobile Training Units, deploy localized, modular training centers to rural Sabah and Sarawak hubs. As of 2026, the CIDB Malaysia continues to prioritize decentralizing IBS Installer Training to reduce travel barriers for local rural workers. Implement regional certification programs that offer *Sijil Kecekapan Kemahiran*

(SKK) with a focus on specific rural-friendly IBS types, such as timber framing or blockwork systems, which may be more feasible than heavy precast concrete.

Strategic Road & River Network Upgrades. Decentralized Manufacturing Hubs through encourage the development of small-scale IBS manufacturing plants within rural corridors to bypass infrastructure-related transport delays and road damage caused by heavy loads. Prioritize the improvement of rural road and river networks to accommodate the specific weight and dimensions of IBS components and heavy assembly machinery. Real-Time Logistical Tracking with utilize IoT sensors and big data to monitor rural supply chains, helping project managers anticipate and mitigate weather-related or logistical delays in real-time.

Despite these insights, the literature reveals gaps in empirical research specifically focused on rural Sabah and Sarawak, with many findings generalized from urban or West Malaysian contexts. Methodologically, a mostly of qualitative and cross-sectional studies limits the robustness and generalise of conclusions. There is a critical need for longitudinal and intervention-based research that evaluates the effectiveness of proposed mitigation strategies within these unique rural environments. In summary, improving IBS implementation in rural Sabah and Sarawak demands a holistic approach addressing workforce skill development, management competency enhancement, robust organizational support, and context-sensitive logistical solutions to reduce delays and foster successful project outcomes.

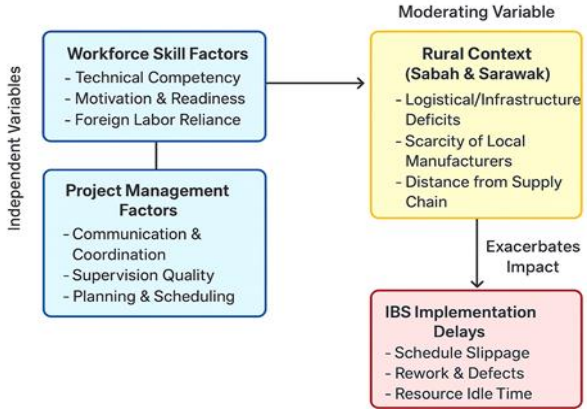


Figure 2: Conceptual framework develop from this paper are reliable to further studies (The Author)

Finally, the conceptual framework was developed for the further studies that can be explore by researcher. This framework draws upon Readiness Theory, which suggests that the success of technology adoption (IBS) depends on the acceptance of the organization (Management) and the users (Workforce). This theory can be extending by integrating Systems Theory, acknowledging that these factors do not operate in isolation but are deeply influenced by the external environment (Rural Context).

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