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LEVEL OF AWARENESS OF INDUSTRIALISED BUILDING SYSTEMS (IBS) IN THE GHANAIAN CONSTRUCTION INDUSTRY

Ako-Adjei, J. T.[1], Alhassan, T.[2], Adjei, P. O.[3] and Asante, A.[4]
[1,2,3&4] *Department of Building Technology, Faculty of Built Environment and Applied Arts, Sunyani Technical University, Ghana.*
[1]*james.ako-adjei@stu.edu.gh*

ABSTRACT

Purpose: Adopting Industrialised Building Systems (IBS) in the developed world has proven beneficial for raising and enhancing project value and productivity while reducing project costs and duration. This study assessed the prevalence of IBS implementation among Ghanaian construction firms, focusing on those in the Bono region.

Design/Methodology/Approach: The study employed a cross-sectional survey research design to elicit responses from construction contractors with a construction firm in the Bono region of Ghana. The study used a structured questionnaire with a 4-point Likert scale for data collection. Purposive sampling was used to sample 42 active firms out of the 61 construction firms registered in the Bono region. Data was analysed using a statistical package for social scientists (SPSS) using descriptive statistical tools such as mean and standard deviation.

Findings: The study identified high awareness of IBS in the construction industry and critical IBS adoption challenges. The industry favours traditional techniques over modern IBS techniques. Financial constraints and a lack of financing are the significant obstacles to the widespread adoption of IBS.

Research Limitation: The Bono Region in Ghana was the study's exclusive focus, particularly on contractors and construction firms. The contractors are classified in the D2K2 and D3K3 categories.

Practical Implications: This will ensure that professionals can manipulate advanced and sophisticated technologies to improve project performance.

Social Implication: Adopting IBS can enhance efficiency, quality, safety, productivity of skilled labour, innovation, and economic growth. IBS can also help improve the housing stock, reduce informal settlements, and improve the quality of life.

Originality/Value: The study contributes significantly to the literature on industrialised building systems (IBS) by exclusively focusing on the prevalence of IBS implementation among Ghanaian construction firms.

Keywords: *Construction industry. Financing. industrialised building systems. performance. productivity.*

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INTRODUCTION

Ghana's construction industry is crucial to developing its economy since it creates jobs, builds infrastructure, and boosts the economy (Frimpong et al., 2020; Usman et al., 2015; Ahadzie et al., 2009). Inefficiencies, delays, and cost overruns are common problems associated with conventional construction techniques (Samarghandi et al., 2016). The adoption of Industrialised Building Systems (IBS) as a contemporary construction methodology is rising in response to these problems. IBS uses prefabricated parts and organised construction techniques, resulting in better construction quality, shorter construction times, and increased productivity (Bamfo-Agyei et al., 2020; Othman et al., 2017; Nawi et al., 2012). Industrialised Building Systems (IBS) involve manufacturing pieces in a structured environment, followed by their transfer, placement, and installation into a structure with minimal additional on-site work (Musa et al., 2015).

The building industry considers IBS a modern technology that offers a variety of advantages and benefits compared to traditional methods and procedures (Zakaria et al., 2018; Bari et al., 2012). Construction processes consider these benefits advantageous. These advantages can be seen in the reduction in project costs, the number of unskilled workers and people, and the amount of waste produced by building operations (Nasir et al., 2016). Alawag et al. (2021) considered IBS a crucial element of the construction sustainability program, as its implementation results in projects that are not only cost-effective and long-lasting but also adhere to modern technology and environmental principles. That is, the adoption of IBS has proven beneficial for raising and enhancing project value and productivity while reducing project costs and duration (Nawi et al., 2015). Zakaria et al. (2017) observed that projects using IBS technology accumulate significantly less waste than typical projects due to sophisticated construction operations managed using procedures and methodologies. When IBS is used, materials are prepared and manufactured at the factory, then quickly and efficiently brought to the job site and installed. However, traditional construction processes often generate tons of waste from concrete, tiles, timbers, glass, and more. Therefore, the procedure involved in using IBS produces far less waste over time (Bari et al., 2012).

In Ghana, IBS implementation is relatively new. Traditional construction techniques have long dominated the sector. However, the demand for more effective and environmentally friendly construction processes has boosted interest in adopting emerging technologies (Kissi et al., 2023). In the past decade, Ghana has grown awareness of the benefits of IBS and other emerging technologies in the construction industry (Kissi et al., 2023; Ghansah et al., 2021). Stakeholders such as government, industry professionals, and researchers have recognised the need for improved construction practices and have started exploring innovative approaches such as IBS

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(Owusu-Manu, 2015). A significant increase in demand for homes, businesses, and infrastructure projects in Ghana has also increased the pressure on the construction sector to complete projects quickly and affordably. Therefore, Bari et al. (2012) have suggested IBS as a potential option to achieve these goals and overcome the drawbacks of conventional construction techniques. The National Housing Policy and National Building Regulations have also acknowledged the importance of modern construction techniques like IBS in enhancing construction quality and efficiency. IBS is supported by the Ministry of Works and Housing, which has asked for enhanced stakeholder cooperation to support its implementation (Ministry of Works and Housing, 2012; National Development Planning Commission, 2012).

It is critical to keep in mind that IBS adoption in Ghana is still in its early stages, and there are still difficulties. Professionals' low knowledge and understanding of IBS, lack of technical proficiency, and the need for specialised training hinder wider adoption. Cultural preferences for traditional construction techniques and initial economic considerations have also hindered the general adoption of IBS (Costa et al., 2023). To encourage the adoption of IBS and remove the hurdles that are now in place in Ghana's construction industry, more needs to be done in research, capacity building, and information dissemination (Costa et al., 2023; Yunus & Yang, 2012). The study, therefore, assessed the prevalence of IBS implementation among construction firms in Ghana. We conducted this study to determine the IBS's current awareness and adoption level and to pinpoint the implementation challenges that hinder its adoption in the Ghanaian construction industry.

THE CONCEPT OF INDUSTRIALISED BUILDING SYSTEMS (IBS)

Industrialised Building Systems (IBS) is a construction methodology that boosts efficiency, quality, and sustainability (Alawag et al., 2021) by utilising pre-fabricated components and off-site construction methods. IBS entails the production of building materials in a regulated factory setting, including walls, floors, and roofs (Elliott, 2017; Lou & Kamar, 2021). The construction site then assembles the completed structure from these arts. IBS has several benefits over conventional construction techniques. Cutting down on the time needed for on-site tasks, first and foremost, increases construction productivity (Nawi et al., 2015). Off-site component manufacturing allows simultaneous construction and component manufacturing (Hamid et al., 2018). The standardised production techniques and stringent quality checks used to make the components in the controlled factory setting also ensure greater quality control (Alawag et al., 2021).

Component prefabrication enhances production scale, lowering material wastage (Alaka et al., 2016). Additionally, there may be labour cost reductions due to faster construction timelines and

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reduced on-site labour requirements (Alaka et al., 2016). IBS also guarantees a more sustainable execution of construction activities (Alaka et al., 2016; Bari et al., 2012). Manufacturing in a regulated factory setting allows for more effective use of resources, leading to a reduction in waste production. Additionally, IBS components' higher quality results in buildings with increased energy efficiency, lowering their overall environmental effect (Abbood et al., 2015; Bari et al., 2012).

IBS is an approach to building that uses prefabricated materials and off-site construction methods to raise productivity, quality, and sustainability in the construction sector. It offers advantages such as greater productivity, cost savings, and lower environmental impact by utilising the benefits of factory-based production and standardised processes. However, resolving issues with industry perception and skill requirements is necessary for the construction sector to use IBS more widely.

Impacts of IBS on the Construction Industry

Industrialised Building Systems (IBS) deployment significantly impacts the construction sector, from increased productivity and cost-effectiveness to improved quality and sustainability (Alaka et al., 2016; Bari et al., 2012). One of IBS's main effects is productivity growth. Azhar et al. (2024) established that IBS enables concurrent building activities using off-site manufacturing and assembly methods, shortening project length and enabling quicker completion. Both contractors and clients may save time and money due to this expedited building schedule. IBS helps the building sector be more cost-effective. We can prefabricate building components in a regulated industrial setting to achieve economies of scale and lower material prices (Nez-Cacho et al., 2020). In addition, IBS can also save money on labour costs due to its simplified building procedure and reduced on-site labour requirements (Azhar et al., 2024).

Construction projects with IBS are of higher quality. Factory-produced components undergo standardised manufacturing procedures and rigorous quality control checks (Gann et al., 1996). This systematic technique reduces the prevalence of flaws and mistakes often associated with on-site building, ensuring constant quality. According to Alaka et al. (2016), IBS contributes to sustainability by having favourable effects on the environment. Again, IBS's controlled manufacturing environment promotes resource efficiency and reduces waste production throughout the building process (Othman et al., 2021; Bari et al., 2012). Ibrahim et al. (2018) discovered that buildings constructed with IBS components have better thermal and energy performance, resulting in less energy use and carbon emissions.

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Despite these advantages, there are barriers to IBS's mainstream adoption in the construction sector. These include the upfront costs of establishing IBS production facilities, workforce training and specific skills requirements, and the industry's resistance to change (Alawag et al., 2023; Ali et al., 2018). IBS implementation has a considerable impact; it can reduce waste and energy efficiency, productivity, project timely delivery and cost improvement, improve building quality, and promote sustainability.

Waste Reduction

Compared to traditional on-site construction methods, IBS deployment dramatically decreases construction waste. Al-Awag et al. (2023) observed that off-site manufacturing reduces material waste through precise planning and production. Additionally, IBS makes recycling and using building waste produced during production easier, lowering the overall waste footprint (Ranjetha et al., 2022). This waste reduction helps avoid using landfills and conserve resources.

Energy Efficiency

Due to enhanced thermal insulation and airtightness, buildings produced using IBS components frequently have increased energy efficiency (Ibrahim et al., 2018). Precision manufacturing of IBS components ensures appropriate sealing and lowers energy losses (Lip et al., 2019). Reducing energy use and greenhouse gas emissions due to improved energy efficiency reduces the built environment's carbon footprint.

Sustainable Material Use

IBS promotes the use of environmentally friendly and sustainable products. For instance, using timber-based components like cross-laminated timber (CLT) reduces the need for energy-intensive materials like concrete and steel (Ibrahim et al., 2018). Ibrahim et al. (2018) further posit that CLT is a low-carbon, renewable substance that helps to slow global warming by storing carbon dioxide.

Water Conservation

IBS implementation can incorporate water-saving design elements. In modular construction, pre-fabricated bathroom pods minimise on-site plumbing work and maximise water usage (Shroff & Joshi, 2022). Off-site production also enables better monitoring and control of water resources, reducing water waste throughout construction (Hussein et al., 2021).

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Reduced construction noise and pollution

Construction noise and pollution are reduced at the project site, which is attributable to IBS Manufacturing's regulated and off-site nature. This advantage favours the environment and improves local citizens' living standards (Liu et al., 2017). IBS aids in a safer and more sustainable construction process by reducing noise and air pollution (Alawag et al., 2021). While IBS offers benefits for sustainability, it is crucial to consider its associated issues. These include energy use related to production facility operation and the environmental impact of transportation during component delivery (Ibrahim et al., 2022; Yunus & Yang, 2011). Due to its overall sustainability advantages, IBS is still a strong option for the construction sector (Alawag et al., 2021).

METHODOLOGY

The study assessed IBS's awareness and implementation challenges in Ghana's construction industry, specifically the Bono Region. Sunyani is the region's capital; in addition to the capital, the region has eleven (11) other districts, including Sunyani West, Dormaa, Dormaa East, Dormaa West, Wenchi, Berekum, Berekum West, Jaman North, Jaman South, Tain, and Banda. Bono has an approximate population of 1.209 million (Ghana Statistical Service, 2021). The region has a land area of 11,481 square kilometres and shares boundaries with the Savannah, Bono East, Ahafo, and Western North Regions.

This study used a survey to investigate the extent of industrialised building systems (IBS) implementation in Ghana's construction industry, specifically the Bono Region. Therefore, the population of this study was considered to be all registered contractors and construction firms operating within the region. The study used the total number of registered contractors and construction firms in active operation in the region as the sample size. A purposive sampling technique was used to collect data from forty-two (42) construction contractors. A structured questionnaire consisting of closed-ended questions was administered to collect data. This was used due to its simplicity and ease of data analysis.

The questionnaire sought to establish and assess the level of IBS awareness and the extent of IBS implementation in the region. The questionnaire comprised three (3) sections. Section A provided the respondents' demographic data; Section B focused on questions that sought to assess the respondents' awareness level of IBS; and Section C determined factors impeding the adoption/utilisation of IBS in the Ghanaian construction industry. The questionnaire was designed using plain and simple language to facilitate easy understanding. Content and face validity were used to ensure the validity of the questionnaire. The collected data were keyed, processed, and

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analysed using descriptive statistics. Descriptive statistical tools (standard deviation [SD] and mean) were employed to analyse, summarise, and present the data.

RESULTS AND DISCUSSION

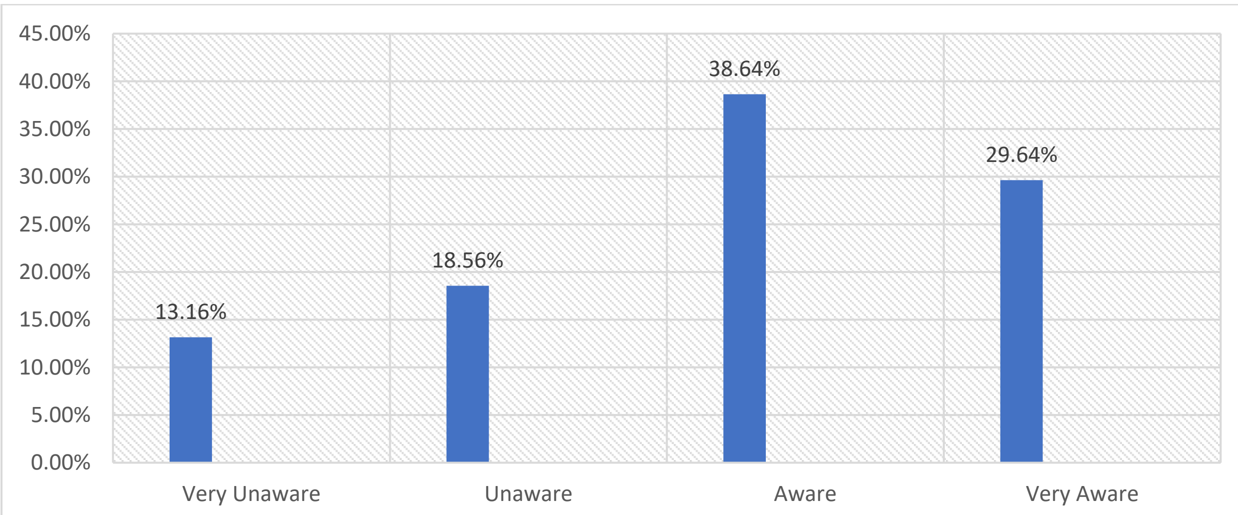

Figure 1: Awareness Level of Contractors on IBS
Source: Field survey, 2024

Figure 1 presents the results on the IBS awareness level of the contractors surveyed. Data were collected from forty-two (42) respondents (100%). Four degrees of awareness level, that is, *"Very Unaware", "*Unaware", "*Aware," and "Very Aware,"* were used to display the levels of awareness of IBS among contractors. It can be deduced that the majority of the respondents have a high level of awareness of the IBS. An average percentage of 38.64% and 29.64% of the respondents are "Aware" and "Very Aware," respectively, indicating a high level of awareness of IBS among the contractors. At the same time, only 13.16% and 18.56% of the respondents recorded "Very Unaware" and "Unaware," respectively (see Figure 1).

The data suggests that respondents are widely aware of or use IBS practices. This finding corroborates studies by Kissi et al. (2023) and Ghansah et al. (2021) that show that there has recently been an increasing awareness of IBS and other emerging technologies in the Ghanaian construction industry.

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Table 1: IBS Adoption Challenges

Item	IBS Adoption Challenges	Mean	Stand. Dev.	RII	Rank
1	The perception and acceptance of IBS by the general public, including homeowners, tenants, and investors	3.476	3.024	0.869	1
2	The overall cost of implementing an industrialised building system (IBS) compared to traditional construction methods is very high.	3.405	2.952	0.851	2
3	The speed of construction and reduced project timelines achieved through IBS implementation	3.381	2.920	0.845	3
4	The adaptability of IBS to different site conditions and constraints, such as limited space or challenging topography	3.381	2.920	0.845	3
5	Integrating advanced technologies, such as Building Information Modeling (BIM) and automation, into the IBS workflow.	3.381	2.911	0.845	3
6	The ability of IBS to deliver visually appealing and architecturally diverse structures.	3.357	2.911	0.839	4
7	The availability of skill level of workers proficient in IBS techniques.	3.333	2.878	0.833	5
8	The extent to which IBS allows for customisable and adaptable design options.	3.310	2.878	0.827	6
9	The ease of maintenance and repair for IBS structures compared to traditional buildings.	3.310	2.854	0.827	6
10	The ability to maintain consistent quality standards throughout the IBS construction process.	3.238	2.812	0.810	7
11	The availability of training programs and educational resources to enhance IBS skills among construction professionals.	3.238	2.777	0.810	7
12	The level of acceptance and demand for IBS in the construction market	3.214	2.795	0.804	8
13	The alignment of IBS practices with local building codes, regulations, and standards	3.190	2.760	0.798	9
14	The environmental sustainability and reduced carbon footprint associated with IBS adoption.	3.167	2.699	0.792	10
15	The efficiency and reliability of the supply chain for IBS components and materials.	3.119	2.743	0.780	11
16	Limited availability and accessibility of IBS-related plant and equipment in Ghana	3.119	2.717	0.780	11
17	Lack of government support and incentives for Industrialized Building Systems (IBS)	3.095	2.655	0.774	12
18	The existing infrastructure and support systems required to facilitate IBS adoption, such as transportation, logistics, and utilities do not exist in Ghana.	3.071	2.619	0.768	13
19	Limited availability and accessibility of IBS-related technologies in Ghana.	2.905	2.488	0.726	14
20	Resistance to change among construction industry stakeholders in the Ghanaian construction industry.	2.467	2.033	0.661	15

Source: Field survey, 2024

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The study sought to assess the challenges inhibiting the adoption of IBS. A plethora of barriers affecting the broader adoption of IBS in the study area were revealed (see Table 1). Ranked as the highest barrier, the perception and acceptance of IBS by the general public, including homeowners, tenants, and investors, was a significant barrier to the extensive adoption of IBS in the country. This resonates with Korra et al. (2024), who concluded that cultural preferences for conventional techniques significantly hinder the implementation of IBS.

Despite IBS projects being considered cost-effective in the long term (Ibrahim et al., 2018; Barri et al., 2012), initial economic considerations have been asserted by Korra et al. (2024) as a threat to the realisation of IBS-related projects. Similar findings were discovered in this study, where participants perceived the preliminary cost of implementing an industrialised building system (IBS) to be relatively high. This contributes to the over-reliance on traditional methods, especially in a region where the economic condition is generally unfavourable. Again, in a region characterised by financial pressures, informal construction practices, and small-scale projects, expedited construction processes are almost non-applicable. Therefore, the speed of construction and reduced project timeline aspects of IBS (Azhar et al., 2024) make it an unpreferred method for many. Another major barrier was the integration of advanced technologies such as Building Information Modelling (BIM) and automation into the IBS workflow. As Ali et al. (2018) found in emerging technologies, industry actors' lack of expertise and skills makes implementing IBS on a larger scale in the region challenging.

CONCLUSION AND RECOMMENDATIONS

The study aimed to determine current awareness and adoption levels and identify implementation challenges impeding the adoption of the IBS in the Ghanaian construction industry. Although IBS adoption may not be widespread in the Ghanaian construction sector, there is more room for development and expansion. Ghana can benefit from IBS in several ways, including collaboration, supporting policies, and investment, as well as better construction efficiency, improved project outcomes, and sustainable development. For the construction industry in Ghana to transform and embrace IBS, all players must collaborate.

The discovery of the constraints preventing the adoption and application of IBS in the Ghanaian construction industry highlights the necessity for focused interventions. Ghana can leverage the potential of IBS to increase construction efficiency, improve project outcomes, and promote sustainable development by tackling obstacles like resistance to change, infrastructure restrictions, and financial limits. Cooperation, education, and supportive policies are essential to remove these obstacles and accelerate the adoption of IBS in the Ghanaian construction industry.

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While some building enterprises have adopted IBS in particular areas, such as prefabrication and modularisation, the adoption rate overall is still relatively low. Lack of knowledge and comprehension of IBS's advantages, reluctance to depart from conventional construction methods, infrastructural restrictions, and budgetary limitations prevent its wider adoption.

To encourage increased IBS usage, efforts should be undertaken to raise awareness and educate investors, policymakers, and other stakeholders in the industry. Information may be shared, and a culture of innovation and collaboration can be encouraged with training programmes and knowledge-sharing platforms. Cooperation between the government, business groups, and private sector organisations is essential to provide supportive laws, regulations, and incentives for adopting IBS.

Adopting industrialised building systems (IBS) in the Ghanaian construction industry has several practical and social implications that can bring significant improvements and advancements to the sector. These implications include increased construction efficiency: IBS adoption can improve construction efficiency by lowering construction time and streamlining project scheduling. Off-site component manufacturing enables concurrent activities, reducing delays and accelerating project completion. This effectiveness results in reduced costs and better project execution.

Improved Construction Quality: IBS promotes standardised production processes, precision manufacturing, and rigorous quality control. Shifting construction activities to controlled factory environments ensures the quality of components, leading to improved overall construction quality. This can help reduce defects, rework, and maintenance issues, resulting in higher customer satisfaction.

Innovation and Technological Advancements: IBS adoption promotes the use of digital technologies, including robots, automation, and building information modelling (BIM). These technologies make better project management, coordination, and planning possible. By adopting IBS, the Ghanaian construction sector may become more innovative and technologically advanced, increasing its competitiveness worldwide.

The adoption of Industrialised Building Systems (IBS) in the Ghanaian construction sector will have a variety of practical effects, including increased construction efficiency, improved construction quality, increased site safety, sustainable construction methods, the development of a skilled labour force, innovation, and technological advancements, as well as opportunities for economic growth and investment. Adopting IBS can result in significant transformations and place Ghana at the forefront of cutting-edge construction techniques. Regarding limitations, the study

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focused on only the Bono region in Ghana. However, to help validate and improve the robustness of these findings, the scope of the study can be expanded to include other regions in the country. Again, a comparative study between local and foreign contractors can be conducted to ascertain their level of adoption and implementation of IBS in their projects.

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