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LEGISLATIVE CHALLENGE TO SUSTAINABLE APPLICATION OF INDUSTRIALIZED BUILDING SYSTEM (IBS)

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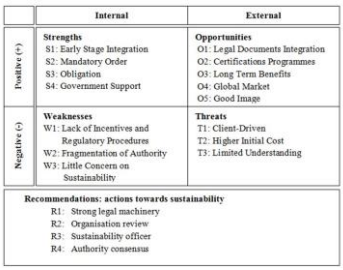
Graphical abstract



Abstract

This paper focuses on the challenges and implications of legislation which has been identified as one of the critical factors in enhancing sustainable deliverables for Industrial Building System (IBS) applications. This study undertakes a SWOT (Strengths, Weaknesses, Opportunities, and Threats) analysis of Malaysian IBS stakeholders, using survey data collected among the industry players. In terms of legislation, this paper reveals that there is a lack of incentives and regulatory procedures in IBS implementation, a fragmentation of authority and little concern on sustainability issues. Early stage integration, mandatory orders, obligations and government support are the strengths of legislation. The external elements consist of opportunities and threats. For opportunities, five components have been identified, namely legal document integration, certification programmes, long-term benefits, global markets and good image. Threats consist of client-driven decisions, higher initial cost and limited understanding of IBS benefits by the stakeholders.

Keywords: Legislation, prefabrication, sustainability, SWOT analysis and qualitative

Abstrak

Kertas kerja ini memfokuskan kepada cabaran dan implikasi garis panduan bagi perundangan yang telah dikenalpasti sebagai faktor asas dalam meningkatkan kelestarian sistem bangunan berindusrti (IBS). Kajian ini menggunapakai analisis SWOT (Kekuatan, Kelemanhan, Peluang dan Ancaman) kepada pemegang taruh IBS di Malaysia dengan menggunakan data kajian yang diperoleh daripada pemain industri. Dalam terma perundangan, kertas kerja ini mendedahkan bahawa terdapat kekurangan dalam insentif yang diberikan dan prosedur peraturan yang lemah dalam perlaksanaan IBS, fragmentasi di kalangan pihak penguasa dan sedikit sahaja perhatian diberikan kepada isu kelestarian. Integrasi di peringkat awal, arahan mandatori, tanggungjawab dan sokongan kerajaan adalah kekuatan dalam perundangan. Elemen luaran terdiri daripada peluang dan ancaman. Bagi peluang, terdapat lima komponen yang telah dikenalpasti, iaitu integrasi dokumen undang-undang, program pensijilan, kebaikan jangka panjang, pasaran global dan imej yang baik. Ancaman terdiri daripada keputusan pacuan daripada klien, kos permulaan yang tinggi dan kurang pemahaman terhadap kebaikan IBS daripada pemegang taruh.

Kata kunci: Perundangan, prefabrikasi, kelestrarian, analisis SWOT dan kualitatif

1.0 INTRODUCTION

Around the globe, sustainability consideration has been an important element in decision making for construction activities. Human aspirations and essential values need to be reflected through environmental, social, economical and political goals and against many tangible project targets [1]. Compared to developed economies, developing countries in general lack the incentive and technical knowhow to pursue sustainability, especially at project levels [2]. Easy to understand collaborative action plans will be useful for construction stakeholders. Through collaborations with the Construction Research Institute of Malaysia (CREAM), the authors have identified potential factors in improving sustainability in local construction projects using Industrialized Building Systems (IBS) [3]. IBS is a local terminology for prefabricated construction. The overall research aims to formulate decision making guidelines to provide assistance to building designers in selecting the most appropriate IBS methods that will not only improve construction efficiency but also maximise the potential for sustainability output.

Sixty-two possible factors are selected from the literature review for further investigation in both the questionnaire and interview studies. The questionnaire survey identified the potential critical sustainability factors, while the interviews investigated each identified factor in depth. From the quantitative analysis, eighteen factors were confirmed by industry respondents as the critical factors in improving sustainability deliverables in IBS construction. They were: 1) Legislation, 2) Project Control Guidelines, 3) Procurement Systems, 4) Standardisation, 5) Production, 6) Knowledge and Skills, 7) Material Consumption, 8) Waste Generation, 9) Labour Availability, 10) Labour Costs, 11) Defects and Damages, 12) Constructability, 13) Construction Time, 14) Working Conditions, 15) Durability, 16) Maintenance and Operation Costs, 17) Usage Efficiency, and 18) Waste Disposal.

This paper will focus on the top ranked critical factors - *Legislation*. This factor was fundamental in ensuring the success of any sustainability efforts. The vision to achieve sustainable development will not succeed if the policy approaches are weak and have only minimal legislation [4]. Legislation was identified as one of the principles of forming a framework for achieving sustainable building [5]. It has a direct impact on sustainability implementation in the long term. Monitoring agencies rely on legislation for making recommendations on how to balance economic, social, environmental and institutional pillars in the making of competent decisions [6]. With the involvement of the key stakeholders in the development of legislation, it is believed that the outcome of this research will be to provide a useful source of information and support for decision making around improving sustainability.

2.0 SUSTAINABILITY, INDUSTRILIAZED BUILDING SYTEM AND LEGISLATION

2.1 Sustainability Potential In IBS

Sustainability development, especially in the construction industry, requires innovative solutions and holistic approaches to provide mutual benefits for all stakeholders [7]. From the previous studies, IBS have unique characteristics well suited to the improvement of sustainable deliverables [8-11]. By producing construction components in the factory environment, IBS based construction avoids problems that affect the performance of construction activities such as bad weather, imprecise measurement and labour shortages. The numbers of IBS benefits were also highlighted by Gibb and Isack [12], who stated that IBS application resulted in less congestion on site, an improvement in health and safety and more predictable quality.

However, intensive planning and strategy is required to prevent unnecessary additional costs, unpleasant community disruption, and degradation of environmental performance. Chen *et al*. [13] highlighted that problems that arise during IBS implementation are mostly due to a lack of appropriate strategy to incorporate sustainability principles in decision making. Most decision tools tend to focus on a certain context, such as economic or technical, rather than the whole area of sustainability. Failure to provide well-defined decision-making tools has hindered the potential of IBS application [14]. It is important to note that the full potential of IBS can only be realised by taking into consideration all the elements of sustainability [9, 11, 13, 15].

Therefore, the development of decision-making tools take into consideration the whole sphere of sustainability; namely the economic, environmental, social and institutional aspects, are vital to ensure the success of sustainable development objectives. Legislation is discussed in the paper as a representative identified factor in order to illustrate the challenges faced by the industry and provide insights into how this factor can be optimised in enhancing sustainable deliverables.

2.2 Legislation

Sustainable development can be achieved only by having strong policy and effective legislation [4]. Legislation is required to ensure compliance and adherence to best practice and to promote consistency in interpretation and application. In Australia, legislation provides the platform for monitoring agencies to make recommendations on how to balance economic, social and environmental factor in resource management decisions [16]. In this context, legislation has been identified as the potential factor to address many shortcomings in sustainable development, such as unclear policy framework and inefficiency in

sustainability assessment, especially in the long term [4]. Legislation also influences the education system and increases understanding of the benefits of sustainability to the public and IBS stakeholders. Swanson *et al*. [17] emphasised that establishing clear and coordinated responsibility for the implementation of policy initiatives to improve sustainability is critical for progress. With a united effort and attention to detail from all key stakeholders, the task of integrating sustainability into IBS implementation can be executed more efficiently and increase the potential benefits. Sustainability can be enhanced by identifying the potential deficiencies and by taking appropriate actions early enough in the process to influence the direction taken.

Investigations into the positive and negative aspects of legislation help to clarify and increase understanding of how to incorporate this factor into the sustainability of IBS application. Fragmentation and misunderstanding of building regulations have been identified as major barriers hindering the total adoption of IBS [18, 19]. Therefore, successful IBS implementation requires simultaneous development of policy and legislation relevant to it.

3.0 DIFFICULTIES AND INADEQUACIES

During the early stages of sustainability investigations in a project, legislation can provide a platform of communication between the parties involved. . However, little attention has been given to this aspect during this stage and most of the available assessment guidelines and tools are used only when the design of the project is about to be completed [20, 21]. Cooperation among IBS stakeholders is also lacking and IBS manufacturers are involved currently only when the design has been completed [22]. Consequently the design has to be redone, but this involves additional cost.

Moreover, comprehensive assessment of available resources, regional climates, and cultural settings to formulate an effective strategy in promoting sustainability that accommodate the local conditions will be highly appropriate [23]. Policy and legislation adopted in developing countries may have different interpretations and acceptance when compared to developed countries. A comprehensive description of preconditions and restrictions based on local circumstances needs to be ascertained to ensure sustainable development can be achieved. Gomes and da Silva [24] pointed out that governmental involvement in the implementation of policy frameworks and public procurement for developing countries is vital in improving sustainability.

Most stakeholders are facing extensive challenges in translating this concept into meaningful action, even though they do understand the importance of sustainability. They do not know how or where to start because the definition of sustainability is sometimes vague and the stakeholders have different perceptions of those definitions. As discussed in the previous section, this research considered the total integration of sustainable elements and the unifying of IBS stakeholders in order to understand the sustainability potential of IBS implementation. This paper discusses legislation that prescribes where and how sustainability should be integrated to improve IBS construction.

4.0 DECISION SUPPORT FOR SUSTAINABLE INDUSTRIALIZED BUILDING SYSTEMS

4.1 Research Approach

This research involved both quantitative and qualitative methods to achieve its main objectives. In the first phase, a quantitative method was employed to identify the critical factors in improving IBS sustainability. 18 factors were identified statistically, with legislation being one of the most critical factors. These factors and their interrelationship have been reported separately [3]. In the second phase, the factors were explored through semi-structured interviews to extract best practices of how these factors can be dealt with. A semi-structured interview form was used because it was flexible and it gave additional scope for the interviewees to provide detailed information based on their experience and capability. It also allowed the researchers to maintain focus on the research objectives. As a result, the interviewees were able to provide more in-depth and detailed answers and suggestions in their responses to the questions. SWOT (strengths, weaknesses, opportunities, and threats) analysis was used to formulate a decision-making guideline, which is discussed in the next section.

4.2 SWOT Analysis

SWOT (Strengths, Weaknesses, Opportunities, and Threats) analysis is the most popular technique to analyse the process of strategic management [25]. Strategic management provides a systematic approach and support for decision-making starting in the early stages. Moreover, this technique allows the decision makers to discover and collect both positive and negative aspects for each factor in providing the best and practical solutions. SWOT analysis originated from business management literature investigating internal and external factors in formulating the best strategy in decision making [26]. The purpose of investigating internal factors is to identify the weaknesses and strengths of the project. On the other hand, the external factors help identify the opportunities and threats to the project [27]. Consensus among the stakeholders from different spheres of work, competence, and interest can be

obtained in order to improve sustainable deliverables in IBS application.

Other scientific research has adopted SWOT analysis in formulating solutions to research problems. According to Zavadskas *et al*. [28], SWOT analysis has been widely used in economic activities and in formulating strategies to improve and strengthen the national innovations system, particularly for developing countries. Ghazinoory and Ghazinoori [29] proposed that SWOT analysis is suitable to be used to examine the innovation system situation as well as to study the best practices to be adopted in Iran. In Australia, Stewart [30] adopted SWOT analysis to develop a strategic IT and monitoring framework to enhance the effectiveness and efficiency in construction. Lu *et al*. [31] adopted SWOT analysis as the basic methodology to gain insight into the internationalisation of China's construction companies in the global market.

In SWOT analysis, the internal and external factors are evaluated simultaneously by collecting all the possibilities and opportunities. In this research, each participant stated their positive or negative perceptions of the role of legislation in enhancing sustainability in semi-structured interviews. Irrelevant or unnecessary answers could be avoided because they were guided by asking sub-questions which focussed on the pertinent issue. In terms of interpreting the results, SWOT analysis has the advantage of being able to focus on all of the discussion regarding sustainable deliverables for IBS application, which can then be used to formulate the proposed guideline. Therefore, SWOT analysis is the most appropriate tool for this research. It is able to assist designers in determining both the benefits of IBS and its limitations, and to make the best use of this system in enhancing sustainability without neglecting the requirements of other key stakeholders.

4.3 Decision Making Guidelines

Guidelines in decision making can help ensure that a decision in favour of sustainable objectives stems from the unified agreement of the key stakeholders in IBS construction. A legislative guideline is a statement provided by the government or relevant authority to streamline particular processes according to a set routine or sound practice. In most situations, a guideline is not legally mandatory. In this research, results from the SWOT analysis helped to develop the implementation guidelines which provide essential solutions for the industry practitioners and project teams to integrate sustainability potential into IBS constructions [3]. The stakeholders can access step-by-step recommendations on how to improve sustainability in IBS construction at the project level. It is expected that the guidelines will facilitate sustainability which has taken into consideration all the stakeholders in the decision-making, and which will provide the best solutions for IBS application.

5.0 DATA COLLECTION AND FINDINGS

5.1 Characteristics of the Sample

Twenty respondents participated in the interviews. They all have different backgrounds and vast experience in construction industry. This helps researchers identify the perception of each type of organisation in pursuing sustainability. The suitability of the respondents to participate in the research was determined by their website and Internet profile. Their vast experiences in IBS applications and solid education background are important criteria in the respondent selections. Moreover, based on the previous questionnaire survey, the respondents who stated that they were willing to participate in the interview sessions were also contacted. This process was important to ensure appropriate respondents were selected for this research. There are seven types of organisations that have been identified as key stakeholders in the IBS construction; 1) Contractors, 2) Designers, 3) Manufacturers, 4) Authority, 5) Clients, 6) Research and 7) Users. All respondents belonged to middle or upper management and had more than five years of experience in IBS construction. The particulars of the respondents are given in Table 1.

Table 1 Particulars of the respondents and their organisations

Interviewee (code)	Designation	Type of Organisation	Sector
C1	Project Manager	Contractor	Private
C2	Construction Manager	Contractor	Private
C3	Senior Engineer	Contractor	Private
C4	Project Engineer	Contractor	Private
D1	Managing Director	Designer	Private
D2	Director	Designer	Private
D3	Associate Director	Designer	Private
D4	Senior Manager	Designer	Private
D5	Senior Engineer	Designer	Private
M1	Chief Executive Officer	Manufacturer	Private
M2	Chief Executive Officer	Manufacturer	Private
M3	Operational Manager	Manufacturer	Private
A1	Senior Principal Assistant Director	Authority	Govern-ment
A2	Senior Assistant Director	Authority	Govern-ment
CL1	Senior Engineer	Client	Govern-ment
CL2	Senior Manager	Client	Private
R1	Manager	Research	Govern-ment
R2	Executive Director	Research	Govern-ment
U1	School Principal	User	Govern-ment
U2	House Owner	User	Private

Before the interviews were conducted, related documents such as an invitation letter, consent form, research framework and the main questions were sent to potential respondents. This process was important to ensure their agreement to participate and facilitate their understanding of the general nature of the outcomes needed from the interview session. These steps also reduced the interview time and allowed respondents to answer the questions more accurately.

5.2 Analysing the Semi-Structured Interviews

The purpose of the interviews was to investigate in-depth and formulate a solution on how to improve sustainability in each factor. The questions were qualitative in nature, which provided the opportunity for the interviewees to share their insights and expand the researchers understanding. The responses from participants were recorded and synthesised using SWOT analysis.

There are three major steps in analysing the results of SWOT analysis. The steps are:

i. Fieldnotes, interview records and related images were sorted and organised to improve the accessibility of the data. All the data was read through to ensure no important information was missed. The interview records were fully transcribed into a text document.

ii. The data was coded using NVivo software. The use of this software helped in reducing the time for analysis and the interpretation process. The data could be categorised into different themes and any additional descriptions were added to provide a clear picture within the context analysed. The interrelationship between themes and description were highlighted.

iii. The strengths, weaknesses, opportunities, threats and potential action plans were explored and interpreted from the available coding. The interpretation process provided a meaning of the themes and descriptions in developing the SWOT frameworks and decision support guidelines.

5.3 Results of SWOT Analysis

Figure 1 presents the result of SWOT analysis for legislation. The purpose of the SWOT analysis was to help decision makers to understand, to plan, to use their strengths to exploit opportunities, to analyse and avoid their weaknesses and to diagnose any possible threats and provide solutions to overcome them [32]. SWOT analysis provides a systematic framework to assist in the understanding of internal and external conditions of legislation about improving sustainability. The recommendations or 'actions towards sustainability' present the method and manner we can use to improve sustainability through legislation in IBS construction.

	Internal	External
Positive (+)	**Strengths** S1: Early Stage Integration S2: Mandatory Order S3: Obligation S4: Government Support	**Opportunities** O1: Legal Documents Integration O2: Certifications Programmes O3: Long Term Benefits O4: Global Market O5: Good Image
Negative (-)	**Weaknesses** W1: Lack of Incentives and Regulatory Procedures W2: Fragmentation of Authority W3: Little Concern on Sustainability	**Threats** T1: Client-Driven T2: Higher Initial Cost T3: Limited Understanding

Recommendations: actions towards sustainability

R1: Strong legal machinery
R2: Organisation review
R3: Sustainability officer
R4: Authority consensus

Figure 1 Guidelines for legislation to enhance sustainability in IBS application

Each point is provided with systematic numbering to simplify its identification. For example, S1 is for strength number 1: early stage integration and W2 is for weaknesses number 2: fragmentation of authority.

6.0 DISCUSSION

6.1 Strengths of Legislation in Sustainable IBS

Early Stage Integration

Integration of sustainability in the early stages is vital to ensure that the sustainable objectives are achieved in IBS construction. In IBS application, the design of the building components is an interactive process that requires early collaboration between architects, contractors and manufacturers [33]. The lead-time provided, especially during IBS component production, allows IBS players the opportunity to plan and integrate sustainability efforts before the installation work starts. However, most of the decision-making and measurement tools in measuring sustainability were not made in the early stages. According to previous research, most sustainability assessments are carried out when the design of the project is almost finalised [21]. Such a lack of consideration of the wishes of stakeholders and the lack of adequate information about promoting sustainability in IBS will result in an imperfect choice of the construction method [34].

Interestingly, one of the contractors from the interview session (C1) highlighted that:

> *"As noted, the Government plays an important role in improving the implementation of IBS. It is good if they can demonstrate to every party involved in construction the advantages of IBS. Consideration of sustainability potential in each type or component of IBS application should be identified during the early stages. If the integration of sustainability is included in contract documents and planning schedules, the implementation should be greater."*

The contractor was aware of the importance of sustainability and very happy to co-operate in making sustainability the main objective in IBS construction. The contractor also highlighted that a sustainability requirement should be included in the legal documents. Moreover, the majority of the respondents agreed that legislation would enable them to integrate sustainability in the early stages.

Mandatory Order

The interviewees opined that strong force from government is the key requirement in pressuring construction stakeholders to make sustainability a priority in decision-making. According to the Cambridge Business English Dictionary [35], a mandatory order is "an official order given by a court of law telling someone that they must do something or stop doing something." A mandatory order is essential to ensure that the requirement will be fulfilled or that the required services will be provided. It is also essential to monitor progress or development based on the order, provided that it is made smoothly [36]. The interviewees shared that the culture of those involved in Malaysian construction is that they will not make an effort if there is no mandatory order from the government.

Obligation

The interviewees noted that there was a level of personal responsibility and obligation for every stakeholder to increase awareness of sustainability and enhance it in IBS construction. Any disparity between the perceptions and obligations of all parties involved in a project, and the actual situation, should be monitored closely to avoid conflicts and disputes [37]. It is advisable to make an extra effort to address any assigned obligation in order to avoid legal disputes and other disruptions in the project progress. Any problems that arise will ultimately result in more costs being borne by all the parties involved. Legal obligations outlined in the contract should clarify any issues related to the contract conditions. Thus, the obligation to enhance sustainability can be put as the main priority in the IBS construction starting from the early stage.

Government Support

The government plays an important role in construction and serves as an exemplar of good practice in terms of being the catalyst for the complete adoption of IBS [38]. It should steer sustainable development by collaborating with people in the industry. The sustainability agenda can be achieved only by a transformation in the policies and activities at all levels of IBS implementation [39]. Every process involved should be evaluated and each potential factor should be exploited to enhance sustainability. The interviewees noticed that the government had put a lot of effort into promoting IBS application and believed this innovation had the potential to improve building quality, site safety and environmental performance. For example, they noticed that the government provides incentives such as levy exemption and "Accelerated Capital Expenditure" for the IBS players [40]. In addition, they were also aware of the IBS Roadmap 2003-2010 and 2011-2015, which are well documented as explanations of the government strategy and action plan for steering IBS development in the right direction.

6.2 Weaknesses of Legislation in Sustainable IBS

Lack of Incentives and Regulatory Procedures

The interviewees highlighted that effort from the government to promote sustainability in IBS construction is not adequate and needs to be strengthened. Regulatory procedures and incentives are not sufficient. According to Shafii and Othman [41], present legislation related to habitation and sustainable development in Malaysia focuses only on physical development and they normally neglect environmental, social and cultural issues such as energy efficiency and material security. In terms of incentives, one of the interviewees suggested that the government should offer them cheap land for IBS manufacturing yards at strategic locations. This suggestion should reduce transportation costs, and directly reduce the cost of IBS components. Another suggestion is that more incentives, such as discounts or government tax exemptions, should be given to companies that want to invest in technology for IBS construction. This opinion echoes the notion that the government needs to encourage IBS adoption through subsidies and tax benefits [38]. The interviewees highlighted that the number of levy incentives provided by the government was too small, and constituted only 0.125% of the total project value. They stated that this incentive would not cover the additional expense incurred from adopting IBS technology, which normally involves higher initial costs. On the other hand, penalties could be given to project participants who caused a negative impact on sustainable development. For example, penalties should be given to companies that generate huge amounts of waste or cause site

disruptions or hinder sustainable deliverables in IBS construction.

Fragmentation of Authority

Communication and cooperation among participants is the key to successful completion of IBS projects. Authority in Malaysia can be divided into three groups; federal, state, and local authority. The interviewees remarked that these three groups often have misunderstandings and misconceptions about IBS implementation. Most of the time, these groups fail to have mutual understanding or agreement on certain issues and sometimes even have different policies. Paradigms are required to encourage creativity, change attitudes, and promote acceptance of IBS implementation. It is important to note that making the paradigm shift to a sustainability 'mentality' requires that all stakeholders unite and act as a team, not as individual champions [39]. Fragmentation of authority will result in additional costs and a reduction in the achievement of goals at the project level.

Little Concerns on Sustainability Issues

Most of the respondents remarked that unfamiliarity with the sustainability approach is one of the main barriers to the complete adoption of IBS construction. For local companies, sustainability is perceived as creating higher initial costs. It is considered less important than the profit gained and other financial issues. Globally, there is an increasing level of awareness of incorporating sustainability principles in the construction industry and there is more pressure placed on developing countries such Malaysia to improve their construction efficiency. Horman *et al*. [42] highlighted that the experience, knowledge, and skill of stakeholders can significantly improve the sense of responsibility towards sustainability features such as low embodied energy, reduced construction waste, and improved durability. Therefore, stakeholders should not hesitate to invest in sustainable projects, not only for financial profit but also for intangible benefits such as the improvement in builders' reputations, social considerations and the creation of employment, all of which result from putting sustainability as the main goal in construction works.

6.3 Opportunities of Legislation in Sustainable IBS

Legal Documents Integration

The interviewees opined that the integration of sustainability requirements in legal documents such as contract documents, construction drawings, and bills of quantity was the main strategy to improve sustainable deliverables for IBS constructions. Interviewee D3 (Designer 3) commented that:

> *"Legislation has the most significant implication in promoting sustainability in IBS. Encouragement from the government in IBS is seen as an appropriate strategy to promote sustainability. Uniform Building by Law (UBBL) 1984 is used as the main document to fulfil a requirement for the construction works in Malaysia. The integration of sustainability into UBBL will force the designer to integrate sustainability in construction works."*

It is recommended that sustainability clauses be included in legal documents and that building construction managers be acquainted with them in order to strengthen the effectiveness of the construction industry in integrating sustainability. Construction contracts should also include each organisation's responsibility in achieving this objective. Such legal support is vital as those documents are written agreements signed by the contracting parties to define their relationships and obligations [43].

Certification Programmes

Monitoring the activities of qualified and skilled personnel is the most important process in ensuring that the quality of the product meets the set standard. Certification programmes are required to validate or endorse any skilled workers or products involved in IBS construction. The certification programmes include the review and release of plans for each IBS component, the workers involved in the production or installation, as well as in-plant inspection. Interviewee CL1 (Client 1) commented that:

> *"As clients do not have wide experience in IBS construction, an appointed authority that can help to inspect and approve buildings, building components, or building systems to comply with the codes, standards, specifications and requirements is essential. This will increase the confidence of the client and the user to use the completed IBS buildings. The certified officer will approve compliance assurance programmes which comply with the Standard Procedures."*

It is recommended that the certification programmes ensure that all parties fulfil their obligations and meet their responsibilities towards completing successful IBS projects. Hamid and Kamar [39] highlighted that there is a need to establish an eco-labelling scheme for construction materials to encourage builders to select the most appropriate materials that can enhance sustainability.

Long Term Benefits

Unlike cast-in-situ production, IBS technology offers several long-term benefits to all project participants. IBS components, such as precast concrete, are produced in a controlled factory environment with computer-aided technology, which results in products of high quality and high durability [44]. According to the interviewees, lower maintenance and operation costs are the major benefits of implementing IBS construction. The evaluation of the

construction costs should include an estimate of all the costs involved for the whole life cycle of the IBS products. In addition, the use of the central measure of Gross Domestic Product (GDP) as the proxy for development should be replaced by the new sustainability mentality that also considers the implications for environmental damage such as global warming, resource depletion, and pollution as the basis of all measures [1]. The interviewees pointed out that IBS applications offer many long term benefits such as enhancement of corporate image, staff and customer satisfaction, material preservation and local economy improvement.

Global Market

According to the interviewees, legal requirements in documents could help IBS construction companies to compete in the global market. In brief, Uniform Building by Law or any regulation imposed would show a level of quality for IBS implementation. By including sustainability outcomes, IBS construction will improve its reputation and competitiveness. As mentioned by previous researchers, the common awareness of the global community has increased and they have started to appreciate any efforts to initiate sustainable development [1, 45]. The interviewees believed that a combination of vast production capacity, sustainability integration and government support could prove to be very attractive features which could provide a big boost to IBS application, specifically when competing in a global market.

Good Image

The construction industry suffers a self-image problem, in that most of the people see this industry as having poor economic performance and as being a major cause of environmental and social problems. The Construction Industry Development Board Malaysia (CIDB) reported that the best option available to eliminate negative perceptions and the poor image of the construction industry is to replace conventional construction activities with IBS construction [46]. Most of the interviewees remarked that IBS construction could improve the image of construction and provide better site conditions. In terms of health and safety, fewer on-site activities and operations will reduce the number of accidents, which will in turn encourage workers or investors to participate in IBS construction. Stable employment opportunities also will increase the workers motivation. Utilising labour from the area will result in society wanting to support the organisation which will indirectly increase the production quality.

6.4 Threats of Legislation in Sustainable IBS

Client Driven

The interviewees commented that most decisions in the selection of construction technologies were client-driven. According to Abd Hamid *et al*. [22], most stakeholders refuse to adopt IBS because of their obstinacy in regard to change, and their lack of information to support the feasibility of change from conventional construction to sustainable IBS construction. Clients, who provide investment for the construction projects, are less likely to support the shift from conventional to new construction methods. Such resistance is due to their reluctance to take risks, especially those related to cost, time and quality [47]. The benefits of IBS should be explained to clients in order to improve the adoption of sustainable IBS implementation. The long-term benefits of IBS construction include higher durability, low maintenance and operational costs and better insulation. A misunderstanding of the benefits of IBS makes clients hesitant to choose IBS technologies as their first option when constructing new buildings.

Higher Initial Cost

The interviewees stated that investment in sustainable IBS construction is perceived as more expensive compared to conventional construction. This is due to additional costs for advanced technology, high initial capital outlay and excessive additional transport costs. Blismas and Wakefield [19] stated that most stakeholders were not aware of the possible cost savings over the whole-life of IBS components. It is necessary to emphasise whole-life costs in terms of long-term value rather than purely in terms of material or labour costs. Such work practices as production efficiency, volume sufficiency and reduction of on-site operations need to be considered as adding long-term value to the project. However, it is important to note that the economic benefits will increase with the number of units produced to repay the investment in the initial process once the break-even point is reached [11, 13]. Therefore, a life-cycle cost report that illustrates the whole investment should be provided to investors.

Limited Understanding

Most of the interviewees stated that the adoption of IBS is still low compared to other developed countries such as the United States, Japan, and the United Kingdom. This is because of the limited understanding among stakeholders of the potential of IBS and its relevance to sustainability. The stakeholders who are not exposed to the potential of IBS have a negative perception of it. Interestingly, the respondents stated that the importance of any plan to improve sustainability must be emphasised to stakeholders so that their consensus can be gained in order to

promote sustainable deliverables for IBS construction. According to Lam *et al*. [48], it is essential for stakeholders to have a clear understanding of sustainable construction and to be aware of their continual responsibility to facilitate its success.

6.5 Recommendations

From the SWOT analysis, a portfolio of action can be derived through a presentation of unified views from all key stakeholders, rather than a single profession and the consideration of the negatives instead of all positives in pursuing sustainable objectives. Thus, the actions recommended to enhance sustainability in IBS construction from a legislation perspective have been categorised into four main areas:

i. Strong legal machinery,
ii. Organisation review,
iii. Sustainability officer, and
iv. Authority consensus.

The action plans are discussed in the following sections.

Strong Legal Machinery

The government has to take some initiative to encourage developers to adopt IBS construction completely. The CIDB has set up a one-stop centre for IBS, named the IBS Centre, to provide training and give consultation in matters related to adopting IBS implementation, and promote it. In addition, Treasury Malaysia issued a Treasury Circular Letter on November 2008, now referred to as the SPP 7/2008, to all Malaysian government agencies, directing them to increase the IBS content in their building development projects. It is mandatory to adopt or include up to 70% of IBS application in its projects [40]. However, these efforts are not sufficient. Monitoring processes should be introduced from time to time. An independent institution or organisation should be established to facilitate policy coordination between the authorities involved. Mandatory use of modular coordination in UBBL will ensure all design will support the "open systems" in IBS construction. The government should be aware that strong institutional machinery is essential to execute the sustainability policies. It is important to ensure that any government policy or effort to integrate sustainability reaches the project level in the construction industry.

Organisation Review

To ensure comprehensive integration of a mentality of sustainability into IBS construction, it is vital to adopt a comprehensive long-term organisational review to develop diversified and centred sustainability options. The review must incorporate any concerns regarding sustainability from all of the participants and remind each party to comply with the regulation and legislation passed by the government. The roles and responsibilities of each organisation should be clearly defined, and any discrepancy or problem should be resolved immediately. The consequences of any actions need to be anticipated and evaluated. The commitment of any participants must be maintained for the whole life cycle of the IBS process to ensure its effectiveness. In addition, an interim sustainability report needs to be provided regularly throughout the entire IBS implementation. This is important to identify any existing unsustainable practices or other practices with sustainability potential so that they can be addressed as soon as they occur.

Sustainability Officer

At the project level, sustainability programmes are expected to be more clearly defined and more sharply focused. Characteristics of project-level sustainability programmes associated with better sustainable deliverables in IBS construction must be identified. It is vital to have specific individuals appointed as sustainability officers to monitor activities involved at the project level. As sustainability is an additional factor for IBS projects to consider, it will require a strong commitment when other aspects of the project demand attention. Although sustainability is a subject that must be specifically addressed, it is not to be isolated from other project functions. It is expected that with the help of a sustainability officer, any dispute or misunderstanding about sustainability efforts in IBS construction can be immediately resolved and the smooth progress of the project can be ensured.

Authority Consensus

It is important to recognise the fact that Malaysia should actively promote its interest in sustainable construction and emphasise the importance of this new paradigm of thinking in any decision making for construction development. As discussed in the previous sections, IBS has much potential for improving sustainability. The fragmentation of authority should be solved by creating an efficient policy that integrates sustainability into IBS construction. With a clear vision from the government, consensus among authority can be achieved. In addition, effective teamwork and communication are required to provide a working platform for all the authority involved.

7.0 CONCLUSION

IBS should be seen as an attractive alternative in pursuing sustainability objectives. Government support (in subsidies and tax benefits) is vital to accelerate the total adoption of IBS application [38]. There is a need to realign the sustainability framework for IBS construction to increase participation in this technology, especially for developing countries such as Malaysia. Legislation is identified as a potentially

critical factor in improving sustainable deliverables for IBS construction and it needs to be part of the strategy employed to ensure that the potential for sustainability in IBS application is fulfilled. The strengths, weaknesses, opportunities, and threats identified in the proposed action plans could improve IBS construction dramatically by fulfilling the requirements for sustainable development.

This research contributed to knowledge by illustrating how a SWOT analysis can improve the perception of legislation by key stakeholders, assist Malaysian IBS personnel and improve sustainability. The main strengths are early integration, mandatory orders, obligations and government support. The weaknesses include a lack of incentives and regulatory procedures, the fragmentation of authority and little concern for sustainability issues. Opportunities resulting from legislation include legal document integration, certification programmes, long-term benefits, global markets and improved image. Threats include client-driven projects, higher initial costs and limited understanding. The study reveals that there are four areas of action regarding legislation that can be engaged to improve sustainability namely; 1) Strong legal machinery, 2) Organisational reviews, 3) Sustainability officers and 4) Authority consensus. The participation of industry experts ensured that this research was able to reflect the challenges faced and that its recommendations were suited to real world practice. Consideration of both the positive and negative aspects of focusing on legislation when pursuing sustainability can help to formulate appropriate strategies to establish sustainability.

Finally, it is worth mentioning that the findings derived from the analyses and recommendations should serve as the strong foundation that is urgently required to catalyse the complete adoption of IBS construction in developing countries such as Malaysia. The guidelines serves as part of the project briefing documents for the designers, who make prominent decisions in selecting the best strategies to embed sustainability potential in IBS application. A focus on developing a holistic and integrated approach, combined with the eighteen factors in the critical guidelines, should improve the effective delivery of sustainability outcomes.

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