Analysis of the current situation of Industrial Building Systems (IBS) in Malaysia

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Abstract

Our current status is founded on the past, therefore, to have a clear understanding of the moment, it is necessary to revisit what happen in the past. Moreover, the appropriate adoption of strategies in any organization and system leads to understanding its current situation. Nowadays, management has becomes professional, dynamic and tasking in all sectors. If the managers want to adopt appropriate strategies and objectives to achieve future goals, they must take action through a strategic planning. At the beginning of any plan, before the organization determines its future efforts, its current situation should be clarified. Therefore, a deep and accurate awareness and understanding of the current situation is essential. The strengths, weaknesses, opportunities and threats (SWOT) features are the areas which explicate the current situation of the organization. This paper first introduces the SWOT feathers as well as the strengths, weaknesses, opportunities and threats. Then, the SWOT feathers, which affects the implementation of the Industrial Building System (IBS) in Malaysia, is addressed throughout the past researches and interviews with experts. In the next step, identified factors will be ranked and prioritized by applying the average ranking method. The classified factors in this study can be used in future studies to provide development strategies for IBS improvement according to its current position.

Keywords
Industrial Building System (IBS), SWOT (Strengths, Weaknesses, Opportunities and Threats), Construction Industry, Malaysia

تحلیل وضعیت فعلی سیستم‌های ساختمانی پیش ساخته (IBS) در مالزی

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چکیده

وضعیت کنونی ما بر اساس گذشته است، بنابراین برای درک روشنی از لحظه، لازم است آنچه را که در گذشته اتفاق افتاده بازنگری کنیم. بعلاوه، اتخاذ راهبردهای مناسب در هر سازمان و سیستمی منجر به شناخت وضعیت فعلی آن می شود. امروزه مدیریت در همه بخش ها حرفه ای، پویا و وظیفه گرا شده است. اگر مدیران بخواهند راهبردها و اهداف مناسبی را برای دستیابی به اهداف آتی اتخاذ کنند، باید از طریق برنامه ریزی استراتژیک اقدام کنند. در ابتدای هر طرحی، قبل از اینکه سازمان اقدامات آتی خود را مشخص کند، باید وضعیت فعلی آن مشخص شود. بنابراین آگاهی و درک عمیق و دقیق از وضعیت موجود ضروری است. ویژگی‌های نقاط قوت، ضعف، فرصت‌ها و تهدیدها (SWOT) حوزه‌هایی هستند که وضعیت فعلی سازمان را توضیح می‌دهند. این مقاله ابتدا به معرفی پرهای SWOT و همچنین نقاط قوت، ضعف، فرصت ها و تهدیدها می پردازد. سپس، پرهای SWOT، که بر اجرای سیستم ساختمان صنعتی (IBS) در مالزی تأثیر می‌گذارد، در طول تحقیقات گذشته و مصاحبه با کارشناسان مورد بررسی قرار می‌گیرد. در مرحله بعد عوامل شناسایی شده با استفاده از روش رتبه بندی میانگین رتبه بندی و اولویت بندی می شوند. عوامل طبقه بندی شده در این مطالعه را می توان در مطالعات آینده برای ارائه استراتژی های توسعه برای بهبود IBS با توجه به موقعیت فعلی آن استفاده کرد.

کلمات کلیدی
سیستم ساختمانی پیش ساخته (صنعتی) (IBS)، SWOT (نقاط قوت، نقاط ضعف، فرصت ها و تهدیدها)، صنعت ساخت و ساز، مالزی

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1- Introduction

In line with the increasing demand for housing, the critical need for housing in Malaysia has become a primary concern. Conventional methods of building are not responsive to the current needs due to their slow implementation and high costs [1]. To address the slow pace and high costs associated with conventional construction systems, there is a need for mass production of buildings under a high-quality controlled system [2]. Considering that the volume of activities in the construction industry exceeds that of other industries, and its nature is based on the use of machinery, equipment, and a vast array of raw materials and components [3], as a result, achieving sustainable construction necessitates the construction industry to bring about changes in its processes [4]. In this regard Malaysian construction industry is experiencing a transition from the traditional system to a mechanized building system is called the Industrial Building System (IBS) [1]. Given the new perspective on rapid and clean construction in developing countries, strong research into prefabricated or industrialized building systems is essential [5].

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فصلنامه پژوهشی

One of the leading aspects of this research is addressing the managerial aspect, especially the implementation of strategic management in the deployment of prefabricated building systems.

Strategic management is widely used in all businesses and organizations. Strategic management can be viewed as a set of decisions and actions which are applied by managers at all levels of an organization. This set of decisions can lead to long-term activities in the organization [6]. Strategic management disciplines are associated with a wide range of approaches. Classic theorists consider the present as well as the future and try to set their strategies for complementary and efficient utilization of the futures' opportunities by the prediction of environmental factors. Our ability to predict the future is limited, because even a small change in a seemingly unrelated phenomena can lead to major changes in the whole system [7]. Currently, in the process of strategic management, various approaches and techniques are used to analyze and evaluate strategies [8]. Among these approaches, analyzing strengths, weaknesses, opportunities, and threats is one of the most applicable approaches [9].

1.1. SWOT Framework

The SWOT approach involves systematic thinking and comprehensive judgment of factors relating to a new product, technology, management, or planning [10]. It summarizes the most important internal and external factors that may affect the organization’s future, which are referred to as strategic factors used extensively in strategic planning [9-12]. Specifically, it allows analysts to categorize factors into internal (strengths, weaknesses) and external (opportunities, threats) as they relate to a decision and thus enables them to compare opportunities and threats with strengths and weaknesses (see table 1).

Table 1. SWOT Template

		Undesirable	Desirable
Uncontrollable	External Factors	**Threats (T)**	**Opportunities (O)**
Controllable	Internal Factors	**Weaknesses (W)**	**Strengths (S)**

Barney [13] argues that the SWOT framework as the, “matching process in choosing strategies”, lies at the intersection between research and practice. The SWOT framework, includes the identification of factors which are internal to the business and also factors that affect the business from outside [14]. The purpose of understanding external opportunities and threats is to evaluate whether an enterprise can seize opportunities and avoid threats when facing an uncontrollable external environment and the purpose of the consideration of internal strengths and weaknesses is to evaluate how an enterprise carries out its internal work, such as management, work efficiency, research and development, etc. [15]. Various approaches and techniques are currently used to analyze and evaluate strategies in the process of strategic management [8], however, SWOT is one of the most applicable approaches.

1.2. IBS in Malaysia

With the growth in the demand for housing, Malaysia is under pressure to meet its housing needs. The conventional construction method, due to the low speed of construction and higher cost, is unable to meet the demand [16-17]. Consequently, the Industrialized Building System (IBS) is introduced as an option which has advantages in term of quality, productivity, time and cost saving through an increasingly advance technology [18]. It is accepted that the IBS is the only way to bridge the gap between demand and supply [19]. IBS has undertaken to solve and improve the current construction method and scenario in Malaysia [20-22]. The implementation of IBS in Malaysia was started since 1966 [23]. An early survey in 2003 reported in the IBS Roadmap 2003-2010 [24] and the IBS Survey [25] indicated that only 15% of overall construction projects in Malaysia used IBS. However, a recent study in 2006, published in the IBS Roadmap Review shows that the percentages of completed projects that used more than 70 % of IBS components in the construction project are in the range of 10%. Additionally, less than one-third of total construction projects used at least one IBS product in the year [26]. This percentage is lower than expected despite huge the publicity campaign by the government. The actual projection for the percentage of completed projects using IBS is in the range of 50 % in 2006 and 70% in year 2008 [19]. It is not as high as the government anticipated at this stage [27]. Nevertheless, the effort to promote the usage of IBS as an alternative to the conventional and labour-intensive construction method has yet to make a headway [27].

The clear understanding of the current status of IBSs will help to set the strategies to improve IBS implementation in Malaysia. However, the first step in any advance study on building systems and its technology should be initiated by knowing the status quo [28]. The current status is founded on the past so to get a clear understanding of the moment it is necessary to revisit what happened. The purpose of this paper is to look beyond the incompleteness of SWOT as a managerial and/or research tool, and to propose the use of SWOT to capture and examine IBS implementation from both the planning view (i.e. back-end perspective) and the intelligence view (i.e. front-end perspective) [29]. Therefore, this paper is seeks to study the current position of the IBS usage to promote its implementation in Malaysia. It is focused on the introduction and ranking of IBS strengths, weaknesses, opportunities and threats by applying the average ranking method. These classified and ranked factors can be used in future studies to provide development strategies for IBS improvement according to its current position.

2- Methodology

Since the goal of this study is the identification the existing situation of IBS in Malaysia through employing the internal and external factors, both the quantitative methods (questionnaires) and the qualitative method (semi-structured interviews) were used. The data is divided into two parts. The first part consists of handbooks (particularly government documents), a literature search, and papers focused on IBS and the construction industry in Malaysia, to review the current state of IBS implementation in Malaysia and determine the main strengths, weaknesses, opportunities and threats of using this building system. In the second part, the information which was gathered from the first part presented to six academic experts during the evaluation process by applying semi-structured interview to finalize a list of factors. According to Morse [30] there is an inverse relationship between the number of participants and the amount of useable data obtained from each participant. As a phenomenological study, six participants would be sufficient to achieve a large amount of data for each participant. The respondents were asked to add or remove factors that they think are or are not significant strengths and weaknesses factors, the areas of improvement, the opportunities and the threats to facilitate the IBS method implementation (see table 2-5).

In the next step, the study is continued by a questionnaire survey developed based on the information gathered in the previous interview session. Respondents were required to rate the existing factors which are prioritized and classified as a questionnaire on the strengths, weaknesses, opportunities and threats (SWOT) of using IBS. Various ranking methods were compared with each other [31-33]. Corne and Knowles [32] reported that the best results were obtained from a simple average ranking method than from more complicated ranking schemes. In the average ranking method, a rank for each objective is assigned to each solution based on the ranking of its objective value for the corresponding objective among non-dominated solutions in the current population. Then, the average rank is calculated for each solution as its rank. Kukkonen and Lampinen [33] examined the average and minimum ranking methods. The average ranking (AR) method has been shown to be highly effective in providing sufficient selection [34]. According to the IBS centre's official site, manufacturers, contractors and consultants were listed as part of the IBS supply chain. Thirty IBS companies were randomly selected through an existing list that included ten manufacturers, fifteen contractors and five consultants.

Questionnaires were sent to the management level of the companies. The respondents were asked to score how important each factor is based on its influence on IBS implementation in Malaysia. Respondents were required to respond to all the information by stating their level of agreement based on five ordinal measures known as Likert Scale from one (1) to five (5) according to specified level [35]. The last section in this questionnaire requires respondents to state their level of agreement on the factor affecting IBS implementation. According to the scale, questionnaire rating is done following the five-point scale previously described and converted into relative important indices for each factor. These indices are adopting from the Relative Index (RI) ranking technique based on Eq. 1 [36].

(1)
$$RI = \frac{n(1)\times 1 + n(2)\times 2 + n(3)\times 3 + n(4)\times 4 + n(5)\times 5}{N_{total}\times 5}$$

Where n(i) is the number of responses with scale, i (i=1,..., 5) and N is the total number of responses to each question. The maximum value for RI is 1, and the minimum is 0.2 accordingly. In total, 23 questionnaires have been collected from respondents (12 contractors, 8 manufacturers and 3 consultants). As a final point, factors are ranked according to their Relative Index (RI).

3- Result and Discussion

As was mentioned in the methodology, the current state of IBS in Malaysia was reviewed through the literature and semi-structured interviews. The main strengths, weaknesses, opportunities and threats were determined as presented on table 2-5:

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تابستان ۱۳۹۸
فصلنامه پژوهشی

Table 2. The Strengths of IBS (Internal factor)

Position	IBS Strengths	References	1	2	3	4	5	Average Index	Relative Index (RI)
1	Reduced construction time and speedier work	[23]	0	0	0	9	14	4.61	0.922
2	Reduce the dependency of foreign labor	[23, 27-28, 37, 40-41, 43, 46-47]	0	0	0	10	13	4.57	0.913
3	Standardization of construction by high quality and better finishes	Interview	0	0	0	11	12	4.52	0.904
4	Easy installation, construction and renovation	[28, 40-41]	0	0	0	12	11	4.48	0.896
5	Optimized use of material and reduce material wastage	[37, 40]	0	0	2	10	11	4.39	0.878
6	Environmental friendly, cleaner and neater environment and construction site	[37, 48]	0	0	2	11	10	4.35	0.870
7	Less affected operation by the weather conditions	[37, 48-50]	0	0	3	9	10	4.32	0.864
8	Systematic implementation plan and better site management	Interview	0	0	5	9	9	4.17	0.835
9	Reduce the total construction costs (saving in material and labor cost)	[27-28, 37-38, 40, 46, 51]	0	0	5	11	7	4.09	0.826
10	Optimized land use	[23, 27-28, 37, 40-41, 43, 46-47, 52-54]	0	0	6	12	5	3.96	0.809
11	Reduce of using temporary formwork and props	[40]	0	0	7	10	6	3.96	0.809
12	Speed of new technology transfer and development	[38, 40, 55-56]	0	0	9	10	5	3.83	0.800
13	Improve productivity	[37, 40]	0		7	13	3	3.83	0.783
14	Innovation in construction method	Interview	0	0	7	13	3	3.83	0.774
15	Flexibility	[23, 27, 47, 52-53]	0	0	8	11	4	3.83	0.774
16	Government attitudes, support and research spend	[37, 41, 57]	0	1	8	9	5	3.78	0.757
17	Economic Growth	[37, 40, 42, 47-48, 54]	0	1	10	8	4	3.65	0.730
18	Increase the level of safety in construction site and working platform	[37, 40, 42, 47-48]	0	2	10	7	4	3.57	0.713
19	Enhance value end users	[37, 40, 48, 50, 54]	0	2	11	7	3	3.48	0.696
20	Improve perceived image of construction	[28, 48]	0	3	12	6	2	3.30	0.661
21	Easy conscience	Interview	0	3	14	6	0	3.13	0.626

Table 3. The Weaknesses of IBS (Internal factor)

Position	IBS Weaknesses	References	1	2	3	4	5	Average Index	Relative Index (RI)
1	Requires a high initial investment capital	[23, 40]	0	0	0	10	13	4.57	0.913
2	Lack of require transportation to carry IBS components	[23]	0	0	0	11	12	4.52	0.904
3	Heavy machineries for the installation process	[40, 58]	0	0	0	12	11	4.48	0.896

JECM
3 (2), 2019
دوره ۳، شماره ۲
تابستان ۱۳۹۸
فصلنامه پژوهشی
مهندسی و مدیریت ساخت

4	Site Accessibility and suitable site condition for the transportation of the IBS components	[23, 40]	0	0	1	12	10	4.39	0.878
5	Structural limitation and problem of joints	[37, 40]	0	0		14	9	4.39	0.878
6	Lack of require standards and regulations	[40]	0	0	2	12	9	4.30	0.861
7	Lack of maintenance and servicing of components after installation	[37, 40, 46]	0	0	2	13	8	4.26	0.852
8	Require experienced and skill workers	[40, 59]	0	0	3	13	7	4.17	0.835
9	Extra cost of training unskilled and semi skilled laborers	[40]	0	0	5	11	7	4.09	0.817
10	Lack of suitable price determination for IBS components	[38, 40, 55]	0	0	6	11	6	4.00	0.800
11	Lack of motivation and incentive for IBS application	[40]	0	0	6	12	5	3.96	0.791
12	Resistance of change by the companies	[40]	0	0	7	11	5	3.91	0.783
13	Lack of awareness about IBS	[40]	0	1	7	11	4	3.78	0.757
14	Lack of communication and advertisement	[40]	0	2	7	12	2	3.61	0.722
15	Lack of specific and local R&D centers and organizations and testing lab	Interview	0	3	6	14	0	3.48	0.696

Table 4. The Opportunities of IBS (External factor)

Position	IBS Opportunities	References	1	2	3	4	5	Average Index	Relative Index (RI)
1	Increasing of professional work force by training and development for workers	[40]	0	0	0	11	12	4.52	0.904
2	Opportunities for country younger generations by decreasing foreign workers	[40]	0	0	0	13	10	4.43	0.887
3	Consultation by the IBS experts	[40]	0	0	0	15	9	4.38	0.875
4	Government policies and incentives	[40-41]	0	0	1	14	8	4.30	0.861
5	The execution of IBS Road Map	[61]	0	0	3	12	8	4.22	0.843
6	Establishing research and development centre for IBS	[40]	0	0	3	10	7	4.20	0.840
7	The standardization of manufacturing process	[40]	0	0	2	16	5	4.13	0.826
8	Meet the local climate condition and material through construction	Interview	0	1	2	16	4	4.00	0.800
9	Development of IBS alternatives in the form of natural building materials	[40]	0	0	3	17	3	4.00	0.800
10	Suitable for all construction class	[40]	0	1	4	16	2	3.83	0.765
11	Material cost saving by using the natural local materials	[40]	0	2	3	16	2	3.78	0.757
12	Meet the local social condition and building tradition through the new design	[40]	0	2	8	13	0	3.48	0.696
13	Enhance the knowledge of design in the IBS components and the machinery	[40]	0	4	7	12	0	3.35	0.670
14	Decreasing foreign technology dependency by improving local industry	[28, 37]	0	5	8	10	0	3.22	0.643
15	Improve domestic and local construction markets	Interview	0	5	9	9	0	3.17	0.635

17	Export of IBS components for overseas application	[40]	0	4	11	8	0	3.17	0.635
16	Improve and change lifestyle standards and conditions	[40]	0	6	10	7	0	3.04	0.609
18	Increase the construction value by IBS components application	[40]	0	6	12	5	0	2.96	0.591

Table 5. The Threats of IBS (External factor)

Position	IBS Threats	References	1	2	3	4	5	Average Index	Relative Index (RI)
1	Location of manufacturers that is far away from the construction site	Interview	0	0	0	10	13	4.57	0.913
2	The increase of diesel and fuel prices	[26, 40]	0	0	0	12	11	4.48	0.896
3	Low loading carrying capacity through the transportation navy	[40]	0	0	0	13	10	4.43	0.887
4	Expensive IBS components	Interview	0	0	0	13	10	4.43	0.887
5	Reluctant to make change in the local building to the acts and laws	[40]	0	0	0	14	9	4.39	0.878
6	Negative perception of using IBS methods from social view	[40]	0	0	2	12	9	4.30	0.861
9	Low skill level of IBS section employees and workforces	[40]	0	0	2	13	8	4.26	0.852
7	Poor Connection System	[40]	0	0	3	13	7	4.17	0.835
8	Consumer confidence and negative feeling on safety	[40, 53]	0	0	3	14	6	4.13	0.826
10	The competition by competitor to produce better quality at a cheaper price	[25-26]	0	0	3	16	4	4.04	0.809
11	The quality of the IBS components are not assured	Interview	0	0	5	15	3	3.91	0.783
12	Not economical IBS components size	[62]	0	0	6	15	2	3.83	0.765
13	The modular sizing of the building are not approved by the local authorities	[23]	0	1	8	13	1	3.61	0.722
14	Lack of inspection of the quality of materials in the manufacturing plant	[28, 37]	0	1	10	12	0	3.48	0.696
15	unwilling in construction industry executives engagement	[46]	0	2	10	10	1	3.43	0.687
17	New regulations and cumbersome bureaucracy	[40]	0	3	9	11	0	3.35	0.670
16	Lack of varieties of products manufactured by the local producers	[40]	0	3	11	9	0	3.26	0.652
18	Attitudes to foreign products and components	[40]	0	5	10	8	0	3.13	0.626
19	Less attentions to local traditional and cultural aspects	[40, 63]	0	6	12	5	0	2.96	0.591
20	Taxation changes specific to product/services	[23]	0	6	13	4	0	2.91	0.583

In the next step, referring to the questionnaire, the following data of the results of respondents is expressed in accord with the standings of the score of average index.

3.1. Strengths of IBS Implementation

Table 2 states the results of the respondents in terms of IBS implementation strengths. The analysis, which is based on the average index shows that the highest average index for the strength of IBS is reducing construction time resulting to speedier work. The average index has a score of 4.61. IBS provides speedier construction completion period because of the introduction of components replacing on-site construction. This s because the prefabricated components are designed in a controlled environment with standard sizes, and then delivered to the site. It requires less construction time because the casting of precast elements at factory and foundation work at site can occur simultaneously and the work at site is only the erection of IBS components. This leads to earlier occupation of the building. Consequently, the successful delivery of a project could be achieved. IBS adoption can minimize the building process, therefore, enabling the faster completion of the construction of projects [28, 37-40].

The second most important factor of IBS strengths is reducing, by 4.57, the dependency on foreign labour. The building components are prefabricated in the factory and delivered on site, at the time the workers require to immediately erect and install the components. Due to a growing demand for housing, solving issues associated with foreign workers is one of the cost-cutting benefits of IBS method implementation. When the IBS components are produced in a factory, a higher degree of utilization of machines is permitted and the use of labour will be reduced. This leads to savings in labour cost. The use of IBS will also reduce the construction process at the site and consequently reduce the amount of labour required at the site. Consequently, the workers required on the site are just professionals such as erectors, precasters and others. Since most of the foreign labourers are unskilled, they can be replaced with indigenous skilled workers. The implementation of the IBS method, results in savings in on site manual labour (up to 40-50% of the input in conventional construction), especially in skilled trades such as formwork, masonry, plastering, painting, carpentry, tiling and pipe lying (electrical and water supply) [28, 37, 39-41].

The next factor is standardization of construction by establishing high quality and better finishes. This gives it an average index of 4.52. The IBS method enables quality improvement through construction standardization. The quality is controlled by the processes of controlled pre-fabrication and simplified installations that has maintained and ensured better finishes and the quality of work in the construction industry. That is why IBS components have higher quality and better finishes because of the careful selection of materials, use of advanced technology, better and strict quality assurance control, this is because production in a factory is done under a sheltered environment [28, 37, 39].

The respondents agreed, by a score of 4.48, that IBS components are easy to be installed, constructed and renovated. The building components are prefabricated in the factory and delivered on site, to be erected and installed. This process converts the building system to a manufacturing system. Subsequently all components are produced, in detailed and standard size, thus making it easy to install and makes it possible for the components to be renovated.

The three next strength factors in IBS implementation are: the optimized use of material and reduced material wastage; environmental friendliness, a cleaner and neater environment and construction site and the reduced effect of weather conditions on operations (by the average index 4.39, 4.35 and 4.32). The use of IBS can greatly reduce the usage of conventional timber and therefore contribute to environmental preservation. Moreover, the utilization of machines during the production of IBS components leads to higher degree of precision and accuracy in the production and consequently reduces material wastage. Optimized and controlled use of material, less site materials and minimal construction wastage with the usage of the standardized components, and less in-site works (by the application of IBS) provides a cleaner site because of lesser construction waste and savings in material cost. In addition, due to faster project completion, construction operations are less affected by weather. The effects of weather on construction operation are less due to the fabrication of IBS components in the factory, and the fact that there is only the erection of the components at site. In other word construction operation is not affected by adverse weather conditions because prefabricated components are done in a factory controlled environment [37, 39, 42].

As it shown on table 2, the IBS systematic implementation plan provides better site management (score: 4.17) due to the reduction of site workers, materials and construction waste. The reduction of construction waste with the usage of the standardized components and less in-site works provides a cleaner site due to lesser construction waste. The utilization of IBS components leads to less construction process especially wet work at site. Its systematic implementation plan will lead to efficient management, neater site condition and increased safety [37, 39].

IBS provides earlier occupation of the building, thus reducing interest payment or capital costs. This method will enable cost savings through the reduction of labour intensity and savings in the cost of materials by the standardization of construction. The IBS system has several abilities to reduce the cost of construction; example: the formwork of IBS components are made of steel, aluminium or other materials that allows for repetitive use and this leads to considerable cost savings. IBS prepares a range of suitable construction for all classes of construction from low-cost housing class to high-cost housing class. Last of all, this method leads to the reduction of the total construction costs (score: 4.13) [28, 37, 39, 43]. Table 2 shows optimized land use, reduction in the usage of temporary formwork and props, speed of new technology transfer and development, productivity, innovation and other strengths of IBS.

3.2. Weaknesses of IBS Implementation

Referring to the Table 3, the respondents indicated that the required high initial capital investment gave the highest average index for the weaknesses of IBS by score 4.57. The initial capital cost of IBS is usually high and this includes the cost of constructing the factory, casting beds and support machinery. IBS requires a high working capital in that the IBS components can be expensive because of the investment in machineries needed to produce the components. The early stage of training of workers to handle machineries is also costly and the training might cause the workers to hop to other companies as it is the normal culture in Malaysia. The high cost also involved the transportation cost of the IBS components for the handling from the factory to the construction site. The cost effectiveness can only be achieved when undertaking large projects.

The second highest score of the weakness of IBS is the lack of the required transportation to carry IBS components that has an average index of 4.52. In the Malaysian logistics and transportation industry, the maximum length of an item that can be carried on a vehicle on the road is only 15 meters and the maximum effective prefabricated concrete (span as in the beams or slabs) can reached up to 20 to 25 meters. Therefore, there are suggestions that the trailer must be designed in such a way that it can be transported with the difficult conditions and to isolated areas and the movement must be flexible. As a result, a suitable transportation system to transfer the IBS components from the manufacturing plant to the construction site is required. On the third and fourth level, the factor of heavy machineries needed for the installation process and site accessibility and suitable site condition for the transportation of the IBS components are ranked by 4.48 and 4.39 average indexes. The transportation and erection of large IBS components requires the use of heavy machineries and suitable site conditions. In addition to that, site accessibility is one of the most important factors in the implementation of IBS. IBS requires adequate site accessibility to transport IBS components from factory to the site.

Structural limitation and the problem of joints are the next weaknesses of IBS with a score of 4.39. In spite of the many advantages of IBS components, they are faced with some structural limitations. Poor connection of the system may cause problems to site works; such that the connections cannot be joined properly due to poor construction details that lead to issues of comfort and safety. Water leakage is often the major problem in building constructed using IBS. This problem is more obvious in Malaysia where there is heavy rainfall throughout the year. Eventually, this gives raise to many serviceability problems such as leakage. Rain water can easily seep into the internal building through the joints between the walls and steel beams. Dampness leads to corrosion of the lighting system and the steel beams. The weaknesses of IBS implementation as shown with other factors on table 3 includes: the lack of required standards and regulations, lack of maintenance and the servicing of components after installation, and the lack of required experienced and skilled workers.

3.3. Opportunities of IBS Implementation

Table 4 shows the average index of the opportunity factors of IBS in the Malaysia construction industry. Among the opportunities, the factor which was suggested to have the highest score is increasing the professional workforce by training and development of workers and this has an average index of 4.52. The IBS method needs a professional workforce to handle construction projects. The training and development of the workers is important to ensure that they are competent to be engaged in the projects. The training includes training in the installation process to learn how to do proper sequencing to ensure the stability of the structure itself and also training on the technical side of the application. On the other hand, the labour force needs to be trained in the application of the proper connection of bolts, nuts and in welding. The workers required on the site are professional such as erectors, pre-caster and others, therefore foreign unskilled workers will be replaced by skilled indigenous workers [40]. Accordingly, this opportunity created for the country's younger generations by the decreased use of foreign workers is the second factor which has a score of 4.43.

The next high level IBS opportunity is the consultation of IBS experts which has an average index of 4.61. There is a need for the consultation in the area of the design, installation and the sizing so that the application of IBS in construction can be designed for safety, durability and the size; to sure they are all in accordance with the international standard for modular coordination.

Government policies and incentives, the execution of the IBS Road Map and the establishment of research and development centre for IBS are the next three opportunities created by IBS implementation. The main issue that the government is concerned about in the Malaysian construction industry is the need to adopt an innovative method of component standardization [38]. The execution of IBS Road Map can aid the construction industry to deal with this issue. The government agencies in Malaysia must provide relevant consultation and create special funding to encourage reengineering and change management initiative to suit the IBS process. Although, government should increase the allocation of research grant through its agencies and provide more incentive i.e. establishing R&D development centres, and tax reduction to encourage more R&D contribution in construction industry particularly in the IBS.

Table 4 shows the standardization of the manufacturing process to meet the local climate condition and material through construction, development of IBS alternatives in the form of natural building materials and other opportunities of IBS.

3.4. Threats of IBS Implementation

The average index of the threat factors of IBS in the Malaysian construction industry is shown in table 5. The location of manufacturers that is far from the construction site and the increase of diesel and fuel prices are the highest threat according to the respondents which have averages of 4.57 and 4.48. Since the IBS components are being transported to the construction site, fuel is therefore an important commodity in the logistics industry. The fluctuation of fuel prices will directly influence the transportation cost and consequently the cost of IBS components will rise significantly. As a result, the construction cost will also rise because the application of IBS also makes use of a lot of machineries. The distant location of the manufacturers from the site will contributes more to the cost [40].

The third threat of IBS method usage is ranked 4.43 by low loading carrying capacity of the transportation navy. The maximum effective prefabricated concrete span (as in the beams or slabs) can reach up to 20 to 25 meters. Therefore, the trailer must be designed in such a way that it can be transported in these difficult conditions to isolated areas and the movement must be flexible. As a result, a suitable transportation system to transfer the IBS components from the manufacturing plant to the construction site is required. Expensive IBS components is the next threats and has a 4.43 score. Some of the factors that contribute to make the IBS components expensive includes: the high investment capital (in terms of the investment in machinery to produce the components), cost of training workers to handle machineries, cost of transporting the IBS components and the handling from the factory to the construction site, and the increasing fuel prices.

The next threat is the reluctant to make changes in the local building laws and acts and this has an average index of 4.39. The approval process of the law takes a very long time and the execution period is even longer. Therefore, it is important for the local authorities to take proactive measures to encourage the use of IBS with more consideration of the national interest. The negative perception of using IBS methods from the social view point is scored 4.30. IBS is often misinterpreted and given a negative image due to its past failures and unattractive architecture [44]. These buildings are normally associated with pre-fabricated, mass construction methods, low quality buildings, leakages, abandoned projects, unpleasant architectural appearances and other drawbacks. Due to poor architectural design, IBS is not creating enough pull factors to encourage developers to adopt it [45]. Changing the current perception is necessary to improve IBS adoption. Better customer perception will create better understanding and demand and will definitely encourage developers to push for IBS adoption. Table 5 reveals that the threats of IBS implementation include: the low skill level of the employees and the workforce in the IBS section, poor Connection System, consumer confidence and the negative feeling on safety.

As it is mentioned earlier, this paper introduces the SWOT feathers as well as the strengths, weaknesses, opportunities and threats. Then, the SWOT feathers which affect the implementation of the Industrial Building System (IBS) in Malaysia is addressed along with the past researches and interviews with experts. In the next step, identified factors are ranked through the IBS supply chain sectors by applying the average ranking method. The classified factors in this study can be utilized in future studies to identify the exact, current position of IBS in Malaysia and provide development strategies for IBS improvement with respect to its current situation.

4- Conclusion

As stated, in terms of IBS implementation, the reduction in construction time and the speedier completion of work; the reduction in the dependency on foreign labour and the standardization of construction by having high quality and better finishes, are the highest average index for the strengths of IBS. Prefabricated components are designed in the control environment and with the standard size then delivered to the site. The quality is controlled through the processes of controlled pre-fabrication and simplified installations to maintain and ensure the best finishing and the quality of work in the construction industry. The IBS method is able to improve quality through speedier construction completion period due to the introduction of components that replaces on-site construction. The building components are prefabricated in the factory and delivered on to the site at the time the workers require them for the immediate erection and installation. It leads to the reduction in the dependency of foreign labour and leads to savings in the cost of labour.

Respondents indicated that the high initial investment capital requirement of IBS, the lack of required transportation to carry IBS components, heavy machineries for the installation process, suitable site conditions for the transportation of the IBS components and site accessibility got the highest average index for the weaknesses of IBS. The initial capital cost of IBS is usually high due to the investment in machineries required to produce the components, the cost of training skilled workers to handle machineries and the high cost of transporting the IBS components from the factory to the construction site. Heavy machineries and suitable site condition are required for the transportation and erection of large-sized IBS components. In addition, site accessibility is one of the most important factors in the implementation of IBS. IBS requires adequate sit accessibility to transport IBS components from the factory to the site.

The high rank opportunities in IBS implementation includes: the increase in the professional workforce by the training and development of workers, opportunities created for the local young people by the decrease use of foreign workers and the consultation of IBS experts. The IBS method requires a professional workforce to handle construction projects to ensure that the workers are competent to participate in the projects. The training programs such as the training on the installation process that adheres to the proper sequencing to ensure the stability of the structure itself and also training on the technical side of the application, can create the opportunity for indigenous youths because of the decrease in the utilization of foreign workers and IBS experts as consultants on project design and installation by the application of IBS as a high speed, safe, durable and high quality method adhering to the international standard.

The highest threat, according to respondents, includes: the far distance between the location of manufacturers and the construction sites and the increase of diesel and fuel prices and the low loading carrying capacity of the transportation navy. Since the IBS components are being transported to the construction site, the fluctuation of fuel prices and the low loading carrying capacity of the transportation navy will therefore directly influence the transportation cost and consequently the cost of IBS components will rise significantly. As a result, a suitable transportation system is required to transfer the IBS components from the manufacturing plant to the construction site.

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