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Critical Success Factors of Industrialized Building System (IBS) Implementation for Construction Industry in Yemen

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Abstract: The construction industry in Yemen is currently challengeable by political instability, economic and technical issues, and armed conflicts among local as a factors negatively influenced socio-economic development and produced a poor development of construction projects. However, implementing an effective construction method is highly required for improving the current poor construction development in Yemen. Therefore, Industrialized Building Systems (IBS) is an alternative solution for improving the Yemeni construction industry by implementing an effective technology to construct projects with good quality and reasonable cost. Thus, this study aimed to identify IBS benefits, investigate IBS implementation challenges, and study the Critical Success Factors (CSFs) of supporting IBS implementation. A quantitative approach was selected for conducting the study by distributing of online questionnaire survey among construction firms. For this study, the sample size was determined as 152 respondents, while only 49 contractors had completely responded online survey of this study with a responding rate of 32.23%. The primary findings showed that respondents have a proper awareness of IBS benefits including improving quality, saving time and cost, environment friendly, and flexibility of products designing. However, lack awareness and standards, poor readiness, cost related issues, and poor government supports are the main challenges that influence IBS implementation. Additionally, the study found clear guidelines, enhance knowledge and awareness, encourage and promote its implementation, capability of planning, controlling, and financing, and intensive trainings are CSFs that should be considered for a proper implementation of IBS and improving construction industry development in Yemen.

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Keywords: Critical Success Factors (CSFs), Industrialized Building Systems (IBS), Yemen

1. Introduction

Construction industry is considered as the one of the largest industries in the world that have a great influences on social activities in modern societies and have a sufficient role in improving the regional economies (Alaghbari *et al.*, 2019). Thus, understanding the nature of construction industry is a crucial at both macro and micro levels for an effective controlling and managing of its constituent organizations and gain the abilities for continues improvements (Hakami, 2017). However, in developing regions, construction industry is suffering from several challenges and issues that related to the severe conditions of uncertainty and risks where the majority of construction works had conducted within informal sector that could occur by self-help or by paid labor (Sultan, & Alaghbari, 2017). However, effective strategies, techniques, systems, and technologies are highly required to minimize and solve the issues effects on Yemeni construction development. Thus, Alwaly & Alawi, (2020) had recommended the application of Project Management Knowledge Guide (PMBOK) to be adapted by construction projects managers. While, Sultan & Alaghbari, (2017) had pointed out that a formulation of various policies and strategies that facilitate projects development process are required for developing the sustainable and economic aspects.

Furthermore, Sultan, (2013) suggested an effective planning and management practices for construction execution are required that could be achieved by providing more choices and adaption of an effective policies and strategies to balance the local and global issues. In addition, Alaghbari *et al.*, (2019) had viewed out that government must works towards a comprehensive development of administrative and human resource and promote function of effective management of labors and human resources for a successful management of construction projects and initiatives.

Implementation of IBS for improving construction industry development is considered as an alternative solution for Yemeni construction industry enhancement. Moreover, using new technology and IBS had considered as one of the significant factors for better quality of housing cost of construction methods in Yemen (Alsanoy, 2011; Alaghbari *et al.,* 2012). IBS is known as off-site production which gained consideration of many governments and private initiatives due to its role of increasing productivity and improving performance of building and other infrastructure development projects (Zakaria & Amtered, 2020).

Additionally, Ali *et al.,* (2018) had highlighted some effective strategies to improve IBS adoption such as governmental facilities and incentives for IBS stakeholders, promote awareness of IBS, and conducting trainings. Furthermore, due to the many governmental initiatives and future outlook in increasing awareness of implementation sustainable elements, IBS is one of these approaches that had considered as an alternative instead of conventional construction methods and offered a new strategies of minimize materials wastes (Soon *et al.,* 2017).

Moreover, since the first introducing of IBS, but its adaption for Yemeni construction industry is still unknown due to various factors including the lack of knowledge and awareness of adaption IBS, lack polices and standards of using IBS, and poor supports from public and private sectors to encourage using IBS in the Yemeni construction industry. It could be mentioned that IBS implementation is absence in the construction industry in Yemen, which is an important to study the industry' stakeholders willingness in implementing IBS as an alternative approach instead of conventional methods. Therefore, this study is expected to investigate the potential challenges that prevent the implementation of IBS in construction industry, and study the CSFs that could support IBS implementation in Yemen.

2. Literature Review

2.1 The Yemeni Construction Industry

In Yemen, construction industry had a unique traditional properties and uniform styles of Yemeni buildings that had existed since centuries. Moreover, the Yemeni construction industry plays an important role towards developing societies and its prosperity, offering several job opportunities, and

distributing wealth among public (Gamil *et al.*, 2020). However, this industry is associated with serious impediments and challenges such as corruption, institutional and administrative weakness, lack of infrastructure requirements, and poor of construction regulations and lows (Sultan, 2013). According to Sultan, & Alaghbari (2017), construction industry had poor development due to the various factors including the current political instability, economic and technical issues that mainly affect the local socio- economic development. Moreover, the large construction projects have many challenges that produced failure to be completed and achieve their plans and objectives (Gamil *et al.*, 2017).

2.2 Definition of IBS

Among the previous literature, there is not exact definition of Industrialized Building System (IBS) due to the lack of a uniform definition that depends on the users' experience and understanding that mainly varied form reign to another (Rashidi & Ibrahim, 2017). According to Zakaria *et al.* (2018), IBS concept could be defined as the prefabrication, precast, off-site construction, modularized construction modern-method construction, and manufacturing aligned process of building methods. While, Construction Industry Development Board Malaysia (CIDB) defined IBS as technique of manufacturing of construction components at a controlled environment, positioned, transported and assembled into a structure with minimal additional site works (Yaman *et al.*, 2019)..

2.3 Global Presence of IBS

The implementation of IBS in each construction industry around the world has an effective positive perceptions in terms of providing an improvement on the overall practice of the construction industry (Kasim *et al.*, 2019). According to Ismail *et al.*, (2019), in several developing countries, IBS have become a popular in the construction industry due to the benefits obtained within IBS' applications in construction projects. In Oman, IBS has a lack of evidence on IBS contributions in construction industry where it is not yet at the top of stakeholders' agenda which is recommended for more promote and improve of its applications. While, in Malaysian construction had influenced by lack of awareness and knowledge and its usage is still low among professionals such as client, consultant and contractor (Ismail et al, 2019). The proportion of IBS buildings was approximately 5% in China, 75% in Europe, 80% in US, and 70% in Sweden and Japan (Gan *et al.*, 2017)

2.4 Benefits of IBS

(a) Reduce Construction Period

IBS implementation in construction industry plays main role in reducing the construction process period. According to Ismail *et al.* (2019), one of most significant benefit that can be derived from implementing IBS is a repetitive system that enhance a completion of project to become faster. Using IBS in construction projects save time due to its prefabrication works that carried out off site and only required to perform the installation at site (Ariffin *et al.*, 2019),

(b) Increase Project Quality

IBS prefabricated components have a great quality comparing with conventional method due to standardized quality considerations in terms of materials selections, manufacturing under controlled environment, and inspection prior transported to site (Saggaf, 2017). IBS enables less intensity of labour and construction standardization since IBS enables on-site prefabrication or pre-cast building components manufactured at factories (Adnan *et al.*, 2019).

(c) Reduce Overall Costs

By implementing IBS for producing prefabricated elements lead to reduce the need of unskilled workers which resulted into reduce the costs of the construction (Saggaf, 2017). In terms of productivity improvement, the implementation of IBS technique had been increased as the appropriate approach for increasing the current productivity of the construction outputs (Ismail *et al.*, 2019).

(d) Reduced Construction Wastes

IBS offers greater benefits than traditional construction method such as applying of less formwork on site, and reduces the wastes that could be produced firm construction material and consequently reduce pollution to environment (Rahim & Qureshi 2018). IBS has been advanced by built environment practitioners and researchers for promoting sustainable environment, improving construction process, productivity and waste reduction (Nduka *et al.*, 2019).

(e) Flexibility of Design

The flexibility of design of IBS products lead to increase the market demands, and the design process at factory should be well supervised to produce a good product (Ismail *et al.*, 2018). While, Kasperzyk *et al.* (2017) pointed out that design flexibility of IBS production practice could be increased by developing a new approach of an automated re-prefabrication system that introduces a robotics-based prefabrication system. Also, industry had been improved and promoting for uptakes of the IBS due to its effective benefits that could be obtained by IBS such as scaling, adapting to changing demand, and flexibility of designing (Abd Rashid *et al.*, 2018).

2.5 Challenges of IBS Implementation

(a) Lack of Awareness

It had mainly suggested that awareness to innovative procurement approaches in IBS project is important for change to take place in the current construction methods (Ariffin *et al.*, 2019). The effects of lacking awareness of IBS implementing and benefits had supported by Baharuddin *et al.* (2016), one of the most significant challenges to adoption of IBS in construction industry is a lack of knowledge and awareness. Thus, there is an urgent need for change people mindset regarding IBS through promotion, awareness programs, and education (Jabar *et al.*, 2018).

(b) Lack of Standards

It had recommended a need for standardization efforts of components as long-term strategic initiatives are required to drive the creation and adoption of IBS standards (Xie *et al.*, 2016). The implementation of IBS is surely low sue to the approving authorities reluctant to change to use IBS because there are no proper guidelines in term of contractual matters (standard form of contract) (Fateh *et al.*, 2017).

(c) Poor Readiness

In terms of lack of construction industry players' readiness, El-Abidi *et al.* (2019) had referenced that consultants and designers were hesitant to implement IBS at their projects due to a wide range of issues including a lack of readiness in terms of knowledge, skills, technology, or experience.

(d) Cost Related Issues

The preparation of IBS is faced a cost issues related to factories setting up that had enforced contractors to consider an extra cost for IBS factories installation and production process requirement included new equipment, machinery, technology and training for the manpower (Kasim *et al.*, 2019)

(e) Lack of Government Interest

Based on the lack of the government supports and concerns towards IBS adoption, Zakari *et al.* (2017) had found that most of construction industry practices performed by the traditional cast on site method. While the implementation of IBS is still in early stage of adoption due to the lack of government interest, insufficient IBS manufacturers, and unfamiliarity and resistance to change by the industry players.

2.6 CSFs for Improving IBS Implementation

(a) Improving the Educational Curriculum

Based on consultant's perspectives, a critical strategy had suggested for enhancing the implementing of IBS which was related to the government supports in terms of increasing the facilities and incentives

for expanding the research and development on IBS (Ali et al, 2018). Education and knowledge of IBS is vital solution to critically overcome the challenges of IBS implementation (Yunus *et al.*, 2017). Also, training and education were identified as one of most CSFs that are need to be considered by industry in order to ensure success IBS implementation (Zin *et al.*, 2020).

(b) Awareness

People awareness is another factor that affects IBS decision-making based on culture, personality, support and values. The basic underlying principle is people abilities to recognize any matter, issue, object, problem or solution by the same, or different, means (Zakaria *et al.*, 2018).

(c) Adopting of Intensive Training

There is a necessity of intensive and sufficient training programs that could be achieved among cooperation among technical institutions and recommended guidelines for enhancing labor skills who are required in the site and factory for overcoming the labor shortages (Yunus *et al.*, 2020). For IBS implementation technique in construction projects, there must be dedicated training programs for both management and technical staff who have adopted goal of IBS initiatives (Nduka *et al.*, 2019)

(d) Effective Management

Management approach plays main role in ensuring the successful delivery of a construction project through adopting of an appropriate processes, planning, goal setting, strategy development and leadership, influences the decisions on IBS adoption (Zakaria et al, 2018). Management processes involving various activities that should preform effectively including organizing, controlling, evaluating and forecasting, impact the IBS adoption decisions.

(e) Demand and Supply

Construction industry players had suggested various recommendations towards enhance IBS practices and applications by improve higher educational facilities, conducting a training programs for skills improvement, governmental initiatives and supports for using IBS, encourage industry players, verify material sources, and establishing a new form for IBS contracted projects (Ismail *et al.*, 2019),

3. Research Methodology

3.1 Research Approach

For this study a quantitative research approach had been used through designing and developing an online based survey mainly related to the benefits of IBS, issues that prevent the successful implementation of IBS, and the CSFs that can support IBS implementation in Yemen.

3.2 Population and Sampling

The total population is indicated to total number of respondents who has the efficiency to respond study survey based on selection criteria and requirements as knowledge, professionalisms and current participates of using IBS. They should share and meet common sets of characteristics to obtain different data varied based on various suggestions, and thoughts of same background professionals. The population sampling was mainly based on the sampling frame and design. The sampling frame is related to the selected population for this study as the contractors from different categories and classifications, while, sampling design had derived from target population that had reduced by selecting contractors at the capital city. According to Federal Yemen press report issued on 14th of January 2020, more than 250 contractors' firms from different categories and classifications who are actively conducting their operations in Sana'a. Thus, by referring to a justification of Krejcie & Morgan, (1970), the sample size for population of 250 is 152. For this study, a random distribution method through various online platforms to reach a wider respond. The randomly distribution were choose due to time constraints and for minimizing sampling error since samples meet the requirement characteristics of study population. Among the target size of respondents, only 49 contractors had responded to the study survey with a complete answer of its questions.

3.3 Data Collection

Two different types of data gathered in this study, secondary data gathered throughout reviewing different sources such as articles, journals, books, conference papers, researches, and websites. While, primary data had collected directly by the survey that distributed among respondents (contractors)

3.4 Data Analysis

Primary data compiled and analyzed using IBM Statistical Package for Social Science SPSS version 26.0. The percentage, frequency and means score value were used to analyze primary data.

4. Results and Discussion

Primary data of the three objectives has been analyzed by ranking them from highest average mean index to the lowest based on the 5 Likert scale categories as shown in Table 1. According to Lee *et al.*, (2018), the mean of the study analysis had been measured by implementing the formula 1 and the average index ranges had used for analyzing and classifying participates responses of several frequencies as shown in Table 1.

$$Mean = \frac{\sum_{i=1}^{5} \text{Weight of ranked position}_1 x Frequency\ of\ respons_i}{\sum_{i=1}^{5} Frequency\ of\ respons_i} \quad 1$$

Table 1: Average Index Scale (Lee *et al.*, (2018)

Range	Average Index	Weightage
Strongly Disagree	1.0 ≤ Average Index < 1.5	1
Disagree	1.5 ≤ Average Index < 2.5	2
Natural	2.5 ≤ Average Index < 3.5	3
Agree	3.5 ≤ Average Index < 4.5	4
Strongly Agree	4.5 ≤ Average Index < 5.0	5

Additionally, every items in the survey has been further analyzed using frequency and percentage to give a whole picture of data collected. Additionally, Furthermore, the analyzed results and findings were discussed in terms of using Pie charts, diagrams, tables, and compared with secondary data findings for evaluating level of accuracy and effectiveness of the study findings.

4.1 Completed Received Responses

Furthermore, collection period had lasted for more than a month and few days (11th of November to 25th of December, 2021). Therefore, this study had completely received only forty nine (49) responses that have used for establishing this research objectives with a response rate of 32.23% which is a valid rate for online survey as had indicated by Saldivar, (2012) that the average response rate for the online survey is 30%.

4.2 Reliability Test

The Reliability Test is mainly used to measure the quality of questionnaire collected data whether data is a reliable or unreliable for conducting and producing a proper findings with more accuracy. According to Zikmund *et al.*, (2010), the Cronbach's Alpha rate and the level of reliability is ranged between (0.95) that indicates to the very good reliability and (0) of poor reliability as illustrated in Table 2. For this study, Cronbach's Alpha had achieve by using SPSS for 30 Likert-Scales items that related

to the three objectives. By reliability analyzing, Cronbach's Alpha was found as 0.942 (Very good reliability).

Table 2: Cronbach's Coefficient Alpha (Zikmund *et al.*, 2010)

Level of Reliability	Coefficient Alpha Rate
Very Good	$\alpha = 0.80\text{-}0.95$
Good	$\alpha = 0.70\text{-}0.80$
Fair	$\alpha = 0.60\text{-}0.70$
Poor	$\alpha = < 0.60$

4.3 Respondents' backgrounds

SPSS was used to analysis respondents' background by determining of frequency and percentage for eight characteristics had involved as shown in Table 3.

Table 3: Respondents' Background

Characteristics	Item	Frequency	Percent
Highest qualification	PhD	4	8.20%
	Master Degree	11	22.40%
	First Degree	25	51.00%
	Other	9	18.40%
Profession	Project Manager	10	20.40%
	Architect	8	16.30%
	Civil Engineer	23	46.90%
	Draftsmen	4	8.20%
	Other	4	8.20%
Company Sector	Public sector	11	22.40%
	Private sector	22	44.90%
	Multi-sector	16	32.70%
Years of experiences	Less than 5 Years	6	12.20%
	6 – 10 Years	19	38.80%
	11 – 15 Years	9	18.40%
	More than 15 Years	15	30.60%
Awareness level of IBS	Not Good	4	8.20%
	Good	24	49.00%
	Very Good	21	42.90%
Degree of industrialization	Prefabrication	42	85.70%
	Mechanization	6	12.20%
	Automation	1	2.00%
No. of IBS projects	Less than 3 Projects	13	26.50%
	4 - 6 Projects	8	16.30%
	7 - 9 Projects	13	26.50%
	More than 9 Projects	15	30.60%
Difficulty level of using IBS	Less difficult	20	40.80%
	Moderate difficult	27	55.10%
	Very difficult	2	4.10%

4.4 IBS Benefits

IBS benefits were analyzed and ranked based on the average mean index as shown in table 2. The highest ranking was obtained for both benefits included produces high quality products and reduce many unskilled workers with the mean score value is 4.33. Additionally, by referring to the average mean index in Table 4, main of these two benefits had score a value between of 3.50 and 4.50, which

is mainly indicates to the agree category. On other words, the mean of 4.33 indicated that most of respondents had positively agreeing of IBS benefits in terms of producing of high quality products and reducing many unskilled workers.

Table 4: Analysis of IBS Benefits

Category	IBS Benefits	R	Mean	Std.D	Variance
Reduce time	Projects become more faster.	**3**	4.29	.791	.625
	By offsite prefabrication works.	**4**	4.27	.730	.532
Quality improvement	Produces high quality products.	**1**	4.33	.718	.516
	Controlled by varied quality standards.	**3**	4.29	.764	.583
Decrease overall costs	Reduce many unskilled workers	**1**	4.33	.718	.516
	Improve productivity of construction outputs	**7**	4.14	.645	.417
Environment friendly	Less onsite formwork & material	**2**	4.31	.742	.550
	Provide cleaner & neater environment	**5**	4.24	.778	.605
Flexibility of designing IBS products	Increases market demands	**5**	4.24	.693	.480
	Producing an alterable components	**6**	4.22	.771	.594

Among 10 main benefits of IBS that had divided into five categories including 5 main benefits that had been investigated such as time reduction, cost saving, quality improvement, enhance environment friendly concept, and provide an effective flexibility of design. Additionally, every category had consisted of two statements questions based on the secondary data of the literature review. Based on analysis results of IBS benefits, the means of all items had been asked were varied from a highest mean (4.33) to lowest (4.14). These values were placed in mean range index of agree that had defined as the average between 3.5 and 4.5.

For more details, the first category "Reducing Time), majority of respondents had agreed that based on time reduction, using IBS as an alternative construction method instead of traditional methods could play main role in terms of the IBS projects become more faster than before with a mean value of 4.29 as the 3rd effective benefit of implementing IBS. While the second statement "IBS saves time by using off-site prefabrication works" which had agreed by most of participates with a mean value of 4.27 and ranked as the 4th important IBS benefit. By comparing the findings on this benefits with a secondary data, most of literatures that concern about the benefits of IBS projects can reduce project overall time. According to Ismail *et al.* (2019), IBS as a repetitive system can enhance a completion of project to become more faster. Additionally, Ariffin *et al.* (2019) supported that by IBS save time due to its prefabrication works that carried out off site and require to be installed only.

In terms of improving the quality of its projects, this category had two statements including IBS produces high quality products and various quality standards to control production of IBS component. Thus, IBS produces high quality products had been agreed by most of respondents (4.33) and ranked as 1st essential benefit of IBS implementation. While, the second statement had ranked as the 3rd IBS benefit with a mean value of 4.29. As previously mentioned in 2nd chapter, IBS produce a highly quality products was discussed in various recent studies including the study of Saggaf, (2017) who indicated that prefabricated components produced by IBS have great quality comparing with conventional method due to various standardized quality considerations in terms of materials selections, manufacturing under controlled environment, and inspection prior transported to the site.

For discussing IBS benefit of reducing the products costs, based on the study analysis results in terms of reducing many unskilled workers was an highly important benefit of using IBS that had ranked as 1st with a mean value of 4.33. Additionally, improving the productivity of construction outputs was the lowest influenced benefit that had been agreed by some respondents with a mean value of 4.14 as the 7th benefit of IBS. By a clear comparison with data in literature review, Saggaf, (2017) who reach to the same findings of this study that the discussed IBS adoption can produce a prefabricated elements

lead to reduce need of unskilled workers and resulted into reducing costs. While, implementing of IBS technique increase current productivity of construction outputs (Ismail *et al.,* 2019).

Moreover, IBS is considered as the environment friendly that had been confirmed by checking the respondents' suggestions in terms of IBS effectiveness on consuming less of onsite frameworks and material and providing a clear and neater environment. Both had been agreed with a mean (4.31 and 4.24) as the 2nd and 5th main benefits of using IBS. By comparing with literature review data, Adnan *et al.* (2019) had indicated that the construction industry could gained several benefits by using IBS approach such as minimal wastage, less site materials used, and cleaner and neater environment. Also, Nduka *et al.* (2019) had indicated that IBS is promoting sustainable environment concept and improving construction process, productivity, and waste reduction.

The final category of IBS benefits included that implementation of IBS provides a chances of having various designs of different products that had considered as alterable components. Based on the results of data analyzing among this study, flexibility of designing various products was considered as less effective benefit of using IBS. For more ensuring, Ismail *et al.* (2018) had pointed out that the products of this system could improve the construction industry by a highly design flexibility that lead to increase current market demands. Additionally, Abd Rashid *et al.* (2018) mentioned that construction industry is improving and promoting for uptakes of IBS due to its effectiveness on adopting various scaling, adapting to changing demand, and flexibility of designing.

4.5 IBS Challenges

Among the analysis process, it was found that the potential challenges of the IBS adoption were ranked gradually from the highest mean of strongly agree with a value of 4.53 to the lowest agree responding with mean average index of 4.16 as shown in Table 5 that consisted of 5 critical challenges categories impact IBS implementation.

Table 5: Analysis of IBS Challenges

Category	IBS Challenges	R	Mean	Std.D	Variance
Lack of Awareness	Unavailability of educational courses focus on IBS.	**1**	4.53	.581	.338
	Lack of knowledge and awareness.	**3**	4.35	.663	.440
Lack of Standards	Lack of technical guidelines.	**2**	4.39	.606	.367
	Improper guidelines of contractual matters.	**6**	4.22	.587	.344
Poor Readiness	Industry players' hesitation to use IBS.	**5**	4.24	.751	.564
	People highly resistance to change traditional method.	**7**	4.18	.755	.570
Cost Related Issues	High costs of setting up IBS' factories.	**8**	4.16	.657	.431
	IBS requires new equipment, machineries, technologies and manpower trainings.	**5**	4.24	.723	.522
Lack of Government Supports	Lack of government interests.	**8**	4.16	.688	.473
	Authorities' reluctant to change.	**4**	4.33	.591	.349

For this part, 10 challenges were identified among the deep literature review had conducted for this study. The highest rank among the IBS challenges was a lack of awareness in terms of unavailability of educational courses that focus on IBS adoption. This challenge is the 1st rank with the mean value of 4.53 that indicated to the strongly agree of responding. The other statement in this section was related to the lack of knowledge and awareness of many construction industry players and customers which had ranked as the 3rd main challenge of IBS implementation in Yemen with a mean value of 4.35. Respondents have agreed that lack of awareness is a critical issue for implementing IBS that can lead to improve the current poor construction industry development in Yemen.

By comparing this challenge effects on adoption of IBS among the secondary data of this report, Baharuddin *et al.* (2016) had indicated that one of the most significant challenges on adoption of IBS

in construction industry is lack of knowledge and awareness. Thus, there is an urgent need for change people mindset regarding IBS through promotion, awareness programs, and education (Jabar *et al.*, 2018). While, Ariffin *et al.* (2019) had suggested that awareness to innovative procurement approaches in IBS project is an important for change to take a place in the current construction methods.

Furthermore, the second challenge was lack of related standards in terms of the poor technical guidelines of how to properly implement IBS as important challenge that had ranked in the second influenced of IBS implementation. This challenge had mainly supported by previous studies included the recommendation by Xie e*t al.* (2016) to a need for standardization efforts of components as long-term strategic initiatives are required to drive the creation and adoption of IBS standards. In addition, Akmam *et al*. (2018) had pointed out that both government and industry stakeholders has to increase the uniformity and offer the demand for consistent building standards and codes and universal harmonization of project requirements for IBS technology adoption.

In addition to that, third challenge was related to "poor readiness" of industry players and consumers. It had investigated that IBS adoption is a moderate influenced by hesitation of industry players to use IBS that had ranked as 5th challenges of using IBS with a mean of 4.24. Also, in terms of poor readiness challenge, the highly resistance to change the traditional method by their consumers had analyzed to be 7th related challenge toward IBS implementation in Yemeni construction industry with a mean of 4.18. El-Abidi *et al.* (2019) indicated to a consultants and designers were hesitant to implement IBS at their projects due to a wide range of issues including lack of readiness in terms of knowledge, skills, technology, or experience. Thus, this is required a corporation of human resources management to improve overall organizational' readiness for implementing IBS.

Beside the pervious IBS challenges, the cost related issues were considered as a main challenge toward this system implementation for improving the poor construction industry development in Yemen. To investigate the impacts of these issues, some statement were asked to the respondents including a requirement of high costs for setting up specialized factories which had agreed by 27 and strongly agreed by 15 among the involved 49 participants. Additionally, the statement of "IBS requires new equipment, machineries, technologies and manpower trainings" which mainly indicate to high budget required. Those requirements had a moderate effects on IBS implementation in Yemen which had agreed by a mean of 4.24. Thus, by comparing this challenge with previous studies, Kasim *et al.*, (2019) pointed out that preparation of IBS is obstacle by cost problems such as enforcement of contractors to consider an extra costs for IBS factories setting up, production process requirement included new equipment, machinery, technology and training for the manpower.

Finally, it was an important to understand the effects of government and related authorities efforts towards the IBS implementation. The impacts of "lack of government interests" had agreed by respondents as the 8th IBS challenge with mean value of 4.16. Also, "Authorities' reluctant to change conventional method" influence on IBS adoption process was agreed by participates as 4th ranked challenge with a mean of 4.33. Among secondary data, IBS use is still in early stage of adoption due to lack of government interest, insufficient IBS manufacturers, and unfamiliarity and resistance to change by industry players.

4.6 CSFs of IBS Implementation

The findings of third objective analyzing results had obtained through SPSS analysis process for investigation the critical success factors that mightily enhance the adoption of IBS for the construction industry in Yemen. Additionally, it had found that the CSFS of implementing IBS were ranked gradually from highest mean of agree responding with a value of 4.49 to the lowest mean average index of 4.12 that was related to mean average index of agree responding as shown in Table 6 that consisted of 5 main categories of the critical success factors that hopefully enhance the implementation of IBS in Yemen.

Table 6: CSFs of Using IBS

Category	CSFs of Using IBS	R	Mean	Std.D	Variance
Clear guidelines	Expanding & developing researches on IBS.	**6**	4.16	.717	.514

	Improving educational facilities & incentives.	**1**	4.49	.681	.463
Enhance knowledge & awareness	For IBS benefits & effectiveness	**5**	4.24	.693	.480
	Improve skilled involved in IBS adoption.	**4**	4.29	.736	.542
Intensive trainings	Among cooperation & technical institutions.	**7**	4.12	.564	.318
	For both management & technical staff.	**5**	4.24	.693	.480
Planning, controlling, & financial capability	A comprehensive cost estimates for taking proper decisions.	**6**	4.16	.688	.473
	Supply chain system to conduct & control adoption process.	**2**	4.43	.707	.500
Encourage & Promote IBS Implementation	Governmental initiatives, strategies & supports.	**3**	4.37	.636	.404
	Effective coordination among industry parties.	**6**	4.16	.717	.514

From data analysis results, it is found that majority of contractors showed positive responses towards investigating the CSFs for proper implementation of IBS based on their suggestions, recommendation, different opinions and various points of views. Thus, key related factors for improving the adoption process of IBS for the construction industry in Yemen to improve the currently poor development of construction projects in Yemen were suggested by the involved respondents. Among all presented factors that had been agreed by the participates, the first five CSFs rankings were related to improving the educational facilities as the first ranked CSFs of IBS implementing IBS with average mean index with a value of 4.49, while the second ranked CSFs was adoption of Supply Chain System with an average mean index of 4.43. At the third and fourth ranking CSFs were Governmental initiatives, strategies & supports and Improve skilled involved in IBS adoption with an average mean index of 4.37 and 4.29 respectively. The fifth ranking was covered to CSFs which are Intensive trainings for both management & technical staff and Enhance knowledge & awareness on IBS benefits & effectiveness with an average mean index of 4.24.

4.7 Framework of CSF for IBS implementation in Yemen Construction Industry

In this study, the dependent and independent variables were defined as shown in Figure 1 that related to the IBS implementation, CSFs for implementing IBS and the challenges associated with IBS implementation for the Yemeni construction industry. An independent variables including IBS challenges, while the dependent variable is IBS implementation, while CSFs is the moderate factors that enhance the adoption process as showing in Figure 1.

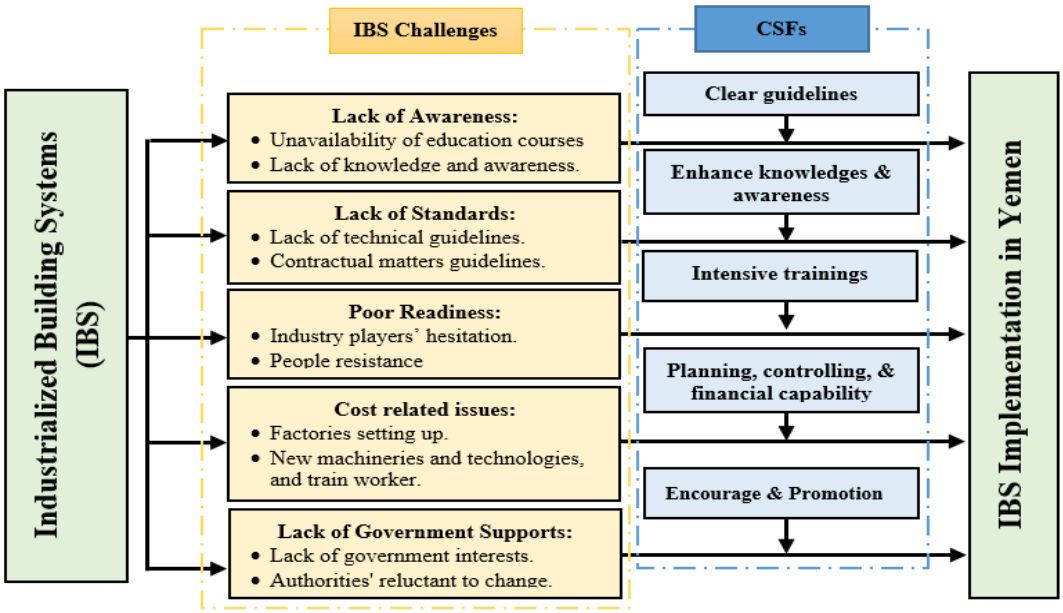

Figure 1: Conceptual Framework of CSF for IBS implementation

5. Conclusion

Through the entire process of conducting this research, the final outcomes could be conclude and summarized in this section. The study had involved a key construction industry players (contractors) who have a main role in improving the current situation of the poor construction industry development and increase its productivity by attempts of applying modern technologies and effective methods. The majority of the professional contractors have an appropriate level of information, knowledge, and awareness of the IBS effectiveness and implementation for the construction filed. Furthermore, this study had identified some IBS benefits based on the secondary data and investigated among the involved respondents. A clear agree responding had obtained in terms of the benefits of IBS towards enhancing and developing the construction industry and improve its current poor situation based on the time, cost, and quality and increase its productivity. However, some challenges of IBS implementation in construction industry in Yemen had investigated. The findings showed that these challenges have an effective impacts on preventing IBS implementation by the majority of construction firms. Moreover, studied CSFs are aiming to guide construction firms towards a successful implementation of IBS. But, a proper considerations and cooperation among private and public sectors, government and related authorities in terms of the involved CSFs for a successful IBS implementation process.

5.1 Recommendation and limitation

During conducting this research, some limitation could be briefly explained as a difficulties of reviewing sufficient secondary data due to the lack of studies focused on IBS implementation in Yemeni construction industry. Additionally, reaching a sufficient number of contractors was another difficulty due to absence of related IBS body that can determine registered groups specialized on adopting IBS. Moreover, in terms of selected participates, there was a lack of cooperation and poor participation for the survey by majority of respondents excepting 49 out of 250. Thus, some suggestions could be recommended to future researchers for more supports of current findings and gain clear image of level use of IBS, benefits, challenges, and effectiveness for construction industry in Yemen including:

- Conducting a future study through using a mix mode including a quantitative and qualitative research approaches in order to go deeper into producing a comprehensive framework of proper implementing IBS in Yemen.
- Future study with expanding the scope that cover different parts of the country and more professionals in terms of achieving adequate information and proper understanding based on varied firms, suggestions, points of views and more professional with different backgrounds.

- It is recommended that future research can carry out a research on other developing country with same construction industry situation and make a comparison in terms of the IBS challenges and CSFs of proper IBS implementation.

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