Contextual Factors in the Decision Making of Industrialized Building System Technology

S. A. S. Zakaria, G. Brewer, T. Gajendran

Abstract—Currently, the Malaysian construction industry is focusing on transforming construction processes from conventional building methods to the Industrialized Building System (IBS). Still, research on the decision making of IBS technology adoption with the influence of contextual factors is scarce. The purpose of this paper is to explore how contextual factors influence the IBS decision making in building projects which is perceived by those involved in construction industry namely construction stakeholders and IBS supply chain members. Theoretical background, theoretical frameworks and literatures which identify possible contextual factors that influence decision making towards IBS technology adoption are presented. This paper also discusses the importance of contextual factors in IBS decision making, highlighting some possible crossover benefits and making some suggestions as to how these can be utilized. Conclusions are drawn and recommendations are made with respect to the perception of socio-economic, IBS policy and IBS technology associated with building projects.

Keywords—decision making, technology adoptions, contextual factors, Industrialized Building Systems

I. Introduction

ENVIROMENTAL factor can be regarded as a perceptual-cognitive phenomenon as seen by decision makers because it influences decision making that is linked with a degree of uncertainty [1]. Thus, in deciding on Industrialized Building System (IBS) technology adoption, it is also important to understand contextual factors in construction environment. IBS is a construction technique in which components are manufactured in a controlled environment, on or off site, transported, positioned, and assembled into a structure with minimal additional site work [2]. IBS is also known as an off-site manufacturing in construction industry. IBS technology is the mass factory-produced building components off-site, then they are properly assembled, and joined on-site to form the final units [3]. Contextual factors are defined as dynamic forces constituted in the user groups' social, cultural, economic, political, technological, and institutional environment [4].

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The focus of this study was on the decision making of IBS technology adoption in construction industry which should be considered as part of the broader topic of technology management.

In this study, IBS technology decision is considered as human responses to the direct and indirect effects of new building technology and unpredictability for the purpose of lessening negative consequences or enhancing beneficial consequences and it presents a series of unique challenges for decision makers in construction industry. In decision science, technology adoption decision involves inter-firm coordination, interplay reaction across individuals in different stakeholders group and interventions based on contemporary research problem and multidisciplinary work with the consideration of technology outcomes, environmental factors, feelings, reactions, and personality characteristics [5]. However, the perception of decision makers pertaining environmental factors on the decision making of IBS technology adoption is uncertain in the literature, thus represents the research disparity that is being explored in this study.

In order to direct this investigation, the foundation of this study is driven by a number of models and frameworks that have been developed. Malaysian construction industry lacks a theory of how individuals or firms come to adopt IBS technology in construction activities [6]. Moreover, it is vital to understand the actions and conduct of decision makers in the context of social and economic phenomena due to the adoption of Industrialized Building Systems (IBS) technology that has been relatively slow in Malaysia [7]. This view persisted when the Malaysian construction industry has been implementing the adoption of IBS technology in building construction. The purpose of this study was to clarify the nature of contextual aspects in the decision making of IBS technology adoption, besides to outline contextual factors and reasoning associated with this type of decision. This paper is also based on an attempt to establish a conceptual framework for IBS decision making in construction industry and to determine the influence of contextual factors on IBS decision making. A broadly stated proposition was defined to guide this study to focus this paper and help in guiding the discussion: IBS decision making is associated with drivers and barriers related predominantly to external environment such as a) political factors like government policy, b) economic conditions like financial matters, c) social factors like skilled workers, and d) technology factors like research, development, and innovation.

II. Decision Making Process And IBS Technology Adoption

There has also been a change in housing construction technology from the conventional system to a wider application of an industrialized building system as the concept of industrialization of the construction industry in Malaysia has been strongly supported by the federal and state governments [8]. Thus, IBS decision should provide for a response to new information as the construction technology unfolds. The unfolding will often occur over a long time scale, a requirement that particularly demands creativity in dealing with the economical and technological context. When IBS technology attributes are positive by nature, they can be still negatively perceived by potential adopters. In the support of earlier completion in building construction projects, IBS is applied for this purpose as the construction process can be finished at a faster rate [9].

In general, according to Kargin and Basoglu [10], technology adoption is based on technology usefulness, users' needs, and requirements, attitudes toward the behavior of technology implementation, diffusion of innovation and relative advantages derived from the way innovation is perceived. Technology decisions are shaped by a set of organizational factors based on one's self-confidence in evaluating technology innovations and the success or failure of technology adoption is based on the need for innovativeness and users' experience as a result of systems control by government and industry policies with system factors such as regulatory, technology culture, and industry trend [11]. In making economic choice, Camerer [12] discovered that decision makers are influenced by market and social factors to rationalize and predict a new phenomenon requires one to understand the environment adaptation in addition to the evolutionary of psychology in decision making in terms of variances in economic behavior such as socialization, cultural adaptations, and individual differences.

Uncertainty is a fact of life in construction projects. Construction projects have many unique features such as long completion period, technological intensity, organizational density and complicated processes in changing environment. Decision making is an important part of controlling in management control process that involves uncertainty about potential solutions and uncertainty in individual and corporate values [13]. There is no best method for problem solving and decision making under these circumstances. In decision making, there is a tendency to track the expected value principle that is to choose the alternative with higher expected value and the risky alternative become less preferred or more aversive based on the integration, restructuring and unitization of events such as experience and the perception of the overall long-run outcome [14].

The current thinking on IBS is that the contractors prefer to choose conventional building system rather than proposing IBS system since the shifting of building system from conventional to IBS is not motivated by cost factors and furthermore, most contractors have been exposed and trained in conventional building system for decades and there is an abundance of cheap foreign workers in Malaysia [15]. However, the risks identified in the IBS construction project could be used as a guide for contractors in making a better and wiser decision when dealing with risk management in the projects that use the industrialized building system [16].

The markets that construction firms operate within will influence their long-term business development as each sector can have unique characteristics and managers need to consider how they are going to take decisions in the short, medium, and long term, along with the need to think strategically [17]. Firms within the construction industry have to be reactive, responsive, and decisive with portfolio management as a facilitator that aids the decision making process which provides a useful framework in which to plan an approach to the market, which takes account of both the market's needs and the firm or business skills and core competencies [18]. New technologies may complement experience and be adopted first by experienced workers [19]. However, Philip [20] proposed that when established demand for a product exists and new technology are both necessary and available, priorities are formed in an effort to justify the adoption decision additional to the total effects of the relationship between the beliefs of adoption and attitude toward adopting the new technology also performs differently in certain environments when demand in uncertain.

Technology usage decisions are more strongly influenced by attitude toward using the technology with continuous learning to see whether organizational philosophy and culture with respect to training can overcome some of the barriers to technology adoption [21]. Technology adoption starts with a state of the uncertainty of new technologies and is dependent upon the extent to which the adopters finds it personally meaningful and relevant with psychological process based on the interaction between cognitive (thoughts) and affective (feelings) towards the meaning of new technology [22]. Thus, the implementation of new technology should consider the factors that are likely to lead to sustained usage, traditional productivity-oriented factors, social factors and facilitating conditions [23]. Technology adoption decisions include explanatory variables such as attitudes and subjective norms to encourage changes in beliefs and evaluations to achieve full technology compliance and conserving behavior from the perspective of the minimal justification principle in social psychology [24]. Therefore, judgment should be understood within a framework where individual judgments, actions, and environment cannot be considered independently of one another as there is mutual influence between them [25] as represented by Fig.1.

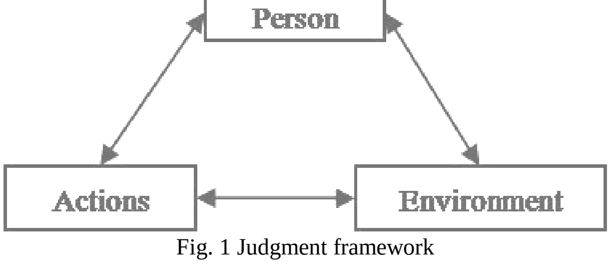

Fig. 1 Judgment framework

Thus, understanding the nature of decision making has been indirectly recognized as a vital component of IBS technology adoption [26], in which construction stakeholders should decide on building technology based matters. In order for these changes to come about, Gomez [27] suggested that less emphasis should be placed on managing isolated facts and concepts, but more emphasis should be placed on extensive and overarching themes including contextual matters and their nature, besides the technology concerns themselves.

III. Contextual Factors And IBS Decision Making

The decision making of using modularization technology for construction projects is based on economic aspect as an important factor besides five other influencing factors such as plant location, labor related problems, environmental, and organizational considerations, plant characteristics besides project risks [28]. Only by understanding the underlying drivers of technology implementation and adoption decisions with environmental influences [29], construction firms can effectively deliver appropriate decision making mechanism in technology adoption. Moreover, a person's situational awareness is also critical to the success of a decision process in any dynamic real world [30].

Basically, the role of decision making involve the control of planning and choice in different situations and the concept of IBS decision is also modeled by several disciplines [31]. There are four points of view which sum up important aspects of the problem to make decisions that are: a)the quality of the decision problems concerning on the type and degree of complexity, the span of time and space besides the type and degree of dynamics b)decision making as cognitive processes concerning the ways in which the decision maker mentally cope with the problems of decisions c)the experiences and knowledge of the decision maker based on their experiences and knowledge of the current problem situation, and d)the complexity of the coordinating contextual concerns which consists of decision making command, control and processes [32]. The whole decision making context in a real situation seems to be a function of these four aspects and each aspect depends on the others. Furthermore many real world decisions are of a dynamic nature in dynamic environments [33].

According to Svenson [34] human decision making involves different stages in decision process and psychological theory reveals that decisions are first based on a problem or post-decision as problems appear and solved at different levels withstand the roughness of the future. As a result of the complexity that characterizes the construction sector and the features involved in the adoption of IBS technology, it would be complex to use a broad theoretical framework in comprehending external influences. Therefore, the use of a contextual focus on external influence is separated into different levels. As the basis of this study, a theoretical model with four levels of external influences is devised on the basis of the relations between the macro environments, the construction industry environment, construction projects, construction stakeholders, and IBS supply chain. The schematic model of variables in this study as applied to IBS technology adoption, also shows general relationships between those variables. The proposed model is presented in Fig. 2.

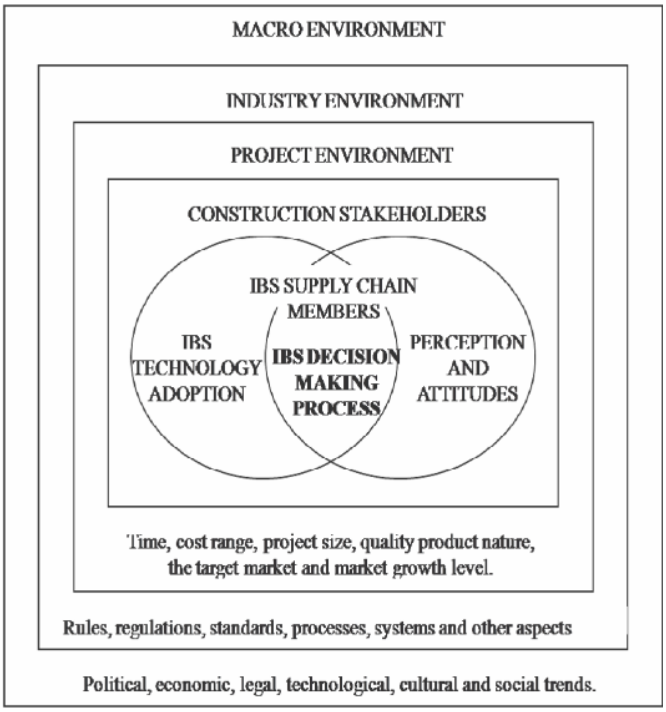

Fig.2 The schematic model of IBS decision making with contextual influences

Fig. 2 describes the elements involve in IBS decision making based on the mapping of contextual elements. According to the model, IBS decision making process has three main aspects namely behavioral dimensions with perception, and attitudes, environmental factors, besides IBS technology adoption itself. Due to the levels of contextual factors that influence decision making, it is likely that influences are not only on IBS technology adoption, but also the decision making process that underlies an individual's or group's perception, attitudes, and believes concerning building technology adoption. Contextual environment can also be described in terms of its level, types, nature, and role responsibilities as presented in Table I.

TABLE I
Nature of Contextual Factors

Level of environment	Types of environment	Nature of environment/ competitive forces	Responsibility for implementation
Level 1	Macro environment	Political, economic, legal, technological, cultural, and social trends	Government: ministries and agencies.
Level 2	Construction industry	Rules, regulations standards, processes, systems	Professional agencies and trade associations

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Level 3	Construction projects	Time, cost range, project size, product nature, the target market, and market growth level	Project team and client
Level 4	Construction stakeholders and supply chain	Risk, values, control, coordination, and performance	Firms in construction industry

Based on the types of contextual factors as stated in Table I, the levels of environment can be explained as follows:

A. Macro Environment

The broadest level is called the macro environment which comprises of political, economic, legal, technological, cultural, and social trends. This is the context that establishes the nature of competitive landscape that indicates to IBS supply chain entities the possible influences of IBS technology adoptions [35]. In making decision, Simon [36] stated that human behavior cannot to be accounted for by assuming perfect adaptation to the environment although decision theories assist in understanding and explaining decision making process. Therefore, the consideration of environment factors is important due to their dynamics and influences on decision making activities and technology adoption in building construction projects.

B. Construction Industry Environment

Subsequently, the environment of construction industry comprises of rules, regulations, standards, processes, systems, standards, and other aspects that are accustomed to construction activities. The nature of construction activity, its structure, its operating systems, and its dynamics are increasing rapidly. Besides the stringent regulations, statutory control, and environmental concern, there are also concerns on building products substitution or building technology. Cheah and Chew [37] mentioned that technology and innovation adoption policy is one of strategic fields in the industrial context of construction industry and with the characteristic of low barriers to entry with a high degree of fragmentation, management decisions have to be responsive to environmental factors such as technical, political, social, and regulatory.

C. Construction Project Environment

Next, the environment of construction projects direct to the identification of construction activities dynamics. The fundamental operating level of the construction industry is construction project which involves building and infrastructure development. Construction industry is a project-based industry. Construction projects also face potential challenges from industry and global trends such the increasing importance of construction technologies that speed up project implementation time, with quality assurance, and cost effectiveness and also the concern of sustainability matters [38]. Other competitive trends such as the entry of new competitors, new forms of competition, merger, and failures of competitors are also of particular importance in projects' environment to ensure projects' sustainable competitive advantage.

D. Construction Stakeholders and Supply Chain Environment

This environment consists of any entity involved in any aspect of the construction process ranging from designers to clients. They are usually contracting firms such as design architect, surveyor, developer, consultant, contractor, project manager, civil engineer, manufacturer, installer, and clients but also include component and material suppliers. Thus, it is more appropriate to consider all firms within the construction industry [39]. Although construction stakeholders appreciate the introduction of IBS in the construction industry but are not as eager to adopt it, thus creating a need for further understanding of stakeholders in the use of IBS that relates to their environment [40]. Therefore, the consideration of contextual environment, from decision making point of view, is the key element at this level.

IV. Framework Of IBS Decision Making And Contextual Factors

This part contains a combination of theoretical ideas, conceptions, and general descriptions on IBS technology adoption from the perspective of decision making and environmental forces. In order to help understanding on IBS technology adoption, it is necessary to observe how IBS strategy fits into a firm and IBS decision making process; and its relationship with other contextual factors in construction environment. Fig. 3 depicts IBS decisions and its transformation process that illustrates the relationship of IBS decision making with IBS business strategy and IBS technology strategy, together with the components and functions of each element, which helps to view IBS decisions in the overall construction industry.

The characteristics of IBS decision making process depends on many factors. Fig. 3 provides a simple model for organizing, understanding, and analyzing these factors. It defines five set of variables:

1) IBS technology foundation, questioning how IBS decisions can be delivered.
2) IBS project strategy, questioning what are required in IBS decision making, with inputs such as needs and supports; and outputs such as infrastructure and services.
3) IBS decision, where is IBS decision making leading to and why, with inputs such as project resources and project foundations; and outputs such as future direction for IBS projects.
4) IBS decision outcomes with the results of IBS project, and
5) Contextual influences towards IBS decision making process which consist of external environment such as political, economic, social, and technology factors.

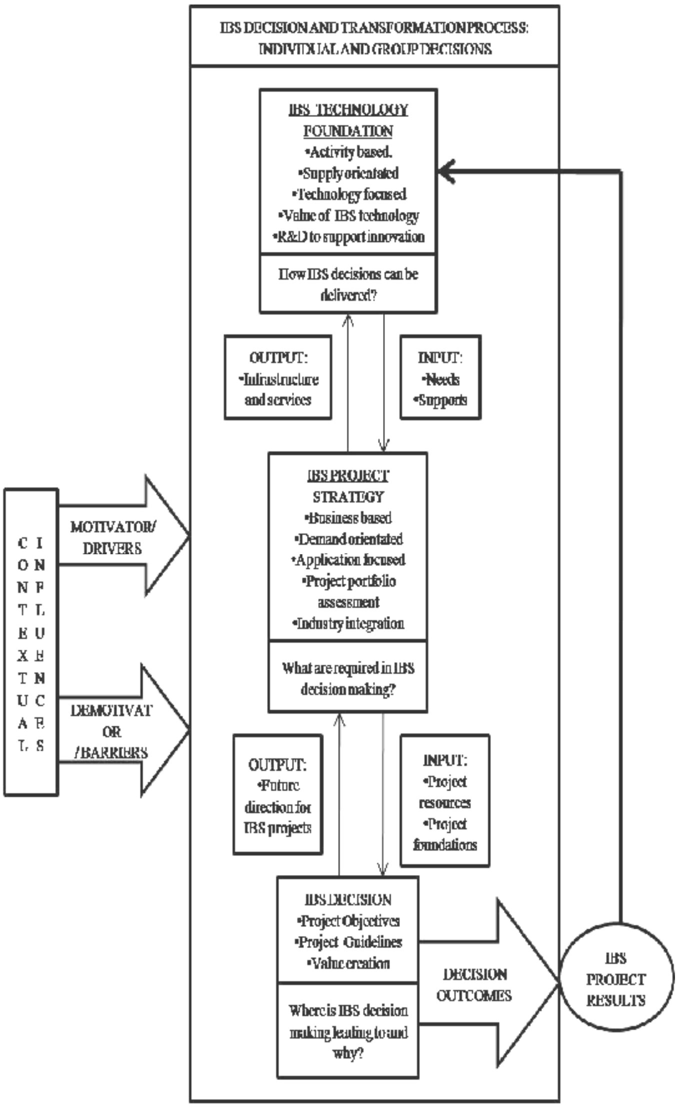

Fig. 3 IBS decision and transformation process

All of these variables are likely to be interrelated in a complex and complicated form. However, Fig. 3 clarifies a clearer understanding to break down the complexity of IBS decision making process and IBS technology adoption which transform decision inputs into specific IBS decision outcomes and project results under the contextual influence of external and internal influences. It can be assumed that both decision makers and construction projects have the same major probability towards technology situation. Moreover, construction project is a multi layered process of reorganizing matter, taking place in a variety of scales, and time frames which is based on concepts, technologies, materials, and economic models resulting from the rise of neo-liberal economy [41]. Convincing stakeholders to adopt building technologies is a an important consideration in the building and construction sector, where the complexity of construction process, the diverse drivers of many entities involved, and the challenges of sustainability requirements are posed to a deeply well-established status quo that come together with dynamics in construction processes and practices [42]. The individual reacts to his or her firm's environment, then to building requirements by considering IBS technology adoption matters which is also determined by his or her own considerations of how he or she perceives about IBS technology adoption matters, then his or her process of deciding whether or not to adopt IBS technology in building projects. Fig. 4 illustrates a model with several variables that are arranged from top to down in order to specify for a particular decision for two types of decision makers namely as an individual and in a group.

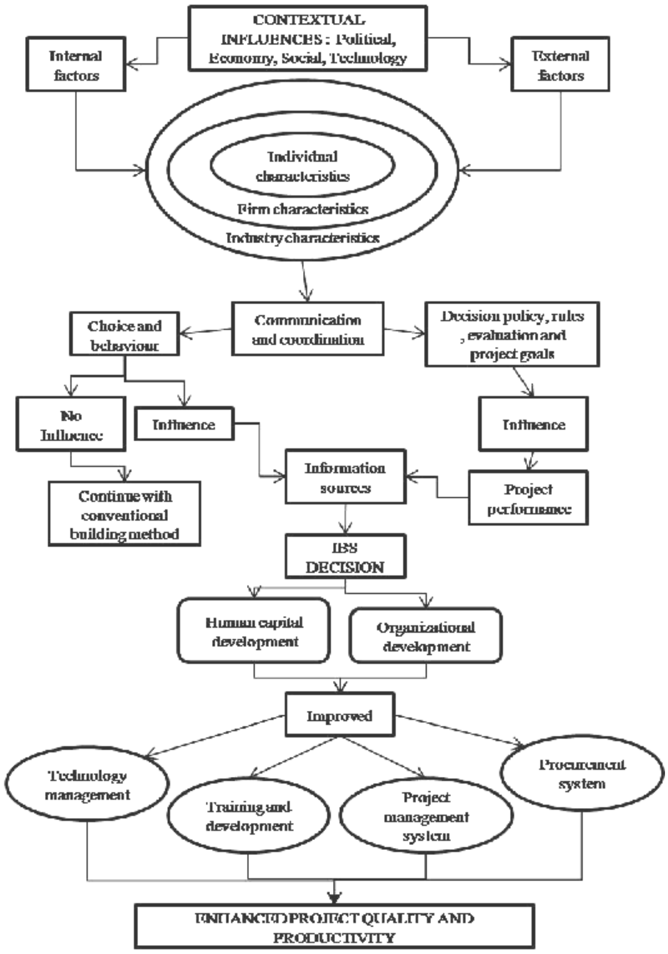

Fig. 4 Inter-actionist model of IBS decision making

The model as illustrated by Fig. 4 proposes an inter-actionist model that recognizes the role of individual, group and situational variables as an integrated approach that seems to hold an undertaking for advancing the understanding of IBS complex occurrence. The proposed interaction model of IBS decision making in construction industry is explained by the relations of individuals in firms or project group members with situational components. Furthermore, Fig. 4 can also provide a framework for studying IBS decision process and characteristics at various phases of a project life cycle. Such investigation has been initiated by the authors [43], [44]. The uncertainty surrounding IBS technology adoption, the importance of decision makers' perceptions and attitudes towards risks, and other contextual items, besides the multifaceted nature of potential IBS responses can make IBS adoption challenging for decision makers.

Decisions made now can have implications that will last for decades, even centuries, and can be costly or impossible to reverse. IBS adoption decisions need to be accounted for current preferences based on the state of project requirements, future uncertainties and relevant business considerations. Attempts to do so via cost benefit analysis for instance, are more on expression of the preferences of those that conduct them than objective science [45]. Moreover, pressures from construction stakeholders or competitions have been found to be an important factor in technology adoption [46].

V. Research Objectives And Methodology

In this study, it is aimed to fill an existing gap in decision practices in IBS technology and to provide a descriptive viewpoint of how decision makers actually deal with IBS technology adoption. This study intends to:

1) Discover the important elements of contextual factors to be considered into the decision making of IBS technology adoption.
2) Determine the perceived contextual factors in IBS decision based on the perception of decision makers, and
3) Identify the comparison of perceived contextual factors between construction stakeholders and IBS supply chain members in IBS decision making.

In order to develop a framework that is compatible to the research objectives, a literature review on the elements and nature of IBS decision making was performed. Based on the review of published literature and previous research, three key dimensions were recognized as being important for this study. The dimensions of policy concern, socio-economic matters and technology considerations which influence the decision making of IBS technology adoption framework are the base of the questionnaire which was designed to determine the perceived contextual factors that influence IBS decision making. As a way to better understand and analyze the feedback gathered from the targeted respondents, three main dimensions were categorized into interrelated variables namely socio-economic, policy, and technology factors. The target questionnaire respondents were focused on two major categories that are construction stakeholders and IBS supply chain members within the Malaysian construction industry based on a purposive sampling. A purposive sampling or judgment sampling involves selecting elements in the sample for a specific purpose as they represent the target population , but they are not necessarily representative [47] .The categorization of these two groups is for the purpose of acquiring comparison in perceived contextual factors influencing IBS decisions between them. In order to obtain perception towards the contextual influences on IBS decision making, 54 respondents were identified in this study constituting 27 respondents for each construction stakeholder and IBS supply chain.

For each group, these respondents include architects, quantity surveyors, contractors, civil engineers, consultants, developers, project managers, and IBS manufacturers. The questionnaires are based on Likert's scale of five ordinal measures of agreement. Ordinal scale 1 to 5 was used in ascending order to show the degree of agreement for the collected data from the questionnaires.

VI. Results And Discussions

In the discussion of the results, percentages given in Table II refer to the proportion of respondents offering their perception on contextual factors in IBS decision making process. The intention of the survey was to reveal areas of concern for the construction industry within the context of socio-economy, IBS policy and IBS technology. It was also to provide evidence of inter-group differences between construction stakeholders and IBS supply chain members.

The survey results as shown in Table II indicate that most of the construction stakeholders and IBS supply chain members perceived and were responsive of the contextual factors of IBS technology adoption.

TABLE II
Perception Of Whether IBS Decision Making Is Influenced By Contextual Factors

Scale	Contextual factors and % of respondents group											
	Socio-Economy				Policy				Technology			
	IBS acceptance by project stake holders.		IBS influences by the potential future projects.		Statutory direction which influence IBS adoption in government projects.		Influence of existing policies governing IBS adoption.		IBS adoption aligned with technology advancement.		Consider -ation of previous projects with IBS adoption.	
	CS	SC	CS	SC	CS	SC	CS	SC	CS	SC	CS	SC
Strongly disagree	0	0	0	0	0	0	7	0	0	4	0	0
Somewhat disagree	7	0	4	7	11	0	44	4	0	0	0	0
Agree	22	33	22	22	30	26	30	30	26	4	11	7
Somewhat agree	52	22	33	26	56	37	7	44	48	44	37	56
Strongly agree	19	44	41	44	4	37	11	22	26	48	52	37

CS = Construction Shareholders,
SC = Supply Chain Members of IBS

They also subsequently perceived contextual factors in construction environment as important for the future growth of the industry. In addition, both construction stakeholders and IBS supply chain members believed that the tendency to replace conventional building method with IBS adoption is based on the increased acceptance by project stakeholders in construction industry.

In the similar case, both construction stakeholders and IBS supply chain members also perceived that their decisions to use IBS in current projects are influenced by the potential of future projects. Consequently, they also perceived that the consideration and influence of socio-economic factors are an important concern in deciding and adopting IBS technology. The recognition of statutory direction that positively influences the adoption of IBS on government projects is an indication of the influence of IBS policy on IBS decision making. However, when it comes to the existing policies governing IBS adoption in IBS decisions, it seems that majority of the construction stakeholders were uncertain whether or not they had considered the influence of IBS existing policies in building projects. This is due to the fact that the practice of conventional building method is still widely used in building projects despite the IBS policy which encourages IBS adoption in the Malaysian construction industry [48]. Moreover, there is a need to re-align the construction industry framework to increase private sector participation as the private sector is promising with huge opportunity and enormous potential for IBS [49]. Therefore, the construction stakeholders were unable to benchmark their perception on IBS performance against the successful IBS building projects based on IBS goals and key performance indicators. Both construction stakeholders and IBS supply chain members agreed that IBS technology adoption will keep the construction industry aligned with technology advancements which is an important determinant for IBS technology decisions. However, when it comes to the consideration of previous projects with IBS adoption in decision making related to IBS, most of the construction stakeholders stated that they had taken into account this consideration. Most of IBS supply chain members were also aware on the importance of considering the performance of previous projects that have adopted IBS technology in building projects. The technology factors emphasize on the features of IBS technology in terms of its viability, constructability [50] and reliability matters by incorporating building performance aspects as well as the prospect to adopt IBS.

From the results, it can be presumed that the concern of contextual factors are likely in practice when deciding on IBS technology decisions, which then implies the construction stakeholders and IBS supply chain members of having a consideration of uncertainties in IBS technology development and adoption. Although IBS or off site manufacturing can contribute to change in the industry, it itself depends on change in order to be widely adopted [51]. The outcome of this study suggests that there are few areas that could be explored for future research and development. The method of survey conducted in this research was specific and prepared for certain targeted respondents. Thus, for future research, a survey combining both personal interviews and questionnaires could be extended to a larger sized target respondent that will give more comprehensive outlook for the immediate and future course of action in IBS decision making. The relevant features for IBS adoption include the importance of considering optimistic assumptions about the future of construction industry [52], taking a multi-disciplinary approach to the identification of building technology options, making small, incremental decisions where information is insufficient and looking at decision making from nontechnical perspectives as well [53]. Thus, IBS decision making also argues that until evaluation is more holistic and value-based rather than cost-based, off-site manufacturing or IBS uptake in construction will be slow [54].

This study has placed a contextual perspective framework and the characteristics of IBS decisions which suggest that decision makers should be guided by a number of contextual principles:

1) IBS technology adoption should be evaluated on a case-by-case or project-by-project basis under different contextual factors. There are no universal rules that apply to all IBS decision responses. Moreover, due to the importance of decision makers' perception and attitude towards contextual factors especially economic items, what is appropriate in one project or a firm might not be appropriate for another. Decision makers should also be alert of the potential for contextual factors to change over time.
2) The responses of IBS adoption are important as overreaction or underestimation can be precious and might lead to greater uncertainty. Timing factor along with cost and quality factors are more likely appropriate when IBS adoption decisions involves project with short lead times, short cost/benefit lifetimes and reversible impacts. Early responses are more likely to be appropriate when the adoption involves projects with long lead times, long cost/benefit lifetimes and irreversible impacts.
3) Government should also support research and information dissemination on IBS technology adoption and its impacts in a more holistic way, ranging from technical development, technology management, managerial approach, and behavioral perspectives. As a base research, managerial research on IBS technology adoption is an essential element in building technology development, but by conducting IBS research from contextual perspectives, decision makers can be provided with an information base for IBS decisions in other projects and facilitates autonomous IBS decision. As building projects progresses, any uncertainty that is spread about the likely implications of IBS responses may adversely affect IBS adoption decisions.

Usually, IBS technology adoption is developed at an individual, firm, project, or national level. This makes it impossible to determine in advance what IBS technology decisions that will be undertaken. Uncertainties in the contextual environment can also result in IBS decision makers pulling in opposite directions, leading to unnecessary losses in short or long term. Thus, additional sources information related to the perception of decision makers is required in dealing with uncertainty and complexity in building projects pertaining IBS technology.

The above discussion generates three dominant features of IBS decisions in this study:

1) The first is uncertainty on how should IBS decision makers respond to contextual factors when all variables in the construction environment of the potentially IBS technology impacts are unknown.

2) The second is that the appropriateness of the IBS responses is often dependent on decision makers perceptions and attitudes towards risks, uncertainty and non-economic or non-market subjects.
3) The third is that IBS technology adoption is multi-dimensional as there are many different types of potential adoption responses with different characteristics, equity, and efficiency implications.

VII. Conclusion

It can be concluded that the influence and consideration of contextual factors in IBS decision making is relatively significant among construction stakeholders and also IBS supply chain members in the Malaysian built environment. At present, the construction stakeholders in particular and IBS supply chain members in general find it difficult to decide on IBS technology adoption in building projects due to the unavailability of benchmarked IBS building projects. There is no doubt that the preference and demand for IBS technology adoption are perceived as 'promising and upcoming' but the decisions and actions of IBS are indecisive because there are also huge considerations on contextual factors that might influence IBS decisions, actions, and implementations. The outcome of the study does reveal the true scenario in the Malaysian construction industry where the understanding of IBS concept is present but the levels of uncertainties on contextual factors are still high which also influence IBS decision making. By considering contextual factors in IBS decision making, this kind of decision principle tool can help clarify nontechnical matters and provide a more practical framework for IBS decision making. Yet, despite its limitations, IBS decision based on contextual factors can still perform as a useful function in the progress and growth of IBS technology adoption. The consideration of contextual factors in IBS decision suggests that decision makers in construction industry should be aware of a number of nontechnical concerns when considering IBS adoption decisions.

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