A Quantitative Method for Ranking the Influence of Competitive Factors on Industrialised Building System (IBS) Decision-making

Sharifah Akmam Syed Zakaria*, Graham Brewer** and Thayaparan Gajendran***

The number of building projects contemplating the integration of modern building methods such as Industrialised Building System (IBS) into their strategic plans and daily operations is continuously increasing. In order to evaluate competitive aspects that will effect IBS decision-making, this paper presents the test results of an IBS decision-making model. The rationality of this study is to explore the applicability of a three dimensional IBS decision model, defined as the symmetrical process, for decision-making within the building projects. This decision model was based on the results of a related qualitative analysis and practice in the area of construction business practices. The resulting IBS decision model is applied to construction stakeholders within a northern region in Malaysia to illustrate its utility as a research transfer strategy. Specifically, this paper presents research evidence using a quantitative method through questionnaire surveys for ranking the influence of competitive factors on IBS decision-making, with attention to the hierarchy of each competitive aspect and outcome measures reported. It is concluded that the significant competitive factors are risks, technology alternative, profit margins and collaboration. It is recommended that the decision model is tested using a greater number of research participants.

1. Introduction

Modern building technologies have been receiving a great consideration from both construction stakeholders and researchers. Correspondingly, multifunctional groups within building projects and construction stakeholders have a role in decisions related to the adoption of modern building technology such as Industrialised Building System (IBS), which is also known as modern method of construction, precast, modular coordination and off-site construction. IBS decisions are one of the latest issues facing construction project with strong internal and external linkages. When building project decisions are to be made, they will necessarily be strategic and usually more complex for this reason, particularly on the adoption of IBS technology. These decisions will have competitive implications for the management of a building project, thus require a specific focus on various competitive aspects (Drew, 2006).

Numerous initiatives have provided incentives for building projects and construction firms to become more sustainable. Some of technology adoptions are mandated, but increasingly construction stakeholders are still uncertain with the competitive aspects of IBS benefits.

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However, in spite of evidence to support use of modern building technologies, they have not been adopted as predicted. Generally, construction stakeholders view many of these IBS projects, which may include building and infrastructure development projects, as possible alternatives for gaining or maintaining a competitive advantage. Therefore, this study aims to answer the following research question: how construction stakeholders perceive the way competitive factors influenced IBS decision-making? Specifically, this study has two major objectives: 1) to explore competitive factors that have influences on IBS decision-making as perceived by the construction stakeholders based on the developed IBS decision-making model and 2) to identify the most significant competitive factors that have influences on IBS decision-making as perceived by the construction stakeholders.

Multiple perspectives research has integrated the efforts of integrating construction stakeholders’ perspectives using qualitative and quantitative methods to investigate the issues relevant to this topic (Dave and Koskela, 2009; Harty et al., 2007; Turskis et al., 2008). Nevertheless, previous studies on IBS decision-making were focusing either on quantitative or qualitative method, rather than the consideration of both methods. This paper focuses on a quantitative test of a dimensional model with competitive influential factors based on a qualitative research findings in IBS decision-making. It highlights various competitive factors in the decision model to address complex issues of adopting IBS technology into widespread building projects. The model is also intended to facilitate discussion around decision-making with respect to adopting current and future IBS technology.

The rest of this paper is organised as follows. Section 2 presents the literature review with descriptions of previous literatures related to the research. Methodology and model of the research are discussed in Section 4, followed by Section 4 that describes the research findings of the quantitative method used in this study with the main technical results. Section 4 also contains some discussion about interesting results that derive from the main technical result with insights on how qualitative results accomplish the research questions and objectives. Lastly, Section 5 provides some final conclusions, knowledge creation, implications and limitations of this research.

2. Literature Review

Research on project decision-making dates back to about several years ago when the focus was on business reengineering (Gibb and Isack, 2003; Sobotka, 2000) and how information and communication technology (ICT) infrastructure helped the processes of project decision-making (Scherer and Schapke, 2011; Vorakulpipat et al., 2010). In terms of decision-making in building projects, the focus has been on project design and performance, including impacts on client needs (Klotz et al., 2010; Thompson and Bank, 2010). Various research have evolved quite a bit with a focus on issues such as building technology decisions (Ortiz et al., 2009; Wang et al., 2009) and investment decision project performance (Qian and Li, 2012; Yang, 2010) but the emphasis has still been on macro issues with little or less focus on IBS decision-making with the consideration of competitive issues.

2.1 IBS Technology Adoption

Nowadays, IBS is the focus of many government and private initiatives to increase the productivity of the building and 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 (Badir et al. 2002). Meanwhile, Sarja (2003) defined IBS as the term given to building technology in which modern systematic methods of design, production planning and control as well as mechanised and automated manufacture are applied. Although numerous works have demonstrated the possible benefits of adopting off-site production to construction projects, yet its uptake has been slow (Blismas et al., 2005).

It is argued that IBS improves the productivity of construction and reduces the amount of site labour involved in building operations (Kadir et al., 2005). The adoption of IBS technology has been relatively slow in Malaysia. Therefore, it is vital to understand the actions and conduct of decision makers in the context of social and economic phenomena. Pan et al. (2004) revealed that barriers to the acceptance of off-site production are centred on human perceptions grounded in the historical failure of off-site practices to deliver improved performance, technical difficulties e.g. site specifics, delivery issues, interfacing problems, cost, lack of opportunities for benefiting from economies of scale, and the fragmented structure of the construction supply chain.

2.2 Decision-Making of Technology Adoption

Technology adoption requires the corporate or senior management of construction firms to analyse the potential of new technology in their business case and make definite decisions of adoption of technologies providing competitive edge to the firm (Langford and Male, 2008). Decision-making in the construction industry involves project strategy as a game plan with industry performance and the properties of competitive aspects, besides making full efforts to reduce the likelihood of making poor decisions and to fully predict the consequences of decision-making performance (Kapliński and Tamošaitienė, 2010).

Meanwhile, Venkatesh et al. (2008) stated that there was often an air of superiority i.e. human over machine that accompanied human successful effort to ignore, delay, refuse, neglect or distance themselves from technological application. According to Sears, et al. (2010), project description is the illustration of the overall project in terms of all decisions which will be made and the project description also refers to a statement of project objectives or expected output which develops into a design specification. When dealing with technology adoption, a decision maker in a building project should be able to overcome any types of problems that customarily arise on any project-limited budgets, tight deadlines, conflicting priorities, and the complexities of defining project priorities (Tam et al., 2007).

2.3 Competitive Factors

The effectiveness of decision-making pertaining technology innovation that is made in building projects is based on a comprehensive project description with the anticipation of competitive pressures (Lim et al., 2010; Salunke et al., 2011). Similarly, the development of project description is made based on project decision-making which later enable each project members to determine not only their roles and responsibilities but enable them to identify what other competitive threats at each stage of the project lifecycle (Fewings, 2013). While each stage requires different expertise, Naaranoja et al. (2007) highlighted that it usually includes both technical and managerial activities in the knowledge and skill area of the decision makers. The client for example, may choose to simplify the entire process into more or less stages based on the size and nature of the construction project.
and thus obtain the most efficient result implementation with a certain level of competitiveness. If possible, the project decision should provide for a response to competitive threats as the construction unfolds (Tan et al., 2011). The unfolding will often occur over a long time scale, a requirement that particularly demands the consideration of competitive elements in dealing with the economic and technological context.

Although setting a perspective, which coordinates the decision-making principles among project team members, is an important aspect of decision-making in project implementation, it is also vital to recognize the significance of competitive factors as perceived by various team members to achieve certain project activities (Kim and Reinschmidt, 2010). Moreover, discovering the competitive aspects influencing on decision-making in relation to issues associated with the introduction of new technology, besides, identifying the stakeholders’ biases and personal agendas, is extremely important (Shen et al., 2010; Thabrew et al., 2009).

In this regard, decision-making can make a difference either succeeding at a task or failing and reducing or increasing the quality or quantity of resources in a project. Moreover, the nature of construction industry also involves changing industry conditions, price and unpredicted futures (Giang and Sui Pheng, 2011). The markets that building projects 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, and need to think strategically (Moodley et al., 2003).

The future of competition is being shaped by changes in the meaning of value, the roles of the consumer and company, and the nature of their interactions (Prahalad and Ramaswamy, 2013). Specifically, competition in any industry does not stem only from competitors, but is also influenced by the underlying structures of the industry (Porter, 2008). Therefore, by analysing their industry firms could understand their current position, influence the structure positively or could define a position where they can uniquely have a competitive advantage (Porter, 2006).

According to Porter and Kramer (2006), with cheap technologies and worker mobility, it is almost impossible to build any sustainable competitive advantage which cannot be copied by rivals. Thus, consistent evaluation based on relevant criteria is necessary to succeed and this helps in understanding the source of competitiveness that are enablers for sustainable performance (Ajitabh and Momaya, 2004). It is therefore considered important to summarize the latest developments in research on competitiveness in construction through a comprehensive review, and to suggest new directions for further studies (Flanagan et al., 2007).

### 2.4 Construction Stakeholders

Typically, the construction stakeholders comprise of professions such as design architect, surveyor, developer, consultant, contractor, project manager, civil engineer, manufacturer and clients. However, neither each member of these professions, nor all groups are necessarily directly affected by the adoption of IBS technology in question and the related construction activities (Chen et al., 2010). In this study, construction stakeholders are those individuals or organisations which may have an interest in the results of a building technology decision or be affected by that decision. In the development of a project, the early stages are crucial since significant and critical decisions are made based on firms’
strategies, strategic direction and strategic management process to grant more effective, efficient, innovative and better solutions for the fulfilment of client and stakeholder needs and objectives (Smith et al., 2008).

In the construction context, this implies that designers and project planners must understand the distinct goals of stakeholders, which proceed from the external social context (Bonev et al., 2015). According to Ann et al. (2007) planners should be aware of uncertainties about the construction projects and the trade-off between their importance and the time and effort required to complete them, given the available analytic resources and the ability to pass information on to other project members. The question of whether all ‘concerned’ or only those ‘affected’ need to be considered stakeholders in the decision-making process remains unresolved to date, not the least because a clear definition of the groups is difficult (Spitzeck and Hansen, 2010).

3. The Methodology and Model

This study's methodology flow begins with an introduction into the competitive issues relevant to IBS decision-making and their management. The paper then structures the various elements of competitive factor influences on IBS decision-making based on a decision model as an illustrative model (Figure 1) which is used to explore the application of the quantitative technique to this problem.

Figure 1: Three dimensional model of IBS decision-making with competitive influential factors [developed from Zakaria et al. (2013)]

The above model that is tested in this paper is a “dimensional hierarchy” that was developed in the earlier study conducted by Zakaria et al. (2013). It can be used to evaluate the influence of competitive factors on IBS decision-making. The technique for analysing the competitive factors in this model was based on the qualitative analysis of
data collection during the interview preamble to focus participants’ comments. In order to
develop this model, interview transcriptions were analysed qualitatively using QSR NVivo
Version 10.0, a software used to support qualitative method evaluations. A detailed
illustration of competitive factors is presented in Figure 1 above which was organised
around several aspects that emerged from the interviewing process: (a) the influence of
competition; (b) the influence of competitive advantage, and (c) the influence of
competitiveness on IBS decision-making in a hierarchical manner. Each of these three
major aspects is believed to capture at least some aspect of all the influences identified in
the literatures.

The dynamic characteristics and complexity of this decision model, which is true for the
decision-making of IBS technology adoption as strategic decisions makes the model a
suitable framework to be tested using a quantitative method. Therefore, IBS decision-
making can be supported through the application of this model after the process of testing
and validation. Issues and possible extensions to the qualitative approach identify some of
its application, limitations and flexibility. These changes suggest a need for various
research mechanisms, such as using quantitative method as an alternative to rank the
influence of competitive factors on IBS decision-making.

In order to obtain perception towards the competitive influences on IBS decision-making,
twenty seven (27) participants were identified in a questionnaire survey constituting the
construction stakeholders of three IBS building projects. The participants of this
questionnaire survey were focused on the construction stakeholders within the northern
region of 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 (Ritchie et al., 2013). For each project, these participants include a/an
architect, quantity surveyor, contractor, civil engineer, consultant, developer, project
manager, and IBS manufacturer. A self-administered questionnaire with in-depth inquiries
was developed and administered to key team players of three building projects to assess
their perceptions towards the influence of competitive factors on IBS decision-making. The
structuring of the questionnaire was developed and supported by a review of related
literatures on the elements of the decision model of IBS technology adoption. The survey
was performed in 2014 for two months.

A total of sixty six (66) items were identified through detailed semi-structured interviews
(Zakaria et al., 2013) and literature reviews grouped under three (3) broad categories of
competitive influences on IBS decision-making by the researchers, namely competition,
competitive advantages and competitiveness. 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. The
participants were asked to provide their opinions based on the statements of competitive
factors as perceived by them in deciding on IBS technology. The assessment and the
perception of competitive factors that influence IBS decision-making are based on the
construction stakeholders’ judgments and the decision-making process of IBS technology
adoption which is encapsulated within the experience, perception and subjective
influences of those who conduct evaluation, prospect, and finally make a decision, based
on what they believe is the most important or significant of a given IBS building project.
4. The Findings

The data analysis was performed by using Statistic Package for Social Science (SPSS) where the scores given to each item of competitive factors by the participants were entered. The collected data from the questionnaires were analysed via the frequency analysis and the index average analysis. The index average was established to identify the importance level of each competitive element as represented by the relative importance index (RII) using this formula: Index Average = (Σ ai X xi)/ Σ xi, where ai = constant, weighing factor and xi = variables representing participants’ frequency of response. The overall results of this study vary from other economic related factors in IBS decision-making as it presents a depth expression of competitive factors in three major classifications. The competitive factors are classified as competitiveness, competitive advantage and competition. The contribution of each of the factors to overall competitive influence on IBS decision-making was also examined.

4.1 The Influence of Competitiveness

The first objective was to determine competitive factors that have influences on IBS decision-making as perceived by the construction stakeholders based on the developed IBS decision-making model. The study revealed that competitiveness related factors had a high influence on IBS decision-making with an aggregated relative importance index of 3.93 and was ranked as the top most influencing factors on IBS decision-making. This category demonstrated the most aggregated relative importance index of 3.93 overall in as far as influencing IBS decision-making. The detailed results on competitiveness related factors are presented in Table 1.

<table>
<thead>
<tr>
<th>COMPETETIVENESS</th>
<th>Frequency of Participants Score</th>
<th>Average Index</th>
<th>RII Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collaboration</td>
<td>0 0 1 9 17</td>
<td>4.59</td>
<td>1</td>
</tr>
<tr>
<td>Work efficiency</td>
<td>0 0 3 10 14</td>
<td>4.41</td>
<td>2</td>
</tr>
<tr>
<td>Innovations</td>
<td>0 0 3 10 14</td>
<td>4.41</td>
<td>3</td>
</tr>
<tr>
<td>Project performance</td>
<td>0 0 3 10 14</td>
<td>4.41</td>
<td>4</td>
</tr>
<tr>
<td>Improved productivity</td>
<td>0 0 1 17 9</td>
<td>4.30</td>
<td>5</td>
</tr>
<tr>
<td>Faster completion</td>
<td>0 1 2 14 10</td>
<td>4.22</td>
<td>6</td>
</tr>
<tr>
<td>Budgeting</td>
<td>0 2 9 8 8</td>
<td>3.89</td>
<td>7</td>
</tr>
<tr>
<td>Higher output</td>
<td>0 2 9 8 8</td>
<td>3.81</td>
<td>8</td>
</tr>
<tr>
<td>Great ideas</td>
<td>0 3 7 10 7</td>
<td>3.78</td>
<td>9</td>
</tr>
<tr>
<td>Automation level</td>
<td>0 0 14 10 3</td>
<td>3.59</td>
<td>10</td>
</tr>
<tr>
<td>Ease of maintenance</td>
<td>7 18 2 0 0</td>
<td>1.81</td>
<td>11</td>
</tr>
</tbody>
</table>
The participants attributed competitiveness factors with the aspect of collaboration in building project implementation as the most influential aspect in IBS decision-making with RII (4.59). This is followed by work efficiency, innovations and project performance with RII (4.41) respectively. The study also revealed that the factors of improved productivity (RII = 4.30) and faster completion (RII = 4.22) had their influences on IBS decision-making. However, the ease of maintenance had minimal influence on IBS decision-making (RII = 1.81).

The results of the study presented in Table 1 could be explained in many different ways. Nevertheless, it can be confessed that the outcome of the results was due to the fact that the construction stakeholders in most projects are not necessarily expected to be technical and knowledgeable in building construction so as to embark on an IBS project and therefore, it is because of this that they go ahead to hire the services of experts like IBS manufacturers, installers, consultants and contractors to execute the work on their behalf and to their satisfaction through various ways of collaborations. This is true to a certain extend as lack of highly skilled professionals in IBS technology adoption for the contractor to implement IBS building projects.

Many participants indicated to the fact that since IBS projects require various interdependent activities such as design, feasibility, planning, installation and maintenance, the aspect of collaboration was considered as a mechanism to execute the whole IBS project implementation. This finding is indeed comparable to the study of Kamar and Hamid (2011) of who identified that creating an IBS cluster of integrated team by creating a partnership with positive integration of supply chain has become a major factor in delivering successful construction projects.

Accordingly, there are needs for the consideration of work efficiency, innovations and project performance in IBS decision-making. Work efficiency and project performance contemplation for gaining competitiveness were also identified as influencing IBS decision-making besides a strong inspiration of innovations. Consistent with the depictions of RII described above, project performance was also described as exhibiting a great level of influence in IBS project development. Similarly, Abdul Kadir et al. (2006) also evaluated the construction performance comparison between the conventional building system and IBS in terms of actual labour productivity, structural cost, crew size and cycle time.

Consequently, improved productivity and faster completion were identified as having competitiveness elements that also influence IBS decision-making. In summary, competitiveness was represented as a regular consideration with respect to its benefits in building projects which also influencing IBS decision-making. This competitiveness aspect pertaining IBS technology adoption was described as hierarchical and able to emerge itself in responding to IBS decision-making.

4.2 The Influence of Competitive Advantage

The characteristics of competitive advantage were also found to be the second important influence on IBS decision-making. The research also revealed that factors related to competitive advantage came second overall in the hierarchy of competitive factors as influencing IBS decision-making with an aggregated relative importance index of 3.63. Generally, the study discovered that dynamic progress of technology alternatives and profit margins projections as future prospects in the construction industry have led to the attainment of long term competitive advantage. The participants attributed this to the top
five factors of; technology alternatives with RII (4.44), profit margins with RII (4.44), better building quality with RII (4.20), competitive bidding with RII (4.00) and cheaper price with RII (3.89) respectively as presented in Table 2.

Table 2: Results of Quantitative Analysis on Competitive Advantage

<table>
<thead>
<tr>
<th>COMPETITIVE ADVANTAGE</th>
<th>Frequency of Participants</th>
<th>Average Index</th>
<th>RII Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Score</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 2 3 4 5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Technology alternatives</td>
<td>0 0 1 13 13</td>
<td>4.44</td>
<td>1</td>
</tr>
<tr>
<td>Profit margins</td>
<td>0 0 1 13 13</td>
<td>4.44</td>
<td>2</td>
</tr>
<tr>
<td>Better building quality</td>
<td>0 1 2 14 10</td>
<td>4.20</td>
<td>3</td>
</tr>
<tr>
<td>Competitive bidding</td>
<td>0 0 7 13 7</td>
<td>4.00</td>
<td>4</td>
</tr>
<tr>
<td>Cheaper price</td>
<td>0 2 8 8 9</td>
<td>3.89</td>
<td>5</td>
</tr>
<tr>
<td>Substitute building materials</td>
<td>0 2 6 14 5</td>
<td>3.81</td>
<td>6</td>
</tr>
<tr>
<td>Design and resources</td>
<td>0 2 9 8 8</td>
<td>3.81</td>
<td>7</td>
</tr>
<tr>
<td>Knowledge and experience</td>
<td>0 5 6 12 4</td>
<td>3.56</td>
<td>8</td>
</tr>
<tr>
<td>Future prospect</td>
<td>2 5 8 10 2</td>
<td>3.19</td>
<td>9</td>
</tr>
<tr>
<td>Minimal labour</td>
<td>2 12 8 2 3</td>
<td>2.78</td>
<td>10</td>
</tr>
<tr>
<td>Mass customisation</td>
<td>7 18 2 0 0</td>
<td>1.81</td>
<td>11</td>
</tr>
</tbody>
</table>

This result is in line with the research of Abdul Kadir et al. (2006) who highlighted that the construction industry must find an alternative solution such as IBS which has immense inherent advantages. Besides this, Begum et al. (2010) also acknowledged that the Malaysian government efforts to promote the usage of IBS have been an alternative to the conventional, labour intensive and wasteful construction method. This result also supports the findings by Kamar and Hamid (2011) who noted profit margins issues such as profit and loss prediction, a very low profit margin and profit sharing amongst partners.

The research however revealed that two (2) factors had minimal influence on IBS decision-making namely minimal labour (RII = 2.78) and mass customisation (RII = 1.81) since their RII was below 2.00. Correspondingly, this finding was consistent to the findings of Majid et al. (2011) who discovered that mass customisation related issues as less significant in IBS technology adoption. This probably could be explained by the low level and sophistication of IBS technology currently used in Malaysia with more labour-intensive construction techniques. Conclusively, in an era of scarce resources, from the perspective of gaining competitive advantages, substitute building materials with cheaper price were perceived as an important consideration in IBS decision-making.
4.3 The Influence of Competition

The study was also accomplished to determine the extent to which competition related factors affect IBS decision-making in building projects. The research undertaken has identified that competition related factors emerged as the least significant influence on IBS decision-making with an aggregated relative importance index of 3.40. Table 3 presents the results of competition factors impacting on IBS decision-making as perceived by the construction stakeholders.

Table 3: Results of Quantitative Analysis on Competition

<table>
<thead>
<tr>
<th>COMPETITION</th>
<th>Frequency of Participants</th>
<th>Average Index</th>
<th>RII Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Score</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Risk</td>
<td>0</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Tendering</td>
<td>0</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>Industrial trends</td>
<td>0</td>
<td>0</td>
<td>7</td>
</tr>
<tr>
<td>Client demands</td>
<td>0</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>Cost issues</td>
<td>0</td>
<td>2</td>
<td>8</td>
</tr>
<tr>
<td>Pricing</td>
<td>0</td>
<td>2</td>
<td>8</td>
</tr>
<tr>
<td>Financing</td>
<td>0</td>
<td>2</td>
<td>8</td>
</tr>
<tr>
<td>Shorter project life cycles</td>
<td>0</td>
<td>2</td>
<td>9</td>
</tr>
<tr>
<td>Procurement process</td>
<td>3</td>
<td>13</td>
<td>3</td>
</tr>
<tr>
<td>Global market</td>
<td>7</td>
<td>18</td>
<td>2</td>
</tr>
<tr>
<td>Competitor threats</td>
<td>7</td>
<td>18</td>
<td>2</td>
</tr>
</tbody>
</table>

From the finding of results in Table 3, it can be observed that the key factors of competition that contributed the most to IBS decision-making were risk (RII = 4.52), tendering (RII = 4.19), industrial trends (RII = 4.00), client demands (RII = 3.93), cost issues (3.89) and pricing (3.89). Additionally, the research also discovered that other factors related to competition namely procurement process, global market and competitor threats had less effect on IBS decision-making in building projects. Therefore, as far as evaluating the influence of competition related factors was concerned in the IBS building context, the factors with registered RII less than 2.50 were considered insignificant in influencing the decision-making of IBS technology adoption. In addition to the responses made to these influences, the role played by competition aspects were perceived as important considerations from the risk point of view.

As presented in Table 3, risk and tendering issues not only appear to influence the decision-making of IBS technology adoption (i.e., whether to adopt IBS technology or not) but the manner in which the industrial trend is moving on. Besides the influence of
industrial trend, the more modest demand level of IBS technology adoption in building projects may help to explain the view of the construction stakeholders with respect to IBS decision-making. The implications of positive demand is a high level of IBS technology adoption as perceived by the construction stakeholder, particularly those with direct interests in new building technology along with fulfilling project specifications. Participants held mixed views about the competition features in IBS decision-making. The research revealed that one of the most critical factors of competition is risk related factors. This finding is indeed in tandem to the findings of Hassim et al. (2009) who identified that in the IBS construction project, it is important to make a better and wiser decision when dealing with risk management in the projects that use IBS in the Malaysian construction industry.

As presented in Table 1, 2 and 3, the survey results signify that most of the construction stakeholders were responsive to the competitive factors in the decision-making of IBS technology adoption. They also perceived that these aspects such as collaboration, technology alternative and risks should be highly considered in deciding on IBS adoption. The results of the study also clarifies the opinion that alluded the major influence of competitive factors on IBS technology adoption through on a viable based on an IBS decision-making model. Although collaboration through partnering has received much attention in the construction industry, the way partnering influences decision-making depends on the degree to which it takes place and the make-up of the partners (Crespin-Mazet and Portier, 2010; Skibniewski and Zavadska, 2013).

Despite the use of an in-depth questionnaire survey, this study was primarily limited by its small sample size. Therefore, it is suggested that the IBS decision model is tested using a greater number of research participants. A larger sample of construction stakeholders across the country with more diversity would have benefited this results. Regarding the results and findings of this study, it is recommended that in the decision-making of IBS technology adoption, the construction stakeholders should pay particular attention to the specifications and requirements of the building projects during the conceptual, feasibility and planning periods with so as to go for decisions that they have competitive advantage.

5. Summary and Conclusions

The study has discovered an in-depth dimension on competitiveness, competitive advantage and competition, besides how these competitive factors have influenced the decision-making of IBS technology adoption. Most common influences on IBS decision-making were the elements of collaboration, technology alternatives, profit margin and risk according to the construction stakeholders’ perceptions. As the primary output of this research is the knowledge advancement in IBS decision-making, it also constructs the contemplation of strategic reactions to technological competitiveness most relevant and appropriate for IBS technology adoption. In the light of competitive influences on IBS decision-making, the following implications are offered; the construction stakeholders expressed their concern on competitive factors in a hierarchical way, a practical prioritisation is important for the adoption of IBS technology and this hierarchy should notably assist the process of IBS decision-making. This study also raises the following policy implications; in IBS decision-making, there is a need to focus not only on technical aspects but also economic. Competitive factors exploration provides an avenue through which perceptions of competitiveness, competitive advantage and competition can be integrated in building projects decisions. These perceptions suggest that as far as competitive factors are concern, collaboration through partnering and strategic alliance will make it possible for building projects to adopt IBS technology. However, the extent to
which competitive factors were perceived by the construction stakeholders as influencing IBS decision-making was limited in terms of the geographical coverage and number of research participants.

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