

Conceptual Framework of Psychology Decision Making on Industrialized Building Systems (IBS) Technology

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Abstract

There is an increasing use of industrialised building Systems (IBS) to replace conventional construction methods, with the intention of speeding up construction times. However the use of IBS technology is often resisted, apparently on grounds other than simply technological. Thus the decision to use IBS is dependent upon satisfactorily addressing a range of issues that include the technological, psychological and sociological. This paper reviews literature on decision making methods or process, in order to model psychological variables influencing the adoption of IBS in the built environment. A theoretical framework/matrix on the psychological aspects of decision-making process in relation to IBS technology adoption in built environment is proposed. The proposed framework illustrates the importance of the descriptive (how people actually behave when making decisions) and the prescriptive (how decisions should be made) aspects of psychology decision making based on well-considered factors in the IBS technology adoption.

Keywords: decision making, industrialized building, psychology, technology adoption.

Introduction

Innovative technology adoption is used as a strategic approach (Tyre and Orlikowski, 1994) by business firms, including those in the construction industry, to maintain a sustainable competitive advantage. 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, 2001). The criteria of decision making should consider all the impacts of the decision based on the benefits and costs. Moreover, discovering the psychological components 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 (Crawford, 1992). This paper presents a framework on IBS decision making which includes psychological dimensions and intended as an initial step towards providing more conceptual clarity concerning psychological dimensions in IBS technology adoption. This paper also contextualises psychological dimensions of decision making based on the scenario of Industrialised building system (IBS) technology adoption in Malaysia. Malaysian construction industry lacks a theory of how individuals or

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firms come to adapt IBS technology in construction activities. This view persisted when the Malaysian construction industry has been implementing the adoption of IBS technology in building construction. 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). Sarja (1996) 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”. There are several benefits of IBS when applied to a building process such as faster construction process, that is earlier completion of building projects, saving in manual labour on site, up to 40-50% of the input in conventional construction and higher quality of component attainable through careful choice of material, use of better production tools and strict quality control (Warszawski, 1999, p.12).

Thus, the major issue in IBS decision making can be stated as: How psychological dimensions and external influences impacted on the decision making process of IBS technology adoption? This question is posed against a background where IBS technology adoption in building construction being a low usage rate despite the government circular which oblige for not less than 70% of IBS component in government projects (CIMP 2006-2015). Thus, the decision making of IBS technology adoption is perceived as being influenced by human factors (internal) and external factors. For many construction firms, it was a revelation that the barriers of IBS implementation were readiness, awareness, cost issue, knowledge, poor planning and negative perception (Kamar et al. 2009). This evolution has brought about a much needed management focus on the decision making of IBS adoption to explore the psychological factors of decision makers and other intervening factors as decisions are made by human. In order to investigate the humanistic part of decision making, psychology has to be collaborated with behavioural economics and management science with the emphasis on the concepts of human uncertainty and rationality (Smithson, 2007).

Mantell et al. (2006) revealed that personal characteristics have their influences on decision making besides task related characteristics and risk elements. In behavioural decision making research, Shiloh et al. (2001) revealed that decision complexity is interfered by interpersonal differences and to obtain the best choice alternative, there are various decision rules utilized by decision makers. Meanwhile, decisions are figured by the contextual influences of past events, preset conditions and future outlooks to move firms further with the consideration of psychological context for each decision, particularly the impact of cognitive bias on decision making (Bateman and Zeithaml, 1989).

Psychology Decision Making

Psychology refers to scientific studies of behaviour and underlying mental and physiological processes in acquiring knowledge with social psychology which focuses on interpersonal behaviour such as conformity and group behaviour; and cognitive psychology which focuses on higher mental process such as reasoning, information processing problem solving and decision making (Weiten, 1998, p. 39).

Psychology decision making is specifically a behavioural-based managerial practice requiring clear assessment of decision makers' actions and conducts in decision which are made correspond to reality based on social perspective besides other economic phenomena. It can offer practical suggestions on how to deal with many common problems in technology adoption decisions. In view of the fact that people are social in nature, their decisions and judgement are subject to social influences (Plous, 1993). Thus, any comprehensive account of judgement and decision making must include social factors.

Contemporary research on the psychology of decision making by Messick and Bazerman (1996) involves three major groups of theories that are theories about the world in terms of the ways in which our decisions influence the world, theories about other people with the element of stereotype and theories about ourselves in terms of individual traits.

The unique nature of strategic decisions involves complexity, uncertainty, high cost, absence of information and long term effects require substantial elements of judgements and a highly detailed analysis by individuals with the most appropriate psychological qualifications in order to improve the quality and effectiveness of these decisions (Gilligan et al., 1983). Given the shortcomings of the classical decision theory or rational-economic model, an alternative perspective has emerged that provides a more descriptive view of managerial behaviour which termed as a behavioural theory of decision making or administrative model which acknowledges the real-world limitations on manager's decision making that provides bounded-rationality where decision makers are restricted in their decision making process (Vecchio et al., 1992).

Issues in IBS Decision Making

The goal of increasing productivity can be achieved with a better understanding of how problems can be solved and decisions are made effectively (Simon et al., 1987). Thus, psychological dimensions provide an empirical context for considering decision making based on a performance gap between the target or required IBS technology adoption and the actual use of IBS in building construction. This situation is illustrated in Figure 1.

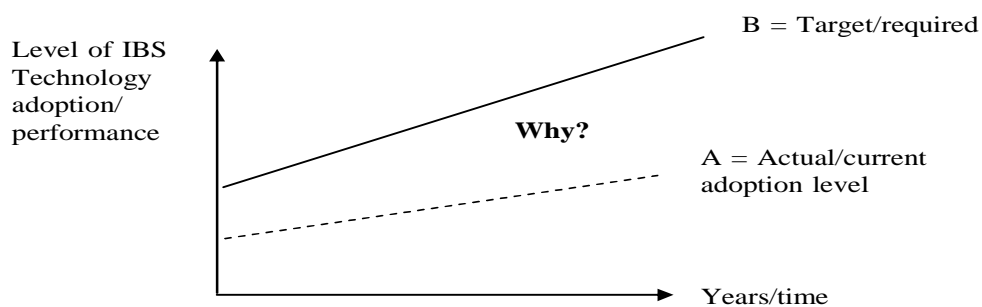


Figure 1. Level of IBS Technology Performance against Time

This performance gap is identified based on the difference in the level of IBS technology performance called for in the IBS Roadmap's strategic trust (CIMP 2006-2015) and the level of performance that seems likely to result from the current adoption of IBS technology to determine the symptoms resulting from underlying problems in the slow adoption of IBS technology. The causes of these symptoms may be explored in technical, managerial or other aspects and one of those may be related to decision making. Thus, it is important to structure psychological dimension as decision making is a facet of human behaviour and by gaining evidence that supports or rejects explanations for the shortfall in IBS adoption performance. This is likely to be characterised by a reactive influence where technology adoption decision is normally sub-optimal because of lack of awareness of the intent of IBS technology adoption and incomplete knowledge of the actual usage rate of IBS technology as illustrated by A line in Figure 1. The identification of gaps between objectives and performance is stated in normative decision making models indicate either random fluctuations or changes requiring revisions in strategy based on cognitive

psychology and behavioural decision theory dealing with making decision in uncertainty, complexity and ambiguity (Schwenk, 1984).

The paper intends to identify psychological dimension that have influence (or no impact) on the decision making of IBS technology adoption by IBS supply chain entities at different stages of building construction project. Decision making would be characterised by a close alignment of IBS technology adoption strategy with the psychological dimension and the external influences as illustrated by B line in Figure 1.

Framework of Psychology Decision Making of Industrialized Building System (IBS) Technology

This part contains a combination of theoretical ideas, concepts and generic description on IBS technology adoption from the perspective of decision making, psychology and environmental forces. Technology adoption involves knowledge-based systems derived from the accessibility and exploitation of technical, managerial and behavioural features.

Psychology decision making (PDM) of technology adoption acts as an ideal way which incorporates the input of psychological dimension from behavioural economics and the input of technology adoption strategy and external influences from construction management. PDM illustrates the approaches of decision making which reflects the technology adoption strategy of construction firms particularly IBS technology with the intervention of external factors, in order to endure in the highly competitive built environment. The desired outcome from PDM is a suitable decision making approach (behavioural-environment-strategy-technology, BEST fit approach) with the consideration of psychological and external factors that are matched with the firm's adoption strategy of building construction technology to illustrate the positive or negative future outlook of IBS technology. The context of PDM is illustrated in Figure 2.

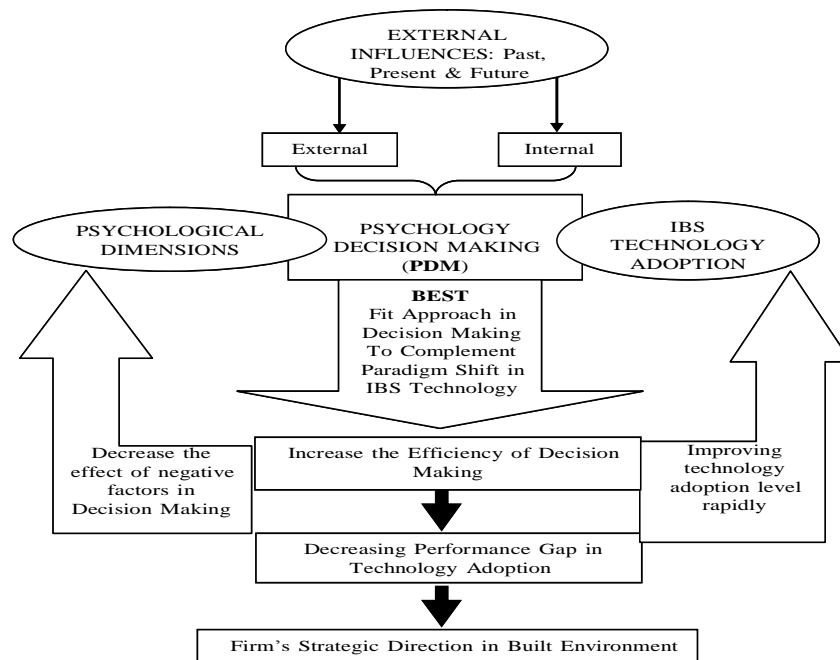


Figure 2. Conceptual Framework of Psychology Decision Making of Industrialized Building System (IBS) Technology

Based on Figure 2, psychology decision making (PDM) of IBS technology adoption covers:

- Decisions: represent programmed and non-programmed decisions, externally focused on firm's positioning in competitive and uncertain building environment to manage firms through economical changes and to compete successfully by creating knowledge-based advantage.
- Decision making: represents the task of making choices from amongst a series of potentially viable options or to opt for the best competitive strategy at firm's level in built environment or construction industry. In the context of this research, decision making will be based on the rationale analytic approach, the intuitive emotional approach and the political behavioural approach.
- Psychological dimensions: consists of all variables or factors that are related to human behaviour, particularly decision making. In this context, specific psychology traits that affect decision making are clustered as applied to technology adoption in construction management.
- IBS: represents building construction processes, techniques and technology which include these attributes: off-site production of building components, the use of standardised building components, the use of fabricated and precast concrete components, design using Modular Coordination concept and repeatability.
- Technology adoption: represents the actual application or use or installation of technology in terms of its physical aspects based on users' knowledge, skills and procedures in real the functioning area of built environment into the firm's operating or functioning systems in implementing building construction projects. The emphasis of this research is on how construction firms adapt and modify their building construction practices with relevant adjustments in response to technological change in built environment.

Conceptual Matrix: Decision Makers, Decision Stage and Psychological Dimensions

Irrationality of individual decision making is examined from a psychological perspective, thus it is important to reduce or minimise those psychological factors such as perception, attention, memory, heuristics, bias and other factors like personality, experience, motivation, feelings, emotions, skills and abilities, which limit rationality in decision making (Jennings and Wattam, 1994). Thus, to improve IBS technology adoption, it is essential to understand in which human behaviour and psychological factors influence the decision of technology adoption.

There is no common structure for describing key features in the decision making context of IBS technology adoption. In order to assist the clarification of conceptual features in this aspect, it is important to develop a matrix for explaining the attributes of psychology decision making in IBS technology adoption. This matrix can be used to identify more specifically who are decision makers in this context (decision making unit), the nature of IBS technology adoption (decision making stage) and psychological dimensions (influencing factors). It facilitates clearer behavioural perspectives on IBS technology adoption which later offers direction in generating appropriate technology adoption strategies with the anticipation of potential environmental influences or forces. The three dimensional matrix illustrates the variables of psychology decision making in IBS technology adoption based on a systematic way of classification. The first feature is the decision making unit which comprises of the decision makers in IBS technology

application. The second feature is the decision making stage of IBS technology adoption. The third feature is the psychological dimensions or factors that influence IBS decision making. A conceptual rubric for visualizing psychological influences in the decision making of IBS technology adoption is presented in a rubric as illustrated by Figure 3.

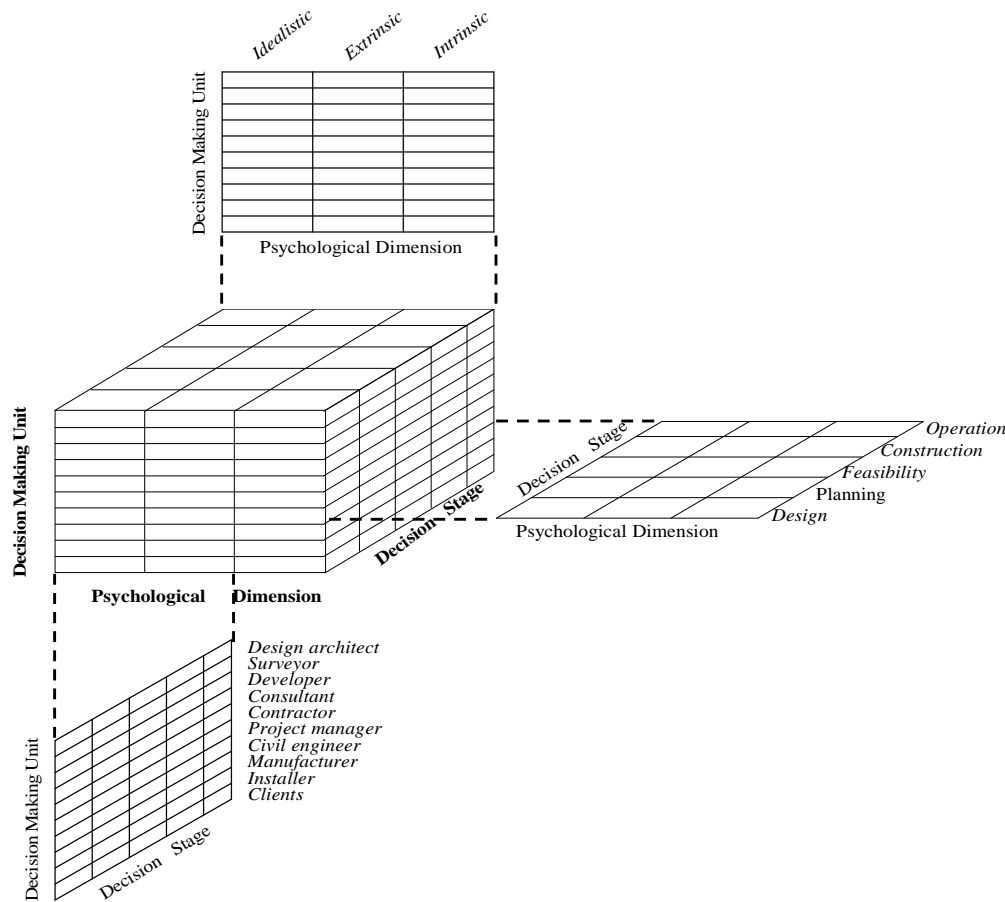


Figure 3. Conceptual Matrix of Psychology Decision Making

Decision Making Unit

The decision making unit of IBS technology adoption is the IBS supply chain which comprises of design architect, surveyor, developer, consultant, contractor, project manager, civil engineer, manufacturer, installer and clients. They are involved in IBS decision making in different ways in terms of their perception and standpoint according to firms needs and regulation requirements. Although the perception and standpoint of decision makers may not be easily characterized, their perspectives can be regarded as the reflection of possible consequence or outcome of any decision on IBS technology adoption through the project completion either at an early or later stage of a building project.

The government’s perspective for example reflects the policy and concern of IBS technology application with specific interests such as the phased reduction of dependency on foreign labour, encouragement strategy on the investment in technologies and the

processes of construction to progress construction industry industrializations (CIDB, 2008). This decision making unit has a particular decision making context. Thus, it is important to identify the difference or similarity among these decision makers due to their role perspective with diverse anticipation, prospect, competencies, vision and trends based on decision making stages that are relevant to them. Decisions taken by project members need to be synchronized with the intention of achieving expected project performance. Otherwise, individual project members may be based on different perspectives towards achieving project goals and objectives within their own roles and responsibilities, thus affecting the overall project performance. Consultants for example work in the background advising the key decision about a wider range of issues in construction projects. They also serve as an early and confidential sounding board for ideas as knowledgeable person about the construction world.

Decision Making Stage

Decision making in the context of IBS technology application despite its stages, relatively depends on decision making goals, authority or policy. It is also essential to assume that in actual decision making, people are rationally bounded but not with the assumptions of perfect rationality. Simon (1979, p.501) stated that in “bounded rationality” human beings have to carry out the work with the limits of man's abilities to comprehend and compute in the face of complexity and uncertainty. In a construction project, by recognizing all connections which actually exist within the construction system, the roles of various project members and the contributions they make are guiding principles to make decision making apparent. Decisions taken by project members need to be synchronized with the intention of achieving expected project performance

The decision making stages in IBS technology application involve five major stages. The first stage is application feasibility phase with the establishment of IBS technology adoption needs and its application feasibility. This stage is an information search phase which comprises of decision based on project definition, objectives and scope that according to IBS innovation strategy. At this stage, decision makers also identify the attributes and characteristics of alternatives in IBS building construction technology. The nature of decision making on technology adoption at this stage is less defined with difficulty in technology forecasting and unavailability of information to fulfil multiple competing goals in technology adoption. In a project, decision making begins early in the design process so it is vital that efforts are made to build effectual collaboration with construction members such as construction manager, architect, engineer, suppliers, contractors, lawyer or accountant.

The second stage is the conceptual planning phase of a building project that involves design tasks such as conceptual plan or preliminary design. This stage is the judgement or choice making point which reflects the prescriptive decision making (how decisions are made). At the second stage, decision makers make their judgement or choice based on the feasibility study of technology adoption performed at stage 1. Various possibilities may be considered in the conceptual planning phase as the technological and economic feasibility of each alternative will be assessed and compared in order to select the best possible project.

The third stage is the feasibility phase of project implementation. This is the evaluation point of decisions made based on construction plans and specifications. After the scope of the project is clearly defined, detailed engineering design will be developed which serves as the blueprint for construction. In addition, definite cost estimation for any building technology will be prepared as the baseline for cost control.

The fourth stage is the construction phase of building process implementation. This stage is judgment or choice making point which reflects the prescriptive decision making (how decisions are made) based on the overall IBS strategy implementation of firms, projects and industry. At the fourth stage, decision makers make their judgment or choice based on some decision rules pertaining IBS technology adoption in terms of its generality, formality and complexity. If the nature of technology adoption is considered as an operational or functional matter, it is categorized as a routine basis, an authority-based, rules applicable and previous experience consideration with complete operational specifications.

The fifth stage is the post-construction phase of project implementation. This is the evaluation point of decisions made based on IBS strategic impact. If the nature of technology adoption is considered as an operational or functional matter, the decision has to be based on physical technology with standardized information with the emphasis of measurable productivity, technical perfection and construction work efficiency.

However, the decision stages of IBS technology adoption in Figure 3 may not be strictly sequential. Some of the stages require interaction and others may be carried out in parallel or with overlapping time frames, depending on the nature, size and urgency of the building construction project. Although each stage requires different expertise, 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.

Influencing Psychological Factors

Psychology has established its place in decision making study after the growing appreciation of behavioural economics application in construction management. In deciding on IBS technology adoption, psychological factors affecting this type of decision making have to be identified. These factors are not appeared as an independent entity in behavioural economics study, but as a collection of dimensions with specific impacts on the decision making of building construction technology. Psychological factors are not taken as a single entity, since every decision maker faces multiple psychological dynamics. Therefore, it is essential to cluster complex psychological factors which later help to clarify different sub-dimensions that are relevant to IBS decision making. According to Cassel (1973), in dealing with various aspects of the psychological process of human behaviour and decision making, there are three major psychological concepts namely self-concept, would-be concept and ideal concept. These concepts are adapted to categorised influencing psychological factors on IBS decision making which can be characterised by three major sub-dimensions that are idealistic concept, extrinsic concept and intrinsic concept.

Intrinsic concept reflects self-thought which recognise decision making as it really is. This is due to the inspiration of personal bias, personal needs and wants, personal values, attitudes and feelings or emotions. The second concept, extrinsic concept shapes decision making based on external elements through decision makers' perception, the conformity of firm's needs and values, leadership style, learning context and previous experience. The third concept is an idealistic notion of decision making which implies the ultimate decision based on significant factors that the individual values most such as goals achievement, heuristics and risk considerations. These dimensions can be used to determine how decision makers fit in the judgement of IBS technology adoption throughout project completion based on a systematic profiling.

The Application of Psychological Decision Matrix

The matrix is an analytic tool for conceptualising major psychological dimension of IBS technology application at various construction phases. It provides a systematic structure for classifying a range of technology adoption perspectives involve at each construction stage. Graphically, it highlights a differentiated decision making stages and perspectives with multiple psychological dimensions. The psychological decision matrix also helps to illustrate that many Malaysian examples of IBS technology adoption are commonly subjected to “technology-push” perspectives with various behavioural interventions in the decision making of IBS despite a clear policy on this matter.

Although the matrix can be used an analytic tool in decision making, it has certain limitations. First, it offers a static picture of psychological dimensions in IBS decision making whereas actual decision making in any of the three psychological dimensions is a dynamic process around a number of different other psychological factors in reality. Moreover, certain roles perspectives and level of IBS supply chain entities may be more applicable to socio-economic factors. Second, the three major construction phases are not the only important analytic element for describing decision making level. Within each phase of construction activity for instance, IBS decision making method tend to be strictly and directly based on regulation requirements or client needs. Additionally, defining an appropriate level or stage of IBS decision making is a prior step to designing IBS components, since some IBS decision are subjected to participative decision making in a construction project.

Conclusion

This framework sets the context for why the decision of IBS technology adoption is such important to the modern construction business and industry. It anticipates the concept of psychology, technology perspective, technology application and decision making, and relates them to the construction sector. It also illustrates how the new paradigm in construction technology adoption with the incorporation of behavioural economics is important to construction management. The decision of IBS adoption is significant as a technology enabler to construction development. Based on this conceptual framework, it is possible to bring elements of both perspectives from behavioural economics and technology adoption to construction decision making. Moreover, this conceptual framework can be used as a post-mortem tool in addressing the buildability issues of future’s construction technology features particularly IBS. It concludes by outlining how such decision making should be taken further in the adoption of new construction technology.

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