Factors influencing the adoption of new technology within SMEs organisations:

Validation Of The Framework

Mazura binti Mahdzir
Department of Quantity Surveying,
International Islamic University Malaysia
Kuala Lumpur, Malaysia
mazuramahdzir@gmail.com

Sharifah Mazlina Syed Khuzzan
Department of Quantity Surveying,
International Islamic University Malaysia
Kuala Lumpur, Malaysia
smazlina@iium.edu.my

Abstract— **The capability of managers remains an important aspect in influencing their decision making to adopt technological innovation. This was proven when thirteen (13) top managers within construction SMEs found that the slow adoption of new technology (e.g., Building Information Modelling), was due to their capabilities. The managerial capability can be classified into two (2) broad factors; namely non-behavioral capability and behavioral capability. From the previous empirical studies, a decision making capability framework has been proposed from 'managerial capability' perspective. The development of framework requires further validation from several experts within construction industry. Therefore, this paper aims to validate the framework from eight (8) top managerial of SMEs organization. The validation purposes is needed for four (4) reasons (i)to assess the importance of the factors listed in the framework (ii)to determine the sufficiency of the factors listed in the framework (iii) to examine the practicability of the factors for top managers in SMEs organizations (iv)to identify the benefits gained from the proposed framework. The results obtained from domain experts confirmed the previous qualitative findings by showing the importance of top managerial capability in decision making (i.e., to adopt new software).**

Keywords- decision making capability factors; new technology; top managers; construction,innovation

I.   INTRODUCTION

The adoption of new technology has been aided by various innovation adoption theories. Among the mainstream innovation adoption theories used include (i) Innovation Diffusion Theory (IDT)/Diffusion of Innovation (DOI) [1], (ii) Technology Acceptance Model (TAM) and its extension [2], (iii) Theory of Reasoned Action (TRA) [3], (iv) Theory of Planned Behaviour (TPB) [4]-[5], (v) Resource-based View (RBV)[6] and [7],(vi) Technology-Organization-Environment (TOE) [8] and (vii) Unified Theory of Acceptance and Use of Technology (UTAUT) [9]. Each theory was developed for (i) different purposes such as to describe patterns of adoption [10] and to predict human behaviour based on the relationship of Beliefs, Attitudes, Subjective Norm, Behavioral Intentions and Behavior [3]. (ii) Different level as some of the theories

remains applicable to be used at organisational or individual level.

Based on ten (10) types of innovation adoption theories, it was acknowledges that the innovation adoption factors related to technological innovation were developed from various factors namely technological, environment and people. Despite the available theories provides multiple factors to determine the adoption pattern (adoption behavior and non-adoption behavior), but none of these provides sufficient factors related to managerial capabilities. In fact, from the context of managerial capability, the existing theories remain inappropriate to be used within SMEs managers particularly to determine their level of capability. The justification lies into two (2) reasons.

First is due to the insufficiency of the influencial factors related to managers specifically their capabilities. The theories available cannot give wider explanation related to the factors influencing managerial capability in adopting new technology [11], [14]. Some theories have been proposed to determine the behavioral capability factors only. This can be seen in the theories such as IDT/DOI theory [10] and TAM theory [11]. Whereas, for UET [12] it has been limited to determine the non-behavioral factors such as age and experience. Meanwhile some were confined to correlate between technology adoption and combinations of non-behavioral and behavioral capability factors, as incorporated in the TOE theory [13]. Despite the existence of various factors in TOE theory posses better explanation for intra organisational compared to other theory [13], but for certain researchers, this theory has disregard the importance of people aspects especially in SMEs organisation [12].

Second is due to the practicality of the theories used during initiation stage [12].The existing theories such as UTAUT, TAM, TAM2, TAM3, TPB and TRA were designed to predict the individual adoption towards new technology [10]. However, such theories were more appropriate to be used during post-adoption stage [3],[5],[9]-[10],[15]-[16] and [31]. Similarly goes to IDT/DOI, TOE, RBV and UET. Despite it can be used at pre-adoption stage, the theories were not

practical to determine the adoption level of managers in adopting new technology (e.g., new software) such as Building Information Modelling (e.g., BIM) due to the missing factor related to their decision making [17]-[20].

Moreover, the empirical studies that adopt innovation adoption theories were inconclusive [21] especially within the context of Malaysian construction.[22].Seeing these gaps, it is best to understand and explain the technology adoption decision in a broader context (multitude factors from SMEs managerial capabilities). The combination of multitude factors (non-behavioral and non-behavioral capability) also is needed due to the following reasons (i) the complexity of the process of technological adoption (ii) unique (but malleable) perceptions raised by individuals regarding to technology (iii) the managerial cognition, emotional, and context differs across country, size and individual [13], [23]. Due to these reasons, a conceptual framework is developed for managers of Malaysian construction SMEs organisations.

II.   DATA AND METHODS

A.   The significance of the framework

The managerial capabilities framework would definitely provides SMEs managers with an idea (e.g., identify the strength and weakness of capabilities possessed) to solve the slow innovation adoption problem. This development is needed since the slow adoption of technology has been influenced by top managerial capability. Moreover, they play a major role within their organizations, which acts as a main driver towards innovation [24]-[27].

The proposed factors were transformed into comprehensive framework. This term (framework) has been preferably used compared to 'models' due to the characteristics itself (i) provides systematic understanding and explanation about the factors influencing the implementation outcomes (ii) the factors influencing the implementation outcomes remains beneficial to develop further the execution plan [28].These characteristics contradicts with models which provides details practical guideline on how to reach the implementation outcomes. As a result, the term 'framework' remains suitable for this research as the managerial capability factors (independent variables) that might influences the dependent variables (e.g slow adoption) are gathered systematically.

Within this context, a decision making capability framework is developed based on the theoretical and empirical findings from thirteen (13) top managers of construction SMEs. They have outlined two (2) categories for managerial capability namely (i) non-behavioral capability and (ii) behavioral capability. There are one (1) theme has been placed under non-behavioral capability namely managerial demographic characteristics (relates with managerial background), whereas another four (4) themes are placed under non-behavioral capability. These include managerial cognition (relates with how managers perceived BIM software); managerial social capital (relates with relationship between managers and other people internally and externally);

managerial human capital (relates with managerial skill and knowledge) and managerial behavior (relates with managerial response and action towards BIM software) See Fig. 1.
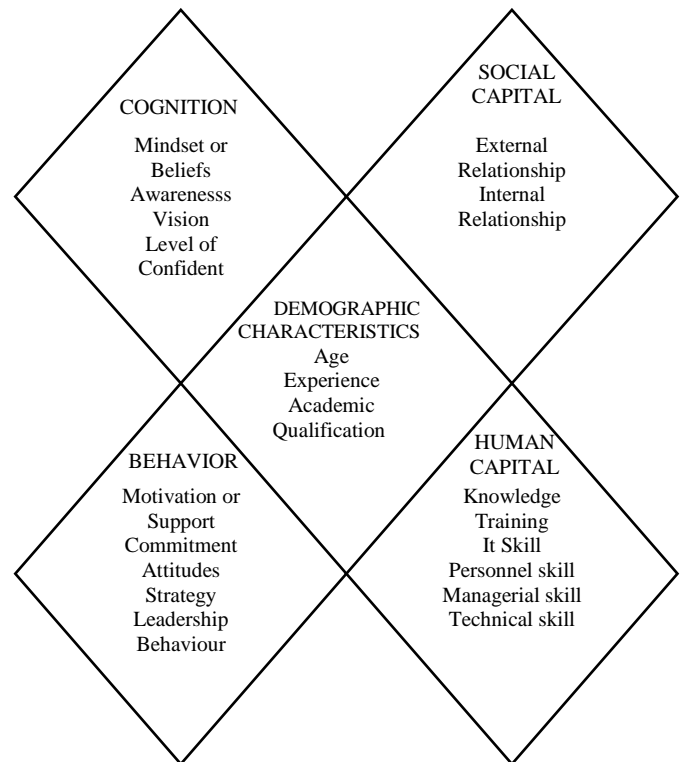

Fig.1. The conceptual framework related to decision making capabilities

This framework is designed for SMEs organisations especially top managers (e.g., Senior Managers, Board of Directors, Owners) from quantity surveyors (qs) consultancy organisations, who have responsible to make an important decision including whether to adopt or not the new technology. The framework has been validated by several domain experts (i.e., qs consultancy organisations). This is due to the reason that the adoption of BIM among them was quite low compared to other organisations such as engineers and architects. This is line with previous literatures made by [29]-[30]. It is hoped that this explicit guideline can be further explored by other construction SMEs managers such as contractors' organisations who have experienced the slow innovation adoption problem.

The information about what factors influence their decision to adopt BIM software, might contribute significant input to make them alert with their own strengths and weaknesses. This framework indirectly assist them to alert with how much gaps (based on their current managerial capabilities), they need to improve before executing any adoption strategies. Realizing the significance of this framework towards managers, this paper aims to validate the framework from eight (8) domain experts of construction SMEs organizations The validation consists of four (4) main objectives, which are: (i)to assess the importances of the factors listed in the framework;(ii)to determine the sufficiency of the factors listed in the framework;(iii)to examine the practicability of the

factors for top managers in SMEs organizations and (iv) to identify the benefits gained from the proposed framework.

B. Research Design

In general, all answered were recorded using tape recorder and being transcribed to analyse the findings. Once every element was recorded, the comparison will be made between the proposed framework and current capability practiced so that the reliability of the answer can be achieved.

Meanwhile for the research sample, there were eight (8) respondents involved in this research study. All of them are top managers from organisational A to H which comprises of Board of Directors, Associate Partner or Senior Manager. The respondents consist of six (6) females and two (2) males. From this research background, generally, all research respondents have working experience for more than (15) year in the construction industry. The background of respondents is sufficient to give the constructive views. They represent the SMEs organisation (i.e., quantity surveying) which have been operated within Klang Valley and Selangor area.

The respondents from the SMEs organisations were chosen due to the following reasons: (i) They faced the innovation problem (i.e, slow decision in adopting BIM software within SMEs) (ii) they had vast experience or limited experience in handling various software packages (i.e; related to bq production) (ii) They have been registered with BQSM and MRISM with ample exposure in Malaysian construction to ensure their credibility in sharing their views.

These include the top managers who had twenty six (26) years experience (for organisational F), followed by top managers from organisations H with twenty one (21) years experience working as a Senior Manager, A, D and G with twenty (20) years experience working as a Senior Manager, then, top managers from organisations C with nineteen (19) years experience working as a Senior Manager. Meanwhile another two (2) top managers have worked as a Board Director with sixteenth (16) years experience.

The date of establishment of their organisation also varies among each organisation. The longest year that has been recorded refers to organisations 'G' with their early establishment in 1983. Meanwhile, the organisations 'D' have started their operation in 1992, whereas organisations 'A' and 'C' have started their operation in 1993, followed by organisation 'H' in 1997. The remaining organisations have just started a few years ago.

These include organisations 'F' in 2010, organisations 'E' in 2014 and organisations 'B' in 2015. Similarly the total numbers of staffs for eight (8) organisations were totally different. Some of them have the total of fifteen (15) number of staffs, ten (10) number of staffs , seven (7) number of staffs, thirty (30) number of staffs, thirty two (32) number of staffs and four (4) number of staffs.

TABLE I. BACKGROUND OF RESPONDENTS

Respondent(s) /Organisation	Position	Gender	Year of experience	Establishment date	Number of staffs
R1/A	Senior Manager	Female	20 years	1993	15
R2/B	Board of Director	Male	16 years	2015	10
R3/C	Senior Manager	Female	19 years	1993	7
R4/D	Senior Manager	Male	20 years	1992	30
R5/E	Board of Director	Female	16 years	2014	4
R6/F	Associate Partner	Female	26 years	2010	4
R7/G	Senior Manager	Female	20 years	1983	32
R8/H	Senior Manager	Female	21 years	1997	30

III. RESULTS

A. To assess the importance of the factors listed in the framework

Generally, the respondents have agreed that their capability might influence their decision to adopt BIM software. They highlight the following points:

''It goes back to the top managers, as within their context of organisational establishment, what is the objective of adopting?'' (R1)

Other respondent added that:

''The decision maker capability remains crucial to expedite the adoption because now the client demand is different than ten (10) or thirty (30) years ago.'' (R2)

The involvement of upper level also has been identified important to execute any new adoption within an organisation. The Board of Director and Senior Managers of quantity surveying organisation mentioned that:

''If we do not start from the upper level, then the operation could not be executed.''(R3,R7 and R8)

''Sooner or later, we need to familiarise with technology and thus it should start from top managerial level.'' (R4)

Another respondent also agreed with the significance of this framework in assisting them to decide. Due to these reasons, remaining interviewees stated that: ''They should know what they need to to.so that they can direct their staff to the proper direction.'' (R5)

''If they do not know from head to toe...they could not recognise the potential of the software, thus, it such a waste for their big investment'' (R6, R7 and R8)

In short, they have agreed with the elements incorporated in this framework could be the main factors influencing their decision making.

B. To determine the sufficiency of the factors listed in the framework

The respondents agree that all factors listed in the framework remains sufficient to represent the capability needed as top managers. These include five (5) main themes which are managerial demographic characteristics (e.g., age, experience and academic qualifications), managerial cognition (e.g., mindset or beliefs, awareness, vision, level of confident), managerial social capital (e.g., external relationship and internal relationship), managerial human capital (e.g., knowledge, training, IT skills, personal skill, managerial skill and technical skill) and managerial behavior (e.g., motivation or support, commitment, attitudes, strategy and leadership behaviour). No other personal capability is needed to assist them in adopting BIM software.

C. To examine the practicability of the factors for top managers in SMEs organisations

Generally, the respondents view all factors listed in the framework remains relevant and appropriate to assist manager to expedite the adoption of BIM software. It is essential to note also that there is no discrepancy between the proposed factors and what has been already practice within their organisation. Nevertheless, at this moment, they could not maximise their capability due to the various challenges. There was a consensus among respondents that the framework also remains practical to guide consultants in adopting other types of software (e.g., system software such as server and operating system).

D. To identify the benefits gained from the proposed framework

The respondents from qs organisations have discussed some benefits gained from this framework which can be divided into two (2) aspects: First , the framework can be regarded as a guideline in assisting them to decide the appropriate software for their organisation (R1,R2,R3,R4,R5,R6,R7,R8). Being at the top management level, they must have their own priority. They must prioritize and review their capability that has been practiced previously. In other words, this framework can be treated as 'check and balance guideline' to determine whether there is a need to maintain the managerial capability for the next five (5) years (e.g.,R1,R2) Second, to increase the level of alertness among top managers regarding the personal capability development.

''This is important to sustain our business and give us more opportunity to procure more projects.'' (R3, R4, R5 and R6).

They stressed that:

''Maybe for the next five years...I might forgot....but if somebody prepare this framework, we able to identify the necessary capability required as a top manager.''(R1,R2).

IV. CONCLUSION

This framework has been developed based on the previous literatures and case study from thirteen (13) organisations. To validate this finding, eight (8) domain experts were selected from qs organisations. Using semi-structured interviews, their opinion have been collected to determine whether each of the element that have been proposed previously remains significance, relevance and practical for them or other qs organisation. The validation analysis obtained from domain experts shows the consistent results with the previous findings. No new element is proposed because the framework was already comprehensive. They only faced some constraints to maximise their capability at this moment. Therefore, the framework has been regarded useful to increase their alertness regarding their potential capability which requires attention and improvement. Thus the refinement of framework is not required.

REFERENCES

[1] Rogers, E. M,''Diffusion of Innovations: modifications of a model for telecommunications,'' Die Diffusion von Innovationen in der Telekommunikation, vol.17,pp. 25-38, 1995.

[2] Davis, F. D., Bagozzi, R. P., and Warshaw, P. R,''User acceptance of computer technology: a comparison of two theoretical models,'' Management science, vol.35, no.8, pp.982-1003, 1989..

[3] Fishbein, M., and Ajzen, I., ''Belief, attitudes, intention, and behavior. An introduction to theory and research,'' Massachussets, Addison-Wesley, 1975.

[4] Ajzen, I, ''From intentions to actions: A theory of planned behavior,'' pp. 11-39, 1985, Springer Berlin Heidelberg.

[5] Ajzen, I, ''The theory of planned behavior. Organizational behavior and human decision processes,'' 50(2), pp.179-211, 1991

[6] Hamel, G., and Prahalad, C. K. ''Strategy as a field of study: Why search for a new paradigm?,''. Strategic management journal, vol.15, no.2, pp.5-16, 1994.

[7] Caldeira, M. M., and Ward, J. M, ''Understanding the successful adoption and use of IS/IT in SMEs: an explanation from Portuguese manufacturing industries,'' Information Systems Journal, vol.12, no.2, pp.121-152, 2002

[8] Tornatzky, L. G., Fleischer, M., and Chakrabarti, A. K, ''Processes of technological innovation,''. Lexington Books, 1990.

[9] Venkatesh, V., Morris, M. G., Davis, G. B., and Davis, F. D, ''User acceptance of information technology: Toward a unified view,'' MIS quarterly, pp.425-478, 2003.

[10] Mumtaz Abdul Hameed., and Counsell, S and Swift, S, ''A conceptual model for the process of IT innovation adoption in organizations,''Journal of Engineering and Technology Management, vol.29, no.3, pp.358-390, 2012.

[11] Wu, W.W, "Developing an explorative model for SaaS adoption," Expert Systems with Applications, vol. 38, no.12, pp. 15057-15064, 2011.

[12] Nor Hazana, Abdullah., Eta Wahab., and Alina Shamsuddin, ''Exploring the common technology adoption enablers among Malaysian smes: qualitative findings,'' Journal of Management and Sustainability, vol.3,

no.4, pp.78-91, 2013. Retrieved August 11, from, http://www. .ccsenet.org

[13] Oliveira, T., and Martins, M. F, ''Literature review of information technology adoption models at firm level,''The Electronic Journal Information Systems Evaluation, vol.14, no.1, pp.110–121, 2011.

[14] Garaca, Z. "Factors related to the intended use of ERP systems," Management, vol.16.no. 2, pp. 23-42, 2011.

[15] Venkatesh, V., and Davis, F. D., ''A theoretical extension of the technology acceptance model: Four longitudinal field studies,'' Management science, vol.46, no.2, pp.186-204, 2000

[16] Gangwar, H., Date, H., and Raoot, A. D, ''Review on IT adoption: insights from recent technologies,'' Journal of Enterprise Information Management,vol.27, no.4, pp.488-502, 2014.

[17] Salman Azhar., Hein, M., and Sketo, B, ''Building Information Modelling (BIM): Benefits. Risks and Challenges,''available at: http://www. fp. auburn. edu/heinmic/Pubs/ASC% 202008-BIM% 20Benefits. pdf (accessed 11 August 2008)

[18] Awa, H. O., Eze, S. C., Urieto, J. E., and Inyang, B. J. ''Upper echelon theory (UET) a major determinant of information technology (IT) adoption by SMEs in Nigeria,'' Journal of Systems and Information Technology,vol.13, no.2, pp.144-162, 2011

[19] Barlish, K., and Sullivan, K,''How to measure the benefits of BIM - a case study approach,''Automation in Construction, vol.24, pp.149–159, 2012.

[20] Sexton, M., and Barrett, P, ''A literature synthesis of innovation in small construction firms: insights, ambiguities and questions,''Construction Management and Economics, vol.21, no.6, pp.613–622, 2003.

[21] Legris, P., Ingham, J., and Collerette, P,''Why do people use information technology? A critical review of the technology acceptance model,''Information & management, vol.40, no.3, pp.191-204, 2003.

[22] Moghavvemi, S., Hakimian, F., Feissal, T., and Faziharudean, T. M, ''Competitive advantages through it innovation adoption by SMEs,'' Social Technologies, vol.2, no.1, pp.24-39, 2012.

[23] Straub, E. T, ''Understanding technology adoption: Theory and future directions for informal learning,'' Review of educational research, vol.79, no.2, pp.625-649, 2009.

[24] Mitropoulos, P., and Tatum, C.B,''Technology adoption decisions in construction organizations,'' Journal of Construction Engineering and Management, vol.125, no.5, pp.330-338, 1999. Retreived August 11, from, http:www.ascelibrary.org/

[25] Ghobadian A., and Gallear, D, ''TQM and organisation size,'' International Journal of Operations and Production Management, vol.17, pp.121-163, 1999.

[26] Wilson N., and Stokes D. ''Managing creativity and innovation,''Journal of Small Business and Enterprise Development, vol.12, pp.366-378, 2006.

[27] Sexton, M, Barrett, P., and Aouad, G, ''Motivating small construction companies to adopt new technology,'' Building Research and Information, vol.34, no.1, pp.11-22, 2006. Retreived August 11, from, http://www.tandfonline.com

[28] Nilsen, P, ''Making sense of implementation theories, models and frameworks,'' Implementation Science, vol.10, no.1, 53,2015.

[29] Zhou, Lei, Perera, Srinath, Udeaja, Chika., and Paul, Charlotte, ''Readiness of BIM: A case study of a quantity surveying organisation,'' Paper presented at the First UK Academic Conference on BIM, Northumbria University, Newcastle- upon-Tyne, 2012, September 5-9.

[30] Wong, P. F., Salleh, H., and Rahim, F. A.,''The Relationship of Building Information Modeling (BIM) Capability in Quantity Surveying Practice and Project Performance,'' World Academy of Science, Engineering and Technology, International Journal of Civil, Environmental, Structural, Construction and Architectural Engineering, vol.8, no.10, pp. 999-1004, 2014.

[31] Davis, F.D,''Perceived usefulness, perceived ease of use, and user of acceptance of information technology,'' MIS Quarterly,vol.13, no.3, pp.319–340, 1989.