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Conceptual Design of Fuzzy TOPSIS DSS for Building Information Modeling (BIM)

[1]Ahmad Taufik Nursal, [1]Mohd Faizal Omar and [2]Mohd Nasrun Mohd Nawi

[1]School of Quantitative Sciences, Universiti Utara Malaysia, 06010 Sintok, Kedah, Malaysia
[2]School of Technology Management & Logistics, Universiti Utara Malaysia, 06010 Sintok, Kedah, Malaysia

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ABSTRACT

Building Information Modeling (BIM) is playing a significant role in the development of Construction industry. Evaluation of BIM software selection is one of the key roles in successfully BIM adoption. Currently, there is limited study on BIM software selection. With a great potential for integration of MADM and the current Web 2.0 technology, the development of Web DSS based on TOPSIS is desired to solve this problem. In order to develop an effective DSS, the development of subsystem which is TOPSIS would be integrated with fuzzy element. The proposed of this integration is to deal with the vagueness of decision makers in order to evaluate and rating the software and attributes of BIM software selection. Inteads of use crips value, the decision maker will asked to weight and rating through linguistics. For example Very Low (VL), Low (L), Medium Low (ML), Medium (M), Medium High (MH), High (H) and Very High (VH) will used for wighting asessement in BIM software selection. In order to demostrade this proposed DSS, a real construction project which UTHM Multipurpose hall will be deploy.

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INTRODUCTION

BIM (Building Information Modelling) is one of the emerging technologies in construction industry which is playing a significant role in supporting the management of project life cycle process such as designing process [1]. The current technology such as 2D AutoCAD tool is incapable of fulfil the complexities of the project which is always lead to the construction problem such as project delay and overrun cost [2]. The adoption of BIM has been proved in increasing the effectiveness and productivity of project. Due to this, the innovation of BIM has gained much attention among the construction communities and lead to increasing the number of BIM software in market. Each of this BIM software has different function, features and cost. Therefore the selection of BIM software becomes more apparent. Currently, there is limited study in BIM software selection and there is no DSS application to apply a real case in BIM software selection. Therefore, for solving the problem, the first step of this study is to identify the list attributes of BIM software selection from the case study which is UTHM Multipurpose Hall. The second step of this study is to develop a decision model through Multi Attribute Decision Making (MADM) techniques and fuzzy set which is fuzzy Technique for Order Preference by Similarity to an Ideal Solution (TOPSIS). The decision model will build based on attributes that gathered from a case study during the semi-structured interview among the BIM expertise. The Next step is to develop a Web-based DSS application through cloud technology.

Background of BIM, Fuzzy TOPSIS and Web 2.0:

i) Building Information Modelling (BIM):

From construction management literature, BIM has been understood in numerous of definition. For example, BIM is generally a three dimensional digital representation of a building and its build in characteristics [2]. Meanwhile, BIM also can be defined as "a digital representation of physical and functional characteristics of a facility and a shared knowledge resource for information about facility forming a reliable basis for decision during its life cycle; defined as existing from earliest conception to demolition" [3]. In simply stated, BIM is

Corresponding Author: Ahmad Taufik Nursal, School of Quantitative Sciences, Universiti Utara Malaysia, 06010 Sintok, Kedah, Malaysia
E-mail: ataufiknursal@yahoo.com,

more than drawing purpose in order to reshaping the construction project management. However, one of the barriers in BIM adoption is the selection of appropriate BIM software that fulfil project needs [1]. The effectiveness of BIM has lead to the numerous of BIM software available in market such as Autodesk, Bentley, Graphisoft, Gehry Technology, Tekla, NemetSchek, and Vico. Moreover, the adoptions of BIM involve high investment, not only for the software and hardware but also in training expenses. Thus, it is vital to select appropriate BIM software due to variability of cost and features as it can be affect the overall construction project outcomes [1], [4], [5].

ii) Overall of fuzzy TOPSIS model for BIM software selection:

Multi Attributes Decision Making (MADM) provide numerous of decision techniques for selection problem such as Technique for Order Preference by Similarity to an Ideal Solution (TOPSIS), Simple Average Weight (SAW), Analytical Hierarchy Process (AHP), Analytical Network Process (ANP), Weighted Sum Method (WSM), and others. Fuzzy TOPSIS has been selected as decision techniques for BIM software selection. For the purpose of developing a DSS for BIM software selection, TOPSIS method is a suitable MADM method to be used. From literature, TOPSIS is more capable in order to deal with numerous of attributes[6]. Through fuzzy set theory, it allows the decision makers to make an evaluation of alternative versus attributes and the important of weight of attributes in linguistic value. Thus, in this study, the integration of fuzzy set with TOPSIS is to deal with the vagueness of decision makers in order to evaluate and rating the software and attributes of BIM software selection [7]. From MADM literature, substantial work of fuzzy TOPSIS has been done in past. For example an Construction project selection and risk assessment by fuzzy AHP and fuzzy TOPSIS methodology [8] and TQM consultant selection in SMEs with TOPSIS under fuzzy environment [9]. Table 1 and 2 below illustrate the one of linguistic variable scale that will be used in this study for weighting and rating assessment in Fuzzy TOPSIS for BIM software selection.

Table 1: Linguistics variable for Weight [7].

Linguistic Variable	Fuzzy Numbers
Very Low (VL)	(0, 0, 0.1)
Low (L)	(0, 0.1, 0.3)
Medium Low (ML)	(0.1, 0.3, 0.5)
Medium (M)	(0.3, 0.5, 0.7)
Medium High (MH)	(0.5, 0.7, 0.9)
High (H)	(0.7, 0.9, 1.0)
Very High (VH)	(0.9, 1.0, 1.0)

Table 2: Linguistics variable for Rating [7].

Linguistic Variable	Fuzzy Numbers
Very Poor (VP)	(0, 0, 1)
Poor (P)	(0, 1, 3)
Medium Poor (MP)	(1, 3, 5)
Fair (F)	(3, 5, 7)
Medium Good (MG)	(5, 7, 9)
Good (G)	(7, 9, 10)
Very Good (VG)	(9,10, 10)

iii) Web 2.0 Technology:

The recent development of DSS through web generates has extend the ability of DSS in order to become more quick, effective, remote and user friendly [10]. Since 2004, the emerging of Web 2.0 technology has opened a new concept for the DSS development. The concept and characteristics of Web 2.0 such as remote, platform-independent, context-rich and easy to use, which is fulfil the concept and purpose of DSS [11].

Unlike the traditional web technology, Web 2.0 is based on lightweight programming techniques, many-to-many relationship network and personalization of data and service [12]. Furthermore, Web 2.0 platform characteristic that allows user to exchange and sharing experience could provide a new idea and useful information for the decision making process [10]. Thus, this study will utilized one of the Web 2.0 tools which is Google Doc and Google Site for the development of BIM software selection DSS.

The development of decision model and DSS for BIM software selection:

In order to develop a DSS for BIM softeare selection, this study will use a real construction project will be deploy. In addition, the intergration of fuzzy set and TOPSIS will be develop. The usability of the proposed DSS will be measure among the user. The recent development of DSS through web generates has extend the ability of DSS in order to become more quick, effective, remote and user friendly. After the identification and validation of attributes and number of alternative BIM software, a decision model will be built. Figure 1 below ilustrusted Model of DSS for BIM software selection.

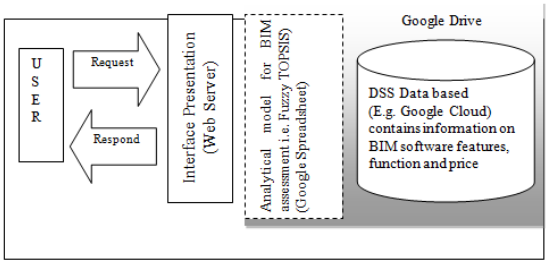

Fig. 1: DSS model of BIM software selection.

Figure 1 ilustrate the proposed model for BIM software selection that consist of three basic component, which are, Database management subsystem, Model management and User interface. Web based DDS of BIM software selection is based on google site as a domain. From DSS literature, Microsoft Excel has been used widely as a DSS generator [13]. However, in order to develop web base DSS, instead of used MS Excel, this study will be utilized the current features of Google which is the Google spreadsheet as a DSS generator. In order to develop an effective and remote DSS of BIM software selection, the technology cloud computing such as Google drive will be utilized. The decision model fuzzy TOPSIS will be built in Google spreadsheet will be stored in Google drive. Moreover, the Google document will be used as a database that contains BIM software information such as features, function and price. After the development of the proposed DSS, the validation of DSS part will be conduct among the user in order to measure the usability of the proposed DSS. A simple of questionnaire will be distributes among the user based on DSS validation criteria from literature.

Discussion and Conclusion:

The introduction of BIM system in construction industry is has lead to the numerous of BIM software available in market. Due to this, the selection of BIM became more apparent. Thus, this paper attempt to develop a DSS for BIM software selection based on fuzzy TOPSIS. Fuzzy element is significant in order to present real world probelm. Fuzzy element is capable to deal with the vagueness of decision makers in order to evaluate and rating the software and attributes of BIM software selection. In order to fulfil that objective, a real case study will be conduct which is will lead to the identification of attributes for BIM software selection in real world situation. A semi-structured interview will be conduct among the BIM expertise. Moreover, this paper also attempt to develop Web based DSS for BIM software selection through Web 2.0 technology. Some of tools from Web 2.0 such as Google Doc and Google Site will be utilized. This approach is anticipated to increase the effectiveness and enhance of BIM software selection process.

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