Expert Consensus on the Usability of the SLC3DM Model: A Fuzzy Delphi Method Application

Faiezah Shamsuddin[a], Ahmad Zabidi Abdul Razak[b]

[a,b] *Faculty of Education, University Malaya, 50603 Kuala Lumpur, Malaysia*
Corresponding author: zabidi@um.edu.my

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Abstract

Each model should undergo a usability evaluation to ensure a model meets the users' needs and expectations. This is a process of testing the model with real users to measure how user-friendly and effective it is. Therefore, this study aims to evaluate a model of School Leaders Competencies in Data-Driven Decision Making (SLC3DM). The model has been designed and developed using the Design and Development Research (DDR) approach, which involves three phases: the need analysis phase, the design and development phase, and the usability evaluation phase. However, the researcher only focuses on this paper in the third phase. The model was designed using the Fuzzy Delphi Method (FDM) technique, which entailed consensus from a 20-expert panel. The model usability evaluation phase discovered that all 13 components of the SLC3DM model had high expert consensus. Overall, based on the consensus of the experts, the SLC3DM model is appropriate for usage and implementation. As a result, school leaders can benefit from the SLC3DM model, an empirically grounded and tested tool, as it can boost their knowledge, skills, and attitudes related to data-driven decision-making.

Keywords: School Leaders, Leadership Skills, Data-Driven Decision Making, Usability Evaluation, Fuzzy Delphi Method

INTRODUCTION

Data holds value in the era of the Fourth Industrial Revolution, which encompasses the transformation of industries through advanced technologies, like the Internet of Things (IoT) big data, artificial intelligence (AI) robotics, and cloud computing. These technologies have led to an increase in data generation, collection, and storage. As a result, data has become a resource that enables us to make informed decisions with accuracy (Ashaari et al., 2020; Akal et al., 2019; Mokhtar et al., 2019; Cech et al., 2018). In the field of education data also plays a role, in enhancing the quality and accountability of education within student-cantered approaches that prioritize student's needs, interests, and abilities (Mandinach & Schildkamp 2020; Schildkamp & Kuiper 2010; Darling-Hammond, 2007).

One of the methods employed to use information in education is known as Data-Driven Decision Making (DDDM). This approach involves making decisions based on data that has been collected, analysed, and interpreted (Mandinach & Shildkamp 2020; Kowalski et al., 2008). DDDM is considered a tool for facilitating rational and accurate decision-making processes ultimately leading to improvements in student and school performance (Schildkamp, 2019; Bulkley & McCotter 2019; Hanapiyah et al., 2018;

Killion & Bellamy 2000). Furthermore, DDDM aligns with policies that advocate for data-driven decision-making, such as the No Child Left Behind Policy (2001) and Every Student Succeeds Policy (2015) implemented in the United States. These policies serve as a foundation, for promoting accountability within the education system (Mandinach & Schildkamp 2020; Schildkamp & Kuiper 2010; Darling-Hammond, 2007).

However, the implementation of DDDM also presents challenges and issues in the current educational landscape. The complexity of this situation makes it challenging to gather, analyze, and present the data. Additionally accessing reliable information is difficult. Understanding it poses further obstacles (Schildkamp, 2007). Presently school leaders and teachers find themselves inundated with an amount of rich data, in quantity but poor in quality when it comes to providing valuable information (Datnow et al., 2017; Coburn & Turner 2011; Schildkamp & Kuiper 2010; Wayman & Stringfield 2006). Furthermore, the increased availability of data raises concerns, about ethics, privacy protection, and data security. These aspects necessitate knowledge, skills, and attitudes toward managing data (Gelderblom et al., 2016; MacBeath, 2013; Marsh et al. 2006).

Hence the main objective of this research is to evaluate the usability of the School Leaders Competencies in Data-Driven Decision Making (SLC3DM) model when it comes to utilizing data for decision making. This investigation aspires to enhance our understanding of data-driven decision-making in education and propose strategies and actions that can optimize data utilization for efficient decisions.

Research Objectives

The study aims to accomplish the following objectives;

1. To evaluate the suitability and usability of the competency component in the SL3DM model based on an expert consensus.
2. To evaluate the suitability and usability of the overall applicability of the SLC3DM model based on an expert consensus.

LITERATURE REVIEW

Competency models play a role, in assessing, identifying, and evaluating performance or talent within organizations (Li et al., 2020). Over time various competency models have been developed to cater to the needs and growth of organizations. Thus, there is one theory and three competencies model as the underlying framework of the study to guide the development of this model. This SLC3DM model has been developed based on Taylor's Theory of Information Use Environments by Taylor (1991), Data-Driven Decision Making Conceptual Model by Mandinach et al. (2008), the School Leadership Competency Model for the era of Education 4.0 (SLCMEduc4.0 Model) by Tai and Omar (2019) and Malaysian School Leader Competency Standard 2.0 (KOMPAS 2.0) by IAB (2020).

Taylor's Environmental Theory of Information Use provides a general framework to examine how people utilize information, across fields. Unlike focusing on technology or information-related aspects this theory emphasizes the significance of users and their interaction with information (Taylor, 1991; Chen, 2020). The theory comprises four elements in this theory such as the set of people, the kinds of problems, the setting, and problem solving. In the context of this study, three elements are particularly relevant; characteristics of school leaders (set of people), data-based decision making (kinds of problem), and the nature of school organization (setting). By understanding the qualities of school leaders in circumstances (such as school location or organizational structure) we can better determine which information or data is most suitable for decision making. Consequently, Taylors' theory allows the role of school leader characteristics as potential predictors for this study.

Afterwards, the researcher utilized the DDDM Model developed by Mandinach et al. (2008) to examine the aspects of competence. This model explains DDDM as a procedure, for converting data into information and eventually into valuable knowledge that guides decision making and actions (Mandinach, 2012). Furthermore, this model is versatile and applicable, to this study as it can be employed by leaders in making decisions and can accommodate various forms of data (Mandinach, 2012). Additionally, the DDDM model emphasizes the necessity of capacity or capability when making decisions based on data (Chen, 2020).

Furthermore, the SLCMEduc4.0 Model developed by Tai and Omar (2019) and the KOMPAS 2.0 framework introduced by IAB (2020) plays a role, in identifying the components and elements of competence within the DDDM process as it pertains to school leaders. By combining both the SLCMEduc4.0 Model and KOMPAS 2.0 we can establish a definition of competence that's highly relevant to DDDM with a specific focus on key aspects of modern education such as 21st century learning and Education 4.0. It's worth noting that these models, SLCMEduc4.0 and KOMPAS 2.0 have been specifically designed to cater to the needs of school leaders, in Malaysia.

Besides enhancing the reliability of a study and making a study more robust, researchers also utilize backup models (Saedah Siraj et al., 2021). The usability evaluation phase was conducted by following the Stake's Countenance Evaluation Model. The model that was developed by Robert Stake in 1972 is derived from the term "countenance," which signifies agreement or approval. In the scientific context, the term Countenance means evaluation by prioritizing the implementation of description and consideration (evaluation).

The researcher opted for the Stake’s Countenance Evaluation Model because it effectively assesses products based on users' perspectives. Apart, from evaluating based on descriptions and considerations this model also incorporates evaluations regarding expectations and suitability. During this process, an expert panel compares the models during development. Then compare the results with the anticipated outcomes during evaluation. Hence the usage of the Stake’s Countenance Evaluation Model aligns with phase III of this study, where the researcher initially describes the components and elements of competence. Following that a panel of experts evaluates these aspects to gather a consensus, on the suitability and usability of the SLC3DM Model.

RESEARCH METHODOLOGY

The third stage of the design and development research (DDR) process hinges on the usability evaluation phase, which assesses the effectiveness and efficiency of the product or solution (Richey & Klein, 2014). In this study, researchers utilized the Fuzzy Delphi Method (FDM) technique to gather consensus on the competencies required for school leaders in DDDM. The decision to employ the FDM technique during the third phase was based on its ability as a robust decision-making tool (Murray et al., 1985). The data collection involved specialists and experts, in national secondary schools. This competency aims to enhance school leaders' skills in Malaysia in the future.

Fuzzy Delphi Technique

The FDM method, proposed by Kaufman and Gupta in 1988, combines the Fuzzy theory and the Delphi technique (Murray et al., 1985). It is a robust decision-making tool that can incorporate the opinions of experts in a specific field of study (Murray et al., 1985; Azli Ariffin, 2018; Hsu & Standford, 2007; Powell, 2003; Adler & Ziglio, 1996). Moreover, it is a flexible method that can be applied to various research problems.

According to Saedah Siraj et al. (2021), Mohd Ridhuan Mohd Jamil (2016) and Ho and Wang (2008), the FDM method has several advantages, such as:

i. Reducing boredom among researchers and experts by decreasing the number of Delphi rounds
ii. Preventing data loss and leakage
iii. Allowing experts to provide complete and consistent arguments for their opinions
iv. Accounting for the inevitable fuzziness during the study
v. Assessing the reliability and consensus level of the experts
vi. Saving time and cost of the study

The usability evaluation phase assesses the quality, applicability, and impact of the prototype model built in the design and development phase. It is an essential and mandatory step in the design and development research process (Richey & Klein, 2014). Usability refers to how well a user can use a product or design to achieve a defined purpose efficiently and effectively. Thus, this phase evaluates the suitability and usability of the model for various design and development projects (Saedah Siraj et al., 2021). Figure 1 illustrates the flowchart for the FDM session.

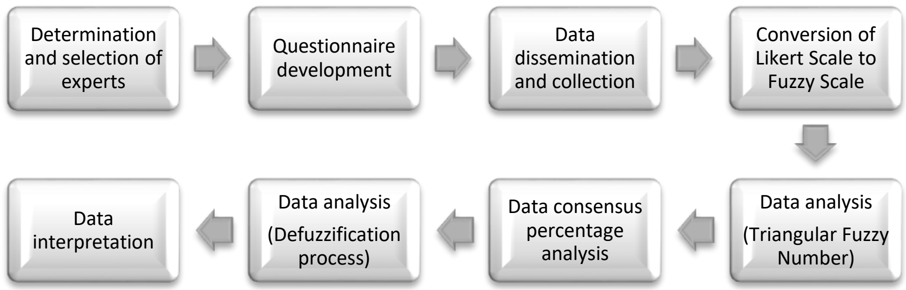

Figure 1 – Flowchart of FDM session for this study.

Panel of Experts
The researchers used a purposive sampling strategy to select the participants. This approach is commonly used and suitable for research with a small sample size and a need to capture the main features of the population.

RESEARCH FINDINGS

a) Usability Evaluation Analysis of Competency Components of the SLC3DM Model

This section analyses and evaluates the expert consensus on the suitability and usability of the SLC3DM Model's competency components. A panel of 20 experts reviewed the competency components of the SLC3DM Model for suitability. The threshold value (d) results for the 13 competency model components were analysed using Microsoft Excel software and are shown in Table 1.

Table 1 shows the threshold value (d) for each competency. Some competencies have a highlight threshold value (d) because it is higher than 0.2, indicating a lack of expert consensus. However, the overall threshold value (d) for each competency is lower than 0.2 ($d \leq 0.2$), which means that the competency meets the level of expert agreement. Chen (2000) and Cheng and Lin (2002) suggest that the items are acceptable if the threshold value (d) is less than or equal to 0.2. Table 2 presents the usability evaluation for the suitability of the 13 competency model components.

Table 2 shows that the threshold value (d) for each item is lower than 0.2 ($d \leq 0.2$), the percentage of each item is higher than 75%, and the fuzzy score of each item is higher than 0.5. These are the three criteria for an expert agreement based on the FDM analysis term. Therefore, the experts agree that the 13 competency components of the SLC3DM Model are suitable and relevant for the study.

Table 1 - The threshold value (d) results for the competency components of the model

Experts	**Competency Components of the SLC3DM Model**												
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**
1	0.142	0.076	0.096	0.104	0.084	0.185	0.153	0.099	0.157	0.118	0.111	0.172	0.164
2	0.034	0.076	0.062	0.104	0.084	0.185	0.153	0.099	0.157	0.118	0.048	0.035	0.033
3	0.142	0.076	0.096	0.104	0.084	0.050	0.242	0.099	0.031	0.118	0.111	0.172	0.230
4	0.251	0.316	0.062	0.288	0.071	0.209	0.242	0.056	0.237	0.276	0.048	0.223	0.230
5	0.142	0.076	0.297	0.056	0.071	0.209	0.153	0.295	0.237	0.041	0.048	0.035	0.033
6	0.142	0.076	0.096	0.104	0.084	0.185	0.153	0.099	0.157	0.118	0.111	0.172	0.164
7	0.142	0.076	0.096	0.104	0.084	0.050	0.025	0.099	0.031	0.041	0.111	0.035	0.164
8	0.142	0.076	0.096	0.104	0.084	0.209	0.025	0.099	0.031	0.118	0.111	0.035	0.230
9	0.034	0.078	0.297	0.056	0.309	0.050	0.242	0.056	0.237	0.276	0.283	0.035	0.230
10	0.142	0.076	0.096	0.104	0.084	0.050	0.025	0.099	0.157	0.041	0.111	0.035	0.164
11	0.034	0.078	0.062	0.056	0.071	0.050	0.025	0.056	0.031	0.041	0.283	0.223	0.033
12	0.251	0.078	0.096	0.104	0.071	0.050	0.025	0.056	0.031	0.118	0.111	0.035	0.033
13	0.251	0.076	0.096	0.104	0.084	0.050	0.025	0.099	0.237	0.041	0.048	0.035	0.033
14	0.034	0.076	0.096	0.580	0.309	0.504	0.025	0.295	0.157	0.041	0.111	0.223	0.230
15	0.251	0.078	0.062	0.056	0.071	0.050	0.025	0.056	0.031	0.041	0.048	0.035	0.033
16	0.142	0.076	0.096	0.104	0.084	0.050	0.153	0.099	0.157	0.118	0.111	0.172	0.164
17	0.142	0.076	0.096	0.104	0.084	0.185	0.153	0.099	0.157	0.118	0.111	0.172	0.164
18	0.034	0.076	0.096	0.056	0.084	0.185	0.242	0.056	0.237	0.041	0.048	0.223	0.033
19	0.034	0.316	0.297	0.056	0.084	0.050	0.025	0.056	0.031	0.276	0.283	0.223	0.033
20	0.251	0.078	0.062	0.056	0.071	0.209	0.025	0.056	0.031	0.118	0.048	0.035	0.033
Thres-hold (d)	0.137	0.101	0.117	0.120	0.103	0.138	0.107	0..101	0.127	0.111	0.114	0.116	0.121

Table 2 - The usability evaluation for the suitability of the competency components of the model

No	Competency Components of the SLC3DM Model	Terms of Triangular *Fuzzy Number*		Terms of *Defuzzification*				Evaluation Status
		Threshold (d)	Experts Consensus (%)	m1	m2	m3	Fuzzy Score (A)	
1	Critical Thinking	0.137	75%	0.740	0.895	0.975	0.870	**SUITABLE**
2	Communication	0.101	90%	0.810	0.945	0.990	0.915	**SUITABLE**
3	Change Management	0.117	85%	0.790	0.930	0.985	0.902	**SUITABLE**
4	Emotional Intelligent	0.120	90%	0.780	0.925	0.980	0.895	**SUITABLE**
5	Integrity	0.103	90%	0.800	0.940	0.990	0.910	**SUITABLE**
6	Digital Literacy	0.138	75%	0.690	0.865	0.965	0.840	**SUITABLE**
7	Data Literacy	0.107	80%	0.720	0.890	0.980	0.863	**SUITABLE**
8	Decision Making	0.101	90%	0.780	0.930	0.990	0.900	**SUITABLE**
9	Data Analytics	0.127	75%	0.720	0.885	0.975	0.860	**SUITABLE**
10	Strategic Thinking	0.111	85%	0.760	0.915	0.985	0.887	**SUITABLE**
11	Collaborative	0.114	85%	0.770	0.920	0.985	0.892	**SUITABLE**
12	Creative and Innovative	0.116	75%	0.700	0.875	0.975	0.850	**SUITABLE**
13	Digital Ecosystem Culture	0.121	75%	0.710	0.880	0.975	0.855	**SUITABLE**

b) Overall Usability Evaluation Analysis of the SLC3DM Model

This section evaluates the overall suitability and usability of the SLC3DM Model. The same analyses performed earlier are repeated to assess the usability of the model. Table 3 presents the Fuzzy Delphi analysis and Table 4 shows its details.

Table 3 - Threshold value (d) for overall model usability evaluation

Experts	**Item**					
	1	**2**	**3**	**4**	**5**	**6**
1	0.159	0.138	0.197	0.153	0.160	0.118
2	0.040	0.138	0.196	0.025	0.026	0.118
3	0.159	0.138	0.061	0.153	0.026	0.041
4	0.040	0.034	0.061	0.025	0.026	0.041
5	0.234	0.255	0.061	0.242	0.235	0.276
6	0.159	0.138	0.197	0.153	0.160	0.118
7	0.040	0.034	0.061	0.025	0.026	0.041
8	0.159	0.138	0.197	0.153	0.160	0.118
9	0.040	0.034	0.196	0.025	0.235	0.041
10	0.040	0.034	0.061	0.025	0.026	0.041
11	0.040	0.034	0.196	0.025	0.026	0.041
12	0.040	0.034	0.061	0.025	0.026	0.041
13	0.040	0.034	0.061	0.025	0.026	0.118
14	0.159	0.138	0.196	0.242	0.160	0.118
15	0.040	0.034	0.061	0.025	0.026	0.118
16	0.234	0.255	0.196	0.242	0.235	0.276
17	0.159	0.138	0.197	0.153	0.160	0.118
18	0.159	0.138	0.197	0.153	0.026	0.118
19	0.829	0.548	0.492	0.242	0.235	0.276
20	0.040	0.034	0.061	0.025	0.026	0.041
Threshold (d)	**0.140**	**0.124**	**0.150**	**0.107**	**0.101**	**0.111**

Table 4 - Applicability of overall model usability evaluation based on Fuzzy Delphi analysis

No	Item	Terms of Triangular *Fuzzy Number*		Terms of *Defuzzification*				Evaluation Status
		Threshold (d)	**Experts Consensus (%)**	**m1**	**m2**	**m3**	**Threshold (d)**	**Experts Consensus (%)**
1	This model clearly shows how school leaders can implement the data-based decision-making process.	0.140	85%	0.885	0.965	0.857	0.720	**SUITABLE**
2	This model can guide school leaders in using data to improve educational outcomes.	0.124	85%	0.900	0.975	0.872	0.740	**SUITABLE**
3	This model can easily mastered by school leaders.	0.150	95%	0.855	0.960	0.832	0.680	**SUITABLE**
4	This model meets high productivity expectations for school leaders.	0.107	80%	0.890	0.980	0.863	0.720	**SUITABLE**
5	This model is practical to implement at the school level.	0.101	80%	0.885	0.980	0.858	0.710	**SUITABLE**
6	This model can be used as an example to develop a new school leader professionalism development model.	0.111	85%	0.915	0.985	0.887	0.760	**SUITABLE**

The data in Table 3 and Table 4 show that the threshold value (d), the percentage, and the fuzzy score of each item meet the criteria for expert agreement. The threshold value (d) ranges from 0.101 to 0.150, which is lower than 0.2 ($d \leq 0.2$). The percentage ranges from 80% to 95%, which is higher than 75%. The fuzzy score ranges from 0.680 to 0.760, which is higher than 0.5 ($\alpha \geq 0.5$).

The study results indicate that the SLC3DM Model has a satisfactory level of usability. The expert panel agrees that the model suits and applies to school leaders.

DISCUSSION

The evaluation of the suitability and usability of the competency components, in the SLC3DM Model is determined by examining the threshold value (d), the level of agreement among experts, and the fuzzy score (A). After analysis, it was found that all items fulfill the requirements, for expert agreement. This demonstrates that all 13 competency components incorporated in the SLC3DM Model align with the context of this study. These competencies encompass critical thinking, communication, change management, digital literacy, data literacy, decision making, data analytics, strategic thinking, collaborative, creative and innovative digital ecosystem culture, emotional intelligence, and integrity.

The SLC3DM Models' overall usability was evaluated by an expert panel using five questions as displayed in Table 5. The first question, concerning the clarity of implementing the DDDM process by school leaders, received agreement, from the panel (d = 0.140, % = 85 A = 0.720). Similarly, the second question regarding the model's ability to guide school leaders in making data-driven decisions also obtained consensus (d = 0.124, % = 85, A = 0.740). The third question received agreement from the panel regarding how easily school leaders can master this model (d = 0.150, % = 95, A = 0.680). Additionally, the expert panel agreed that this model meets productivity expectations for school leaders (d = 0.107, % = 80 A = 0.720). Lastly, there was agreement among experts that this model is practical to implement at the school level, for the question (d = 0.101, % = 80%, A= 0.710). Moreover, the expert panel also expressed their agreement, concerning the query regarding the model's suitability as a prototype for crafting a professionalism development model, for school leaders (d = 0.111, % = 85, A = 0.760).

The study's findings indicate that the evaluation of the SLC3DM Models usability meets all three conditions of the Fuzzy Delphi analysis demonstrating its suitability, for leaders at the school level. This aligns with Mohd Ridhuan Mohd Jamil (2016) belief that a model should guide its users effectively. Additionally, there is a consensus that a good model is user-friendly and easily understandable (Abdul Muqsith Ahmad, 2018). Hence this evaluation confirms that the design and development of the SLC3DM Model are appropriate and address needs. Moreover, making data-driven decisions may seem straightforward. It carries implications, for organizations.

CONCLUSION

In conclusion, this study is manifold and significant for the education sector in Malaysia. Firstly, it provides a comprehensive and validated framework for assessing and developing the DDDM competencies of school leaders. Secondly, it offers practical and evidence-based suggestions for enhancing the DDDM culture and capacity of schools. Thirdly, it contributes to the literature on DDDM in education, especially in the Malaysian context, where such studies are scarce. Lastly, it paves the way for future research on the impact of DDDM competencies on school performance, student outcomes, and stakeholder satisfaction. Consequently, there is a need for research to gain a deeper understanding of the study context beyond just implementing the model. The implementation phase is not carried out in this study as it does not align with its objectives. Nevertheless, exploring the implementation of the model can assist researchers in examining its effectiveness. Therefore, this study has the potential to advance the theory and practice of DDDM in education and to foster a culture of data-informed decision-making among school leaders in Malaysia.

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