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by Aang Kisnu

Identifying Success Factors in Smart City Readiness using a Structure Equation Modelling Approach

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***Abstract*— The concept of a smart city is now expected to be a solution to various city problems that are becoming increasingly complex. IoT and ICT-based city governance are expected to be able to carry out efficiency in monitoring and managing traffic, transportation systems, power plants, water supply networks, waste management, crime detection, schools, libraries, hospitals, etc. However, in its implementation, there are many crucial problems such as lack of competent human resources, ICT policies, and governance that have not been efficient, lack of government commitment and lack of community participation. This study aims to identify crucial factors in the process of readiness and application of the smart city concept to regional governments in Indonesia. The method used is descriptive quantitative by conducting a smart city readiness survey on related stakeholders, namely the government and the community. The combination of models in Delone & McLean and the Technology Acceptance Model (TAM) is used as a research framework. Data analysis used the Structural Equation Modeling model with the help of AMOS 24.0 Software. The results of the study are that there is a significant relevance to the model constituent variables. This research contributes to the relationship model of smart city preparedness factor and the recommendation that the government and stake-holders pay more attention to the factors that determine the success of the application of the concept of a smart city.**

Keywords-Smart City Readiness, Delone & McLean Model, Technology Acceptance Model, Structural Equation Model

I. INTRODUCTION

The Smart City concept is expected to be a problem-solving in urban areas, such as congestion, accumulated garbage, energy needs, poor quality of public services and so on while managing various resources well and efficiently. Some major cities in Indonesia have tried to implement the Smart City concept to solve the above problems, including cities of Bandung, Bogor, and Surabaya. In 2016, the Center for Digital Society (CfDS) Faculty of Social and Political Sciences, Gadjah Mada University named Surabaya City as the top-ranked as the brightest city in Indonesia from 12 smart cities in Indonesia[2][3].

The four districts on Madura Island, namely Bangkalan, Sampang, Pamekasan and Sumenep Districts do not want to be left behind from cities that have implemented the smart city concept by starting collaboration with Faculty of Computer Science Universitas Brawijaya to make a Masterplan for the application of smart city concepts, but in practice constraints so that until now it has not been able to start the realization of Smart City development.

There are quite complex problems in the effort to implement smart cities in Indonesia, among them are sporadically done[4], do not have a suitable framework[5], templates are limited because each city has specific problems and needs.[6]. The other problems of implementing smart cities is the lack of understanding and mindset of SCity Building[3], lack of integrated systems and data management[7], lack of participation[8], involvement and coordination of SCity stakeholders[9], inefficient policies [10]and ego issues, sectoral ego and political leadership[11].

In developing smart cities, there is no identification of factors for checking readiness to use smart city technology. In a previous study, various researchers have looked at the level of preparedness of the citizens and the government's readiness to accept smart city technology[12], but are still separate. This study seeks to identify the readiness of local governments and communities simultaneously and integrally as an important part of the successful implementation of a smart city. In this study, it was used to combine the Delone & Mc Lean method to measure the success of smart city implementation[13][14] as well as the Technology Acceptance Model method to measure user acceptance of technology adoption[15][16].

The results of the study show that there is a significant relationship of relevance between the constituent variables in the Delone McLean model and the Technology Acceptance Model to measure the level of success and acceptance of local government and society in the process of technology adoption. This study contributes to the relationship model of smart city preparedness factors and recommendations for the government and stakeholders to pay more attention to the factors that determine the success of implementing the smart city concept. This is one way to avoid local government unpreparedness when new technology has been made for them to support their services

II. Literature Review

A. Smart City and Smart City Readiness

Smart City is an area that has used various types of sensor Internet of Things (IoT) sensors to collect data and then be managed as resources efficiently. This data includes data collected from the community, devices, and assets which are then processed and analyzed to monitor and manage traffic, waste management, water supply networks, fire detection, transportation systems, power plants, school information systems, libraries, hospitals and services for other communities [17][18]

The concept of smart cities integrates information and communication technology (ICT), and various other physical devices that are connected to IoT networks for efficient city operations and services that are connected to citizens.[19]. There are many factors that greatly influence the success of implementing Smart City, including Technology, Management and organization, policy, economy, citizens, infrastructure, and the Environment. In smart city governance, there are six most basic dimensions, namely Smart Government, Smart Economy, Smart Environment, Smart Living, Smart People, Smart Mobility [20].

Fig. 1. Smart City Dimensions

B. Delone & McLean Model

The DeLone and McLean are models that are used to measure the success of an information system, as an alternative model of IS success. This model seeks to provide a comprehensive understanding of IS success by identifying, describing, and explaining the relationships between the construct variables, which are the most dimensions for the success of evaluating an information system. The earliest development of this theory was first carried out by William DeLone and Ephraim R. McLean in 1992[13], then refined by the original author ten years later in response to feedback received from other scholars working in the area[21][14]. This IS success model has been widely cited in thousands of scientific papers and is considered one of the most influential theories in contemporary information systems research.

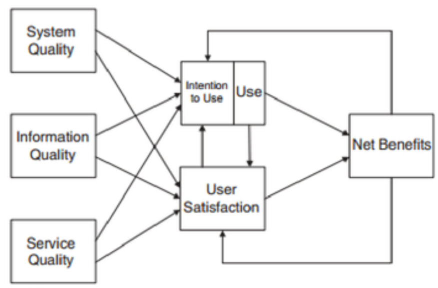

Fig. 2. Delone & Mc Lean Model

C. Technology Acceptance Model

Technology Acceptance Model or TAM is an adaptation of the Theory of Reasoned Action (TRA) into the Information System field. TAM believes that the usefulness and ease of use that is felt to determine the individual's intention to use a system by entering values serving as mediation from the actual use of the system. The perceived usefulness can be seen as a result of the direct impact of perceived ease of use. The researchers then simplified TAM by removing the attitude variables that exist in TRA[16][15][22]. Efforts to develop TAM, in general, are then carried out by using three approaches, namely by introducing constructs of the related models, by introducing additional or alternative constructs of beliefs, and by examining the antecedents and moderators of perceived usefulness and convenience[23]. In the latest study of Gefen and Larsen[24] showed that contractual relationships in TAM emerged from semantic relationships between questionnaire items. A theory that explains their findings is explained by the Semantic theory of the response of the survey conducted.

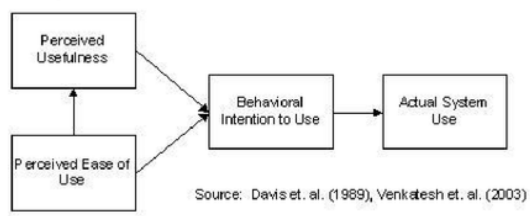

Fig. 3. Technology Acceptance Model

III. Methodology

The method used in this study is descriptive quantitative. The researcher makes direct observations on the object being analyzed. Observation process is carried out to obtain quantitative data that is relevant to the research. This study uses primary and secondary data. Primary data is carried out by conducting interviews and questionnaires on Smart City Stakeholders, namely the Government Sector and the community in Sampang and Pamekasan Regencies. The questionnaire was compiled according to Venkatesh's research with a 5-point Likert scale. This study uses a sample of 201 respondents. While secondary data comes from activity reports, books, and official articles made by the local government.

In conducting data analysis, a Structural Equation Modeling and Path Analysis model is used using AMOS

24.0 software. More comprehensive SEM methods in explaining the phenomenon of research. While path analysis and multiple regression are only able to reach the level of latent variables so that they have difficulty in parsing or analyzing empirical phenomena that occur at grain levels or indicators of latent variables.

A. Proposed Research Framework

The proposed conceptual framework of this research was carried out by combining and rebuilding nine construct variables from the Delone & Mc I[35] and TAM Models. The nine contracted variables are perceived Ease of Use [34]OU), Perceived of Use (PU), Service Quality (ServQ), System Quality (SysQ), Information Quality (IQ), Intention Use (IU), User Satisfaction (US), Net benefit (NB), Actual Use (AU).

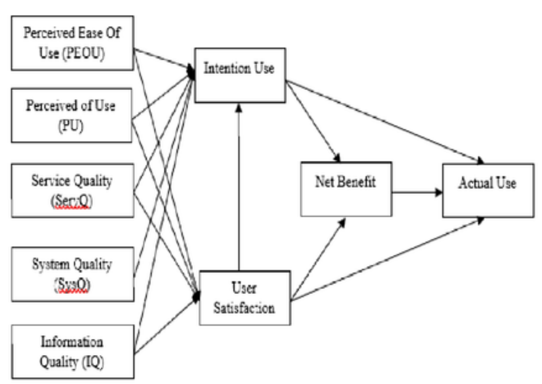

Fig. 4. Proposed Research Framework

TABLE I. MAIN CONSTRUCT PROPOSED MODEL

No	Variables	Definitions	Indicators	Symbols
1	Perceived Ease Of Use (PEOU)	A measure where one belives that a system brings convenience to users	Ease to learn	PEOU1
			Controlled	PEOU2
			Clear and understood	PEOU3
			Flexible	PEOU4
			Ease to master	PEOU5
			Ease to use	PEOU6
2	Perceived of Use (PU)	A measure where the use of the system is believed to brings benefits to the people who use it	Faster use	PU1
			The performance	PU2
			Increase effectiveness	PU3
			effectiveness	PU4
			helpful	PU5
3	Service Quality (ServQ)	Comparison of user expectation with the perception of the real services they receive	Technical ability	ServQ1
			empathy	ServQ2
			present	ServQ3
			responsive	ServQ4
			Flexibility system	ServQ5
4	System Quality (SysQ)	Measurement of the quality of the information system itself, whether software or hardware	Ease to learn	SysQ1
			Safe and stable system	SysQ 2
			System response time	SysQ 3
			Flexibility system	SysQ 4
5	Information Quality (IQ)	The quality of information that is measured subjectively by the user wich is then called perceptual information quality	completeness	IQ1
			accurate	IQ2
			reliability	IQ3
6	Intention Use (IU)	Differences in use into the use of the system wich means the use of information and use of the information system itself	Daily use	IU1
			User frequency	IU2
			Light of use	IU3
			Various Uses	IU4
7	User Satisfaction (US)	Is a response and feedback that emerges from the user after using the information system	Information satisfaction	US1
			Overall frequency	US2
			Accuracy of information	US3
			Various information	US4
8	Net benefit (NB)	The result or benefit felt by individuals and organization after implementing an information system	Speed of completing work	NB1
			performance	NB2
			effectivity	NB3
			Increase efficiency	NB4
9	Actual Use (AU)	Measurement of frequency and duration of use of technology	continue	AU1
			Use more	AU2
			Use in general terms	AU3
			Use in certain cases	AU4

IV. RESULT AND DISCUSSION

After the questionnaire from the community and the local government was collected, the validity test, reliability test, were conducted. Validity testing is done to see whether each question is built based on a valid construct. While reliability testing is used to see whether the questionnaire made can be counted or not. A good and reliable questionnaire instrument will have close results for measuring the same object. Whereas convergent validity is used to measure correlation scores from correlations between indicator score scores.

Validity Test is used to measure the accuracy of the instrument in this study, then testing the validity. Namely, test convergent validity and discriminant validity test. if the outer loading value of each indicator is> 0.5, then it can be said to be valid

TABLE II. VALIDITY TEST RESULT

Latent variable	Reflective Indicator	Outer Loading	Information
Perceived Ease Of Use (PEOU)	PEOU1	0.705	Valid
	PEOU2	0.863	Valid
	PEOU3	0.638	Valid
	PEOU4	0.696	Valid
	PEOU5	0.685	Valid
	PEOU6	0.601	Valid
Perceived of Use (PU)	PU1	0.732	Valid
	PU2	0.675	Valid
	PU3	0.669	Valid
	PU4	0.553	Valid
	PU5	0.652	Valid
Service Quality (ServQ)	ServQ1	0.620	Valid
	ServQ2	0.528	Valid
	ServQ3	0.478	Valid
	ServQ4	0.624	Valid
	ServQ5	0.743	Valid
System Quality (SysQ)	SysQ1	0.678	Valid
	SysQ 2	0.770	Valid
	SysQ 3	0.877	Valid
	SysQ 4	0.529	Valid
Information	IQ1	0.492	Invalid

Quality (IQ)	IQ2	0.747	Valid
	IQ3	0.625	Valid
Intention Use (IU)	IU1	0.678	Valid
	IU2	0.479	Invalid
	IU3	0.400	Invalid
	IU4	0.422	Invalid
User Satisfaction (US)	US1	0.549	Valid
	US2	0.556	Valid
	US3	0.610	Valid
	US4	0.611	Valid
Net benefit (NB)	NB1	0.607	Valid
	NB2	0.568	Valid
	NB3	0.692	Valid
	NB4	0.579	Valid
Actual Use (AU)	AU1	0.616	Valid
	AU2	0.626	Valid
	AU3	0.604	Valid
	AU4	0.407	Invalid

Based on the table above, the results of the convergent validity test conducted in this study indicate that most indicators of latent variables have outer loading values above 0.5. But there are still indicators that still have an output value of loading below 0.5, namely IQ1, IU2, IU3, IU4, and AU4.

TABLE III. DISCRIMINANT TEST RESULT

	SysQ	ServQ	PU	PEOU	IQ	US	IU	NB	AU
SysQ	0.683								
ServQ	0.705	0.850							
PU	0.611	0.840	0.846						
PEOU	0.602	0.730	0.783	0.811					
IQ	0.505	0.510	0.484	0.420	0.403				
US	0.410	0.528	0.532	0.563	0.301	0.456			
IU	0.410	0.525	0.525	0.542	0.304	0.434	0.416		
NB	0.600	0.740	0.707	0.603	0.471	0.443	0.445	0.610	
AU	0.474	0.585	0.558	0.475	0.373	0.348	0.350	0.485	0.413

Test the validity of discrimination, based on the table above; it can be seen that the value of cross loading is variable> 0.5. So that it can be concluded that some latent variables fulfill discriminant validity. but there are still several variables that have values below 0.5 including variables IQ, US, IU, and AUAU

TABLE IV. RELIABILITY TEST RESULT

Latent variable	Composite Reliabilities	Information
PEOU	0.811	Reliable
PU	0.846	Reliable
ServQ	0.850	Reliable
SysQ	0.683	Reliable
IQ	0.403	Not reliable
IU	1.000	Reliable
US	0.821	Reliable
NB	1.092	Reliable
AU	0.935	Reliable

Reliability Test, after testing the validity, then performed reliability testing. This test is done by calculating the composite reliability value. If the value of the reliability test is> 0.5, then the latent variable can be considered good or reliable. Based on table data, it shows that the variable is latent PEOU, PU, ServQ, SysQ, IU, US, NB, AU has a value above 0.5, so it is considered reliable. But IQ variables have values below 0.5, so they are considered unreliable.

Confirmatory Factor Analysis Test the structural model in AMOS was evaluated using path analysis, here is the CFA and the model in this research study

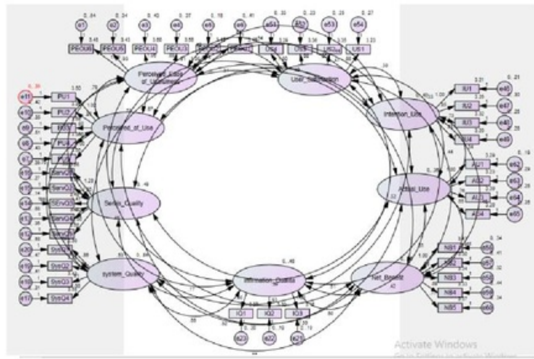

Fig. 5. Confirmatory Factor Analysis Model using AMOS 24.0

based on research results can be seen in the following results

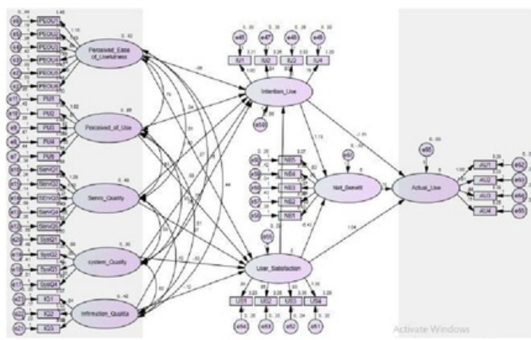

Fig. 6. SEM Model Result using AMOS 24.0

TABLE V. HYPOTHESIS TEST RESULT

Hypothesis	Relations	Critical Ratio	Noted	Result
H1	PEOU-> US	3,368	>1.96	accepted
H2	PU-> US	2.857	>1.96	accepted
H3	ServQ-> US	1.926	>1.96	accepted
H4	SysQ-> US	1.936	>1.96	accepted
H5	IQ-> US	1. 996	>1.96	accepted
H6	PEOU-> IU	1.314	<1.96	rejected
H7	PU-> IU	1.385	<1.96	rejected
H8	ServQ-> IU	2.203	>1.96	accepted
H9	SysQ-> IU	2.158	>1.96	accepted
H10	IQ-> IU	1.137	<1.96	rejected
H11	IU-> NB	9.898	>1.96	accepted
H12	US-> NB	2.275	>1.96	accepted
H13	IU-> AU	0.406	<1.96	rejected
H14	US->AU	0.408	<1.96	rejected
H15	NB-> AU	3,857	>1.96	accepted

Based on Table V above, the final results are shown as variable Perceived Ease of Usefulness (PEOU), Perceived of Use (PU), Servis Quality (ServQ), System Quality (SysQ), Information Quality (IQ) positive and significant effect variable User Satisfaction (US) positive and significant effect partially and simultaneously. That means the community and local government employees see the factors of expediency, convenience, service quality, system quality, and information quality are variables and important factors in user satisfaction.

Variable Servis Quality (ServQ) and System Quality (SysQ) has a positive and significant effect on Intention Use (IU) but Variable Perceived Ease of Usefulness (PEE), Perceived of Use (PU) and Information Systems (IQ) does not have a significant effect on Intention Use (IU). It means they believe that service quality and system quality are important factors on the intention to use systems. The otherwise they believe that benefit factor, convenience, do not influence the intention factor in using the systems.

Variable Intention Use (IU) and User Satisfaction (US) have a positive and significant effect on Net Benefit (NB). It can be seen that civil's society see factors intention and satisfaction are variables and important factors in Net Benefits.

Variable Intention Use (IU) and User Satisfaction (US) does not have a positive and significant effect on Actual Use (AU). That means the community and local government employees see the factors of intention and satisfaction are variables and important factors which has an effect user's actual Use.

V. Conclusion

Smart city in Sampang and Pamekasan districts as a concept must be started consistently and continuously following the previously prepared master plan. It is necessary to prepare the community and local government in accepting and adopting new technologies. This study identifies factors that influence regional readiness for the application of smart cities.

Based on the analysis carried out 10 out of 15 hypotheses were accepted while the rest were rejected. Therefore, it can be concluded that the factors that influence the public and civil servants in Sampang and Pamekasan districts are influenced by PEE, Perceived of Use (PU), Service Quality (ServQ), System Quality (SysQ), Information Quality (IQ), and Intention Use (IU).

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