COMMUNICATIONS IN
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Determinant of success factors in intelligent transport system (ITS) implementation in Jakarta

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Article history:
Received: 27 September 2021 / Received in revised form: 15 December 2021 / Accepted: 23 December 2021

Abstract

As the capital city of Indonesia, Jakarta has always become the cornerstone of economic development in this country. This condition then creates a logical consequence in which one of the crucial problems is transportation management implicating the congestion levels. This research is an initial attempt to design a structural framework of conceptual relationships among the determinants of the implementation of the intelligent transport system (ITS) in the land transportation system in Jakarta. The eight factors that affect the development of ITS strategy include funding, skills, operational guidance, human resources, utilization of available data, political policies, cooperation between parties, and socio-economic benefits. The Fuzzy-Total Interpretive Structural Modeling (TISM) method was applied to develop a structural framework that can provide greater flexibility to express the level of influence using fuzzy numbers. On the other hand, the Matrice d'Impacts Croisés Multiplication Appliquée un Classement (MICMAC) analysis method was used to improve the understanding and classification of factors based on the driving forces and interdependencies between factors. We found out that the skill was a driving factor that had the highest level of driving force compared to other factors and the success of ITS services in Jakarta can be judged from the socio-economic benefits because this factor was found to be determined by the sustainability of other factors.

Keywords: Intelligent transport system; land transportation systems; MICMAC analysis; total interpretive structural modeling

1. Introduction

Based on a survey conducted by the TomTom Research Institute (2020), it was known that Jakarta has a 36% congestion level. This number has decreased from 2019, thus causing DKI to move out of 10th position and shifted to the 31st place. Previously in 2019 Jakarta was in the 10th place on the list of big cities with the high congestion level. At that time, TomTom issued a congestion level result in DKI that reached a value of 53%, while in 2018, Jakarta was in the 7th place. On the other hand, the transportation management problems in Jakarta are getting more complicated considering the rapid growth in the number of vehicles that has exceeded the development of road infrastructure. Therefore, a sustainable development plan for infrastructure and public transportation facilities is deemed necessary.

The Jakarta Provincial Government is still consistent in building and developing the public transportation system throughout the city. Various ways have been carried out, for example through the integration of mass public transportation services in Jakarta namely JakLingko as a part of the pull strategy, while the implementation of the odd-even system as the push strategy. The integration system of mass public transport as the priority of the Jakarta Provincial Government is also a part of the intelligent transport system (ITS) development.

However, the intelligent transport system (ITS) development project in Jakarta has still not finished yet due to some governance and management factors. Many stakeholders are involved, thus causing the absence of a reference point that can be used for completing the intelligent transport system (ITS) development project. Hence, attempts to design a structural framework to support the development and successful implementation of the intelligent transport system (ITS) are necessary to find the potential solutions for traffic congestion problems in Jakarta. This study aims to facilitate policy makers and stakeholders by designing decision making related to the development of ITS implementation for land transportation as a further action for traffic congestion in DKI Jakarta. A structured framework among the determinants of ITS implementation for land transportation in Jakarta needs to be built.

Intelligent Transport Systems

Intelligent transportation systems (ITS) refer to a

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https://doi.org/10.21924/chss.1.2.2021.15

compilation of multi technology that includes electronic technology, information processing, wireless communications, and controls. The system is created to improve the safety, efficiency, and convenience of the transportation network as a whole. (Shaheen and Finson, 2013). ITS deployment can be categorized into three stages: (1) initial ITS technology testing and implementation; (2) Initial connecting of ITS technology; and (3) developing an integrated system of ITS technology.

Application of ITS in several countries

The application of ITS improves traffic management, and creates a smoother traffic flow, and a higher level of safety and security. This system also covers telematics and all types of communication in-vehicle, between-vehicle and between-vehicle and infrastructure. Generally speaking, ITS can overcome traffic congestion, and reduce traffic accidents and environmental externalities caused by road transportation. This causes the groundwork for creating benefits such as increasing the competitiveness of transportation logistics, ensuring the effective use of relevant resources, and minimizing carbon gas emissions by realizing low-carbon green transportation (UNESCAP, 2017)

Experiences and lessons learned from the policy, planning and operations processes in each country will provide important guidelines and directions for building the ITS model. Since its inception in the mid-1990s, ITS China has experienced two decades of development. In the 9th Five-Year Plan (1996-2000), the Ministry of Transportation carried out China's intelligent transportation development strategy and a national ITS architecture study. During the 10th Five-Year Plan (2001-2005), based on major national science and technology projects, research on important technologies and development of ITS and key products was launched. The implementation of ITS that was demonstrated in 13 cities showed some positive results. During the 11th Five-Year Plan (2006-2010), parallel to the main demands of the national economy and the people, a series of demonstrations on integrated services and mass applications were carried out and achieved some significant results. The governments and the citizens had deeper insights about the impact of smart transportation on the improvement of management levels, service quality, and emerging industries.

Implementation of ITS in Jakarta

In Jakarta, the design for implementing the intelligent transport system (ITS) has been regulated in Presidential Regulation of the Republic of Indonesia Number 55 of 2018 concerning the Master Plan of Transportation for Jakarta, Bogor, Tangerang, and Bekasi (RITJ) in 2018 - 2029:

- Improvement of Urban Transportation Safety and Security Urban Transport
- Development of Infrastructure Network
- Development of road-based urban transportation system
- Development of Rail-based Urban Transportation System
- Development of Integrated Urban Transportation Development
- Strategies and Programs for Policy
- Traffic Performance Improvement
- Development of Integrated Urban Transport and Spatial Planning
- Development of Urban Transport Environment

These points above become the priority orientations in building and developing the land transportation system in Jakarta. Specifically, the development of the intelligent transport system (ITS) is the embodiment of 5th point in this Presidential Regulation. However, if studying it further, it can be seen that at least there are several other points that have also been, are being, and will be developed in a sustainable manner.

2. Methodology

Zadeh (1965) developed the fuzzy theory to handle real-world uncertainty more efficiently (Jain & Soni, 2019). The fuzzy set is analogous to human thinking and is represented by a membership function. Two theorems were briefly discussed and used in this paper (Khatwani et al., 2015):

- Theorem 1: Suppose two triangular fuzzy numbers are A1 = (l1, m1, u1) and A2 = (l2, m2, u2). The addition operation A1 and A2 is denoted by A1+A2, producing a triangular fuzzy number and can be represented by

$$A1 + A2 = (l1+l2, m1+m2, u1+ u2) \quad (1)$$

- Theorem 2: Based on Opricovic and Tzeng (2003) using the CFCS method (Converting Fuzzy data into Crisp Score) and defuzzification method.

Step 1: Computing L = min(lk); R = max(uk); k = 1,2, .., .., n and Δ = R – L, then compute for each alternatives Eq. (2).

$$x_{lk} = (l_k - L)/\Delta,\ x_{mk} = (m_k - L)/\Delta,\ x_{uk} = (u_k - L)/\Delta \quad (2)$$

Step 2: Computing left score (ls) and right score (rs) normalized values using Eq. (3).

$$x_k^{ls} = x_{mk}/(1 + x_{mk} - x_{lk}) \text{ and } x_k^{rs} = x_{uk}/(1 + x_{uk} - x_{mk}) \quad (3)$$

Step 3: Computing total normalized crisp value using Eq.(4).

$$x_k^{crisp} = \left[x_k^{ls} \times (1 - x_k^{ls}) + x_k^{rs} \times x_k^{rs}\right]/\left[1 - x_k^{ls} + x_k^{rs}\right] \quad (4)$$

Step 4: Computing crisp value using Eq.(5)

$$\tilde{B}_k^{crisp} = L + x_k^{crisp} \times \Delta \quad (5)$$

The TISM methodology is an extension of the ISM methodology as it explains the interactions between variables (Sushil, 2012). Fuzzy-TISM is an advanced version of TISM.

The integration of TISM with fuzzy sets facilitates the decision makers more flexibly to understand the level of influence of one criterion on other criteria, which previously only existed in the form of binary numbers (0,1). 0 represents no influence and 1 represents influence. Therefore, the Fuzzy-TISM approach provides greater flexibility to express the level of influence using fuzzy numbers (Khatwani et al., 2015).

Fuzzification is the process of transforming firm values in a set into fuzzy values and linguistic values. Linguistic values are based on triangular fuzzy numbers for linguistic variables. This methodology incorporates algorithms for Fuzzy-TISM. There are several methods of defuzzification. The conversion of fuzzy data into crisp scores is one of the defuzzification methods originally proposed by Opricovic and Tzeng (2003) and later used by (Khatwani et al., (2015), Uygun and Dede (2016)). They are categorized into five linguistic variables, such as Very High Impact (VH), High Impact (H), Low Impact (L), Very Low Impact (VL) and No Impact (see figure 1). For example, if (i,j) entry in SSIM is V(VH), then it is denoted as (0.75, 1, 1) and entry (j, i) is denoted as (0, 0, 0.25), which represents fuzzy.

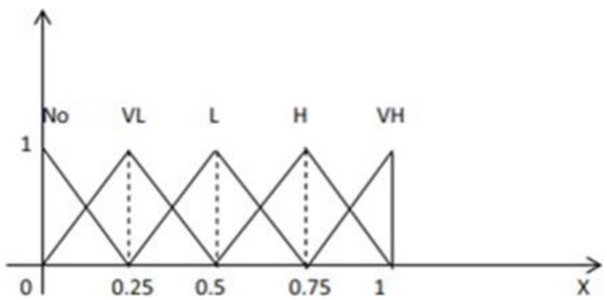

Fig. 1. Triangular Fuzzy-TISM

This research was conducted to determine a relationship between variables based on contextual relationships, so it can produce a structured framework. The flow in this research is divided into several stages as shown in figure 2.

3. Results and Discussion

Based on the literature study and the opinions from 5 experts with Focus Group Discussions (table 1), there are 8 determining factors that are used as research variables that influence the development of ITS implementation for land transportation in Jakarta (table 2).

Table 1. Experts Profile

Job Title	Desc.
Construction Manager PT. Kereta Api Indonesia Properti Manajemen	15-20 years
Head of Business Portfolio PT. Transportasi Jakarta	10-15 years
Head of Power System PT. MRT Jakarta Perseroda	5-10 years
Vice President Research & Development ITS Indonesia	5-10 years
Head of Operation and Service Division PT. LRT Jakarta	10-15 years

In the first questionnaire, an assessment of the significance level of each factor was obtained for all experts. The geometric mean method was used with 5 Likert scales with a value limit of 3.43 where the minimum limit was the average limit accepted in a criterion that was still considered (Mohapatra et al., 2010). Having done the calculations, the abovementioned eight factors have been determined to be included in the analysis since all those factors reached the minimum limit. In the second questionnaire, the types of influence, the form of influence, and the level of influence between variables were obtained. Table 3 and 4 depict the results from the second questionnaire.

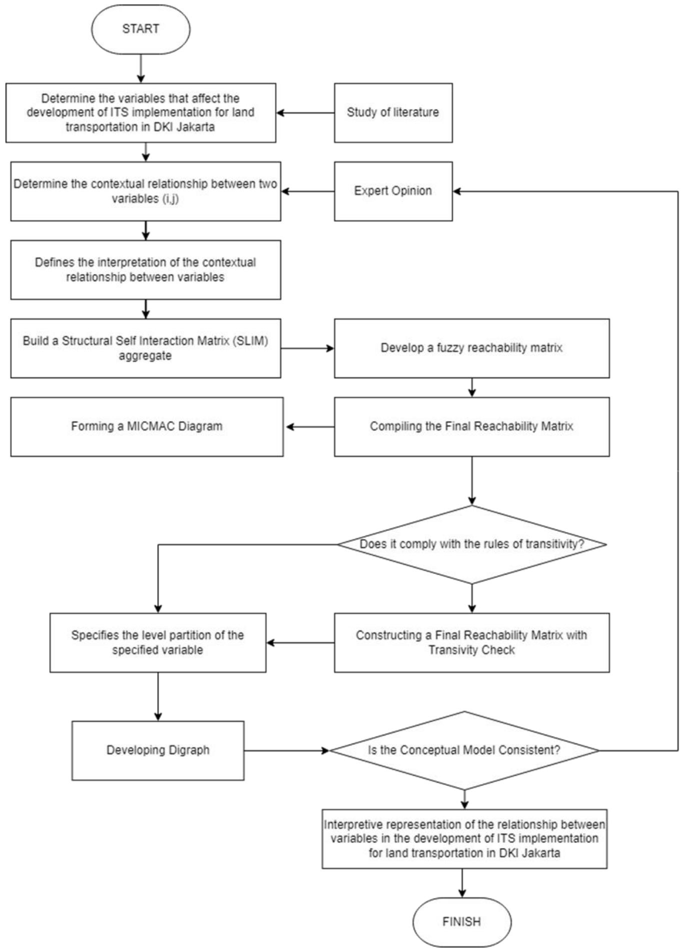

Fig. 2. Flowchart of Research Stages

Then, the level of influence was changed into a fuzzy value to produce Crisp Value with Eq. (5) (see table 5).

Then, it could be determined the category for each variable into four MICMAC quadrants, which consisted of Quadrant I for "Autonomous Variables", quadrant II for "Dependent Variables", quadrant III for "Linkage Variables", and quadrant IV for "Independent Variables", showing the level of driving power and dependence for each variable (figure 3).

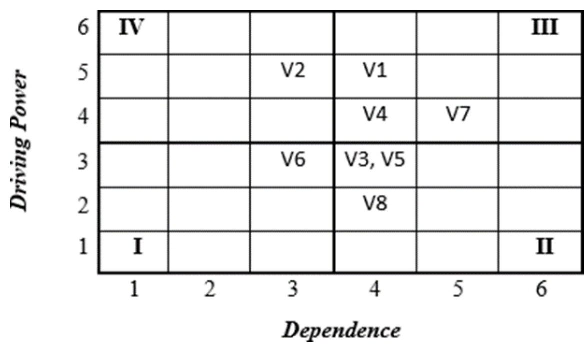

Fig. 3. Classification Driving Power and Dependence

Table 2. Identification of Determinants of ITS Implementation

Code	Determinants Factor	Definition	Reference
V1	Funding	This factor relates to the quantitative justification of the ITS program financing by calculating savings and meeting financial needs in implementing the ITS program.	UNESCAP (2017), The ASEAN Secretariat. (2017)
V2	Skills	This factor relates to the ability to implement ITS with the current state of technology (IoT, Computer Vision, Machine Learning), combined with strategic management that will create an optimal transportation function as a whole.	UNESCAP (2017)
V3	Operational Guide	This factor relates to the guidelines/principles in implementing ITS as a benchmark by various parties who focus on developing ITS architecture, technological capabilities, development capacity, and strategic plans for optimizing a sustainable ITS implementation.	UNESCAP (2017), ITS Asia-Pacific (2013)
V4	Human Resources	This factor relates to the readiness and good planning of the "Human Resources" owned by each party in implementing ITS.	UNESCAP (2017).
V5	Utilization of Available Data	This factor relates to the success of translating data into useful information for location-based telematics services.	UNESCAP (2017), ITS Asia-Pacific (2013).
V6	Political Policy	This factor is related to public policies that regulate the access control of transportation system services, road pricing, and environmental control accompanied by more equitable law enforcement efforts and the harmonization of applicable policies.	UNESCAP (2017), The ASEAN Secretariat. (2017).
V7	Collaboration between stakeholders	This factor relates to collaboration between stakeholders to share resources by utilizing technical strength and industry experience in identifying and implementing the most suitable ITS technical solutions.	UNESCAP (2017), ITS Asia-Pacific (2013), The ASEAN Secretariat. (2017).
V8	Socio-Economic Benefits	This factor relates to the role of implementing ITS in increasing efficiency in the use of transportation infrastructure, which results in some economic benefits. With the efficiency of time, costs, and pressures associated with travel time, ITS has the potential to contribute to poverty alleviation by facilitating a transit via public transportation.	UNESCAP (2017), ITS Asia-Pacific (2013).

Table 3. Results of Level of Influence between Variables

	V1 Funding	V2 Skills	V3 Operational Guide	V4 Human Resources	V5 Utilization of Available Data	V6 Political Policy	V7 Collaboration between Stakeholders	V8 Socio-Economic Benefits
V1 Funding		VH	L	H	L	H	H	No
V2 Skills	No		VH	VH	VH	No	H	L
V3 Operational Guide	L	No		VH	No	No	L	No
V4 Human Resources	No	No	No		VH	No	H	H
V5 Utilization of Available Data	L	No	H	No		No	H	No
V6 Political Policy	H	No	No	No	No		No	VH
V7 Collaboration between Stakeholders	H	No	L	No	H	H		L
V8 Socio-Economic Benefits	No	L	No	No	No	No	L	

Table 4. Results of Assessment of Contextual Relationship between Variables

	"Funding"	"Skills"	"Operational Guide"	"Human Resources"	"Utilization of Availabel Data"	"Political Policy"	"Collaboration between stakeholders"	"Socio-Ecomonic Benefits"
"Funding"		Support the cultivation and provision of relevant competencies		Support the creation of skilled quality human resources		Transparent and guaranteed "funding" facilitates political decision making	Accountable "funding" optimizes the continuity of the collaboration process	
"Skills"			Able to carry out "Operational Guide" to the fullest	The quality of the type of "Skills" will affect the developed human resources	Effective and efficient data processing and presentation capabilities		The company's internal "skills" determine the scope of the cooperation strategy	
"Operational Guide"				Explicit and systematic SOPs improve human resources understanding and capabilities				
"Human Resources"			Support the creation of a systematic "Operational Guide"		Competent human resources optimizes data into useful analysis for strategic decisions		The availability of communicative human resources makes it easier to coordinate and determine the pattern of collaboration	Creating more productive and job opportunities
"Utilization of Availabel Data"			Support the creation of a systematic and comprehensive SOP	Materials and supplies to improve human resources competencies			Availability of existing assets as a material for initiating the collaboration process	
"Political Policy"	Strategic direction from High Level Policies determines budget portion							Rules that can be direct and indirect (combination of outputs from the process of deriving other variables)
"Collaboration between stakeholders"	KPS, KPBU or collaboration with partners and/or other parties				Solid and stable cooperation maximizes data utilization			
"Socio-Ecomonic Benefits"								

Table 5. Calculation of Dependence and Driving Power

	V1			V2			V3			V4			V5			V6			V7			V8			Dependence			#
V1	1	1	1	0,8	1	1	0,3	0,5	0,8	0,5	0,8	1	0,3	0,5	0,8	1	0,8	1	0,5	0,8	1	0	0	0,3	3,8	5,3	6,8	5,16
V2	0	0	0,3	1	1	1	0,8	1	1	0,8	1	1	0,8	1	1	0	0	0,3	0,5	0,8	1	0,3	0,5	0,8	4	5,3	6,3	5,15
V3	0,3	0,5	0,8	0	0	0,3	1	1	1	0,8	1	1	0	0	0,3	0	0	0,3	0,3	0,5	0,8	0	0	0,3	2,3	3	4,5	3,19
V4	0	0	0,3	0	0	0,3	0	0	0,3	1	1	1	0,8	1	1	0	0	0,3	0,5	0,8	1	0,5	0,8	1	2,8	3,5	5	3,68
V5	0,3	0,5	0,8	0	0	0,3	0,5	0,8	1	0	0	0,3	1	1	1	0	0	0,3	0,5	0,8	1	0	0	0,3	2,3	3	4,8	3,24
V6	0,5	0,8	1	0	0	0,3	0	0	0,3	0	0	0,3	0	0	0,3	1	1	1	0	0	0,3	0,8	1	1	2,3	2,8	4,3	2,98
V7	0,5	0,8	1	0	0	0,3	0,3	0,5	0,8	0	0	0,3	0,5	0,8	1	1	0,8	1	1	1	1	0,3	0,5	0,8	3	4,3	6	4,33
V8	0	0	0,3	0,3	1	0,8	0	0	0,3	0	0	0,3	0	0	0,3	0	0	0,3	0,3	0,5	0,8	1	1	1	1,5	2	3,8	2,28
Dr.P	2,5	3,5	5,3	2	3	4	2,8	3,8	5,3	3	3,8	5	3,3	4,3	5,5	2	2,5	4,3	3,5	5	6,8	2,8	3,8	5,3				
#	3,70			2,73			3,88			3,88			4,31			2,78			4,98			3,88						

Table. 6. Final Reachability Matrix with Transitivity

	V1	V2	V3	V4	V5	V6	V7	V8	Driving Power
V1	1	1	1*	1	1*	1	1	1*	8
V2	1*	1	1	1	1	1*	1	1*	8
V3	1*	0	1	1	1*	1*	1*	1*	7
V4	1*	0	1*	1	1	1*	1	1	7
V5	1*	0	1	1*	1	1*	1	1*	7
V6	1	1*	1*	1*	1*	1	1*	1	8
V7	1	1*	1*	1*	1	1	1	1*	8
V8	0	0	0	0	0	0	0	1	1
Dependence Power	7	4	7	7	7	7	7	8	

To create a digraph, it was done by checking the transitivity with defuzzified values in which VH and H became 1 and the other influence levels became 0. In TISM, transitive links with misinterpretations can be adjusted in the framework. (Sushil, 2018) Table 6 shows the final reachability matrix with transitivity.

The set of reachability, antecedent, and intersection for the variables was determined from the final defuzzified reachability matrix. The reachability set consisted of the variable itself and other variables at the same level that could be achieved by that variable. While the set of antecedents consisted of a group of variables supporting the variable itself and other supporting variables that could help to achieve these variables. So, the intersection set was obtained from the intersection of the two sets. The partition level in each iteration was determined from the same set of reachability sets and intersection sets. If the appropriate level of the variable has been determined, then it was removed from the variable set and iterated by repeating the procedure until all levels have been determined. (Khatwani et al., 2015) (see table 7).

Table. 7. Partition Level Reachability Matrix

Code	Determinants Factor	Reachability Set	Antecedent Set	Intersection Set	Level
V1	Funding	1,2,3,4,5,6,7,8	1,2,3,4,5,6,7	1,2,3,4,5,6,7	II
V2	Skills	1,2,3,4,5,6,7,8	1,2,6,7	1,2,6,7	III
V3	Operational Guide	1,3,4,5,6,7,8	1,2,3,4,5,6,7	1,3,4,5,6,7	II
V4	Human Resources	1,3,4,5,6,7,8	1,2,3,4,5,6,7	1,3,4,5,6,7	II
V5	Utilization of Available Data	1,3,4,5,6,7,8	1,2,3,4,5,6,7	1,3,4,5,6,7	II
V6	Political Policy	1,2,3,4,5,6,7,8	1,2,3,4,5,6,7	1,2,3,4,5,6,7	II
V7	Collaboration between stakeholders	1,2,3,4,5,6,7,8	1,2,3,4,5,6,7	1,2,3,4,5,6,7	II
V8	Socio-Economic Benefits	8	1,2,3,4,5,6,7,8	8	I

Based on the data processing, a structured framework was produced and showed the conceptual relationship of the determinant of factors in implementing the intelligent transport system (ITS) in the land transportation system in Jakarta. Figure 4 shows the structured model as the results from the Fuzzy-TISM framework.

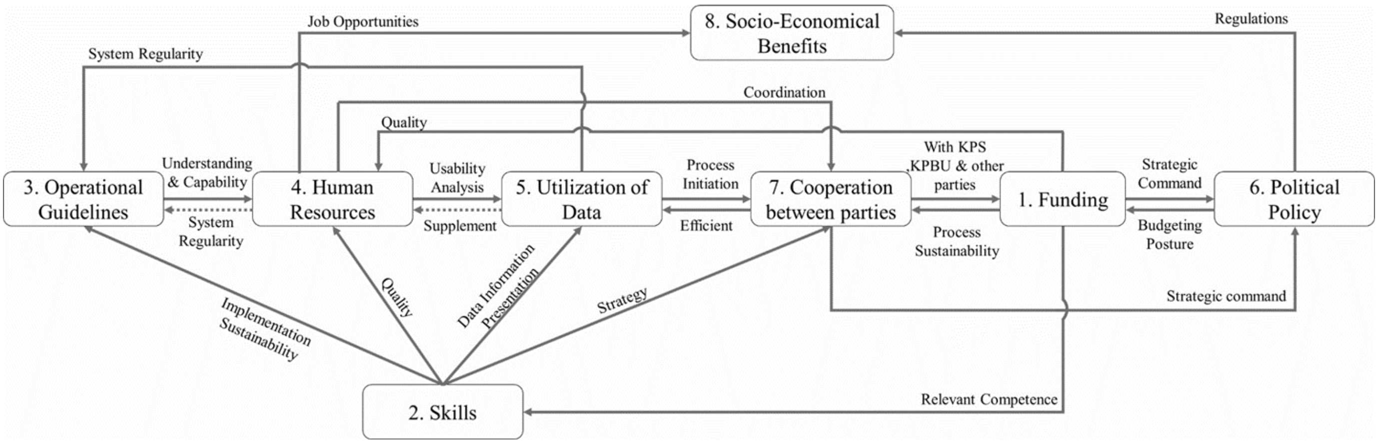

Fig.4. Fuzzy-TISM Framework Model for ITS Implementation in Jakarta

MICMAC Analysis

Based on the driving forces and their dependencies, the MICMAC analysis categorized each factor into four different groups. The first quadrant is a group of “Autonomous Variables" that have weak locomotion and weak dependency. This variable is relatively unrelated. The results showed that (V6) "Political Policy" was in the autonomous quadrant. The second quadrant is the "Dependent Variables" group which has a weak driving force and strong dependence. In this study, there were variables (V3) “Operational Guidelines", (V5) “Utilization of Available Data”, (V8) “Socio-Economic Benefits” as the parts of this Quadrant, which had dependencies on other variables. The third quadrant is a group of “Linkage Variables" that have strong drive and strong dependability. In this study, (V1) “Funding”, (V4) “Human Resources”, (V7) “Cooperation between Parties" became the important variables for having a significant impact on other variables; therefore, the changes in these variables could bring an effect on other variables, and had the same driving force as the dependence of the other variables. The fourth quadrant is the “Independent Variable” group, which has a strong driving force and a weak dependency. The results showed that (V2) "Skills” had a significant effect on other variables.

TISM Analysis

In the results of the TISM framework, there is a level partition that determines the arrangement of the paths between variables. Three level partitions were obtained for all variables in this study, which were then used as the basis for developing the fuzzy-TISM framework as shown in figure 4. In this study, (V2) “Skills” factor was found at the lowest level, the level 1, consisting of variables that supported other top-level variables. The “skills” factor is a factor that supports other factors in developing the implementation of ITS in Jakarta. Meanwhile, 6 factors are the part of level 2, namely (V3) "Operational Guidelines", (V4) "Human Resources", (V5) "Utilization of Available Data", (V7) "Cooperation between Parties", (V1) “Funding”, (V6) “Political Policy”. Then at level 3, which is the top level in the TISM framework, the variables contained at this level were the variables supported by other variables at lower levels. In this study, factor (V8) “Socio-Economic Benefits” was the variable as the top level in the TISM framework. This meant that “Socio-Economic Benefits” became the expected effect of various other factors, either directly or indirectly, meaning the output of the process of decreasing other factors.

ITS Implementation Development Strategy in Jakarta

The analysis of the MICMAC and TISM Framework, namely (V2) "Skills" which was the lowest level according to the categorization, was in quadrant four. The “Skills” factor being an independent variable had a strong driving force and a low level of dependence on other variables. This is in accordance with the levels in the TISM framework, the “Skills” factor is a factor that must be maximized because it is considered a starting factor in the success of other factors at the top level based on the TISM framework. In the ITS implementation in the Russian Federation, especially the ITS development concept developed by the Federal Road Agency in 2009, the ITS development concept was based on 3 layers. The first layer was to build the coordinated interactions from all authorized parties who had skills in the field of ITS development (UNESCAP, 2017). So, the "Skills" factor is indeed a driving factor for the implementation of ITS. Based on the definition in Table 3.1 Identification of Determinants of ITS Implementation, the "skills" referred to more about mastering the technology. In determining the strategy for Jakarta, the “Skills” factor can also be interpreted as determining the focus of ability excellence in improving ITS services, which will determine priorities and condition other factors in the implementation process. As for the successful ITS implementation in Turkey, they had the “Skills” in identifying the on-board units in vehicles (UNESCAP, 2017). The United States had a “Skills” focused on telephone data dissemination, collision avoidance systems at intersections, and emergency transport operations. (Singh et al., 2014).

Meanwhile (V8) “Socio-Economic Benefits” at the top level in the TISM framework, was included in the dependent category in quadrant 2. Therefore, the sustainability of the “Socio- Economic Benefits” factor depended on the success of other factors, directly or indirectly. Based on the UNESCAP study (2017) for countries in the Asian region, it is necessary to develop ITS services tailored to classify the member countries appropriately according to socio-economic characteristics, such as population growth rate, road density, transportation ownership, and poverty levels. This is related to the implementation of ITS in which the stakeholders and policy makers are trying to maximize various other factors to increase the success rate of "Socio-Economic Benefits". Japan leads the world in ITS based on the importance of ITS acceptance in Japan, social benefit from the application of ITS along with the overall maturity of the application. (Singh et al., 2014). An effective public participatory process could also be developed to increase the ITS acceptance in a country by involving citizen groups, business communities, as well as individual citizen (Syahrir, 2021).

Then the factors at level 2, including (V1) “Funding”, (V3) “Operational Guidelines”, (V4) “Human Resources”, (V5) “Utilization of Available Data”, (V6) “Political Policy”, (V7) “Cooperation between Parties”, were found in several categories in MICMAC. This was because there were fuzzy values that made each variable to have an expansion value from real numbers. Based on the calculation results, the "Funding", "Human Resources" and "Cooperation between Parties" factors were in quadrant 3, namely factors with a strong drive and strong dependence. Thus, a special concern is needed on these three factors to support success in (V8) “Socio-Economic Benefits” during the ITS implementation development process. Factors “Operational Guidance” and Utilization of Available Data were in quadrant 2 along with “Socio- Economic Benefits” meaning in the dependent category. Therefore, during the process, this factor was categorized to be dependent upon other variables although the level of dependence was not so high.

Furthermore, the factors in quadrant 1 with the level of dependence and incentives tended to be weak, i.e. "Political Policy". Although it did not have a very low weak tendency. This factor also needs to be considered in optimal conditioning because it is still present at the same level as the other five factors.

4. Conclusion

In supporting policy makers and stakeholders to improve the implementation of ITS services for land transportation as an effort to reduce traffic congestion in Jakarta, it was done by analyzing 8 determinants of ITS implementation, including Funding, Skills, Operational Guidelines, Human Resources, Utilization of Available Data, Political Policy, Cooperation between Parties, and Socio-Economic Benefits, and by designing a structured framework based on the conceptual relationship between these factors. Finally, the concept of results from modeling the theory in a structured manner was done to improve the implementation of ITS services in Jakarta. The skill factor was found as a driving factor that has a high level of driving force against other factors. Funding, Operational Guidelines, Human Resources, Utilization of Available Data, Political Policy and Cooperation between Parties factors were found as the key factors that had the similar high level of dependence and driving force. The success of ITS services in Jakarta can be judged from the "Socio-Economic Benefits" factor as this factor was determined by the sustainability of other factors.

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