Developing a delay risk model for toll road construction project: a conceptual framework

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ABSTRACT

In the realization of the medium-term development plan in 2014-2019 (RPJMN), toll road construction development was only reached 51 percent. construction projects had complex and dynamic nature, which caused delays, construction risk assessment that considers risk as a system was done before, for example, using techniques such as SD, Fuzzy DEMATEL, STEEP-SD, DEMATEL-ANP, and SD-DEMATEL, but the technique still has some shortcomings. in indonesia, research related to this matter is still rarely done, to address this concern, we propose a conceptual framework that can be used to develop a delay risk model for toll road construction project especially in indonesia. for this purpose, we introduce the system dynamic- fuzzy dematel-anp (sd-fdanp) method. the results of the development of the sd-fdanp method can be used as a guideline that can help achieve behavioral knowledge of delays and the success of risk assessment in toll road infrastructure development projects.

1. Introduction

Indonesia’s economic growth continues showing improvement over the last 9 years (2009–2017 period) with the latest rate of 5.05% in 2017 [1]. One of the challenges in increasing Indonesia's economic growth and increasing economic competitiveness is good infrastructure development. The rapid development of infrastructure has been running in various sectors, from road, energy system, Road Transport, Schools etc, , all of which require reliable infrastructure support [2]. But In the realization of the medium-term development plan in 2014-2019 (rpjmn), toll road construction development was only reached 51 percent. construction projects had complex and dynamic nature, which caused delays.

Based on data from the Toll Road Regulatory Agency (BPJT), The toll roads that have been operated throughout the country currently reach 1577 km. That data is still less than toll road that operated in Malaysia, which operates 3,000 km of toll roads [3]. In fact, Indonesia has built toll roads earlier than Malaysia. From 2014 to 2019, the government is targeting toll roads in Indonesia to increase by at least 1,000 km, higher than the previous target of 852 km Thus, until the end of 2018 it is estimated that the total length of toll roads that have been operated from 2014 reaches 897.07 km. From this amount, the trans-Java toll road from Merak to Surabaya is connected now [4].

Every infrastructure development of a country has different delay factors in the completion of infrastructure work, Indonesia is a developing country, the case in Indonesia is different from developed countries but almost the same in developing countries, According to Smith, Merna [5], Construction Risk [1], [6], [7], [8], [9], [10], [11], [12], [13] SosioPolitic Risk [6], [9], [11], Technical

Risk [1], [6]-[13], financial Risk [1], [8], [12] dan Logistical Riks [1], [8], [10], [12] is something that should be considered for construction work in developing countries and supported by previous research the risks are real in the construction of toll roads that can cause delays in developing countries.

The increasing complexity of infrastructure projects has increased the challenge of developing risk management theories. Risks in different stages of the project vary greatly and dynamically [14] means, Assessing the risks that arise at the design stage can be very different from those at the construction stage. also some of the risks of delays can still exist in several stages or appear at certain stages, both of which cause the presumption that risks are interrelated in one system. [15], [16]. Contrary to conventional project risk management understanding, the link between risks assesses risk as a separate thing. As Fang and Marle state, risks can be linked through causal relationships. Negligence in modeling such risk interrelasies leads to low accuracy or estimation of significant risk effects and limits research results' effectiveness. Therefore, it is important to consider the dynamic interaction between project risks to assess the risks impacting the project schedule [17].

Based on previous research, the application of dynamic risk assessment has been carried out but some of the above methods still have some weaknesses, for example for SD-Fuzzy [18], [19] and the scope of the method has weaknesses in the risk assessment is still considered as a separate, and the scope studied is limited to the highest risk, ANP-SD method [20] has a weakness in the ANP process in describing the dependency and intervention factors between risks, DEMATEL-ANP [21] and fuzzy DEMATEL-ANP [22] has a weakness in the inconsistency that exists in the DEMATEL method, in 2017 SD-DEMATEL was carried out to support the level of inconsistency of the method [23] but the DEMATEL method is less accurate in determining the weight in determining critical risk, for this reason, a method is needed that can cover the shortcomings of the previous method in analyzing the toll road project.

2. Method

Research methods used in this study using literature studies and validation experts in the field of construction safety, as illustrated in the Fig. 1 below.

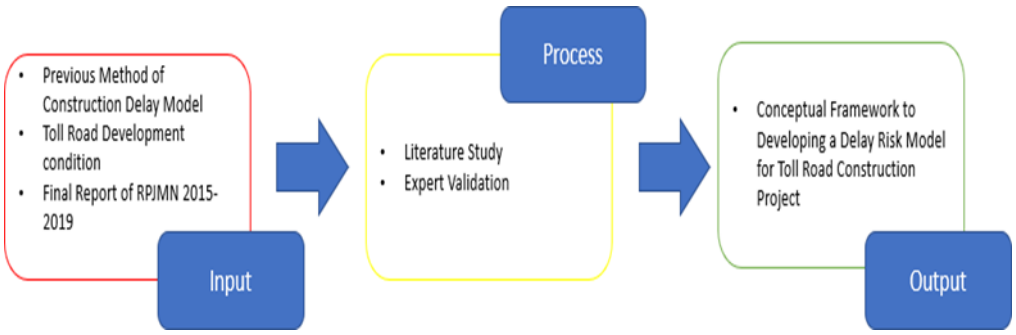

Fig. 1. Research Methodology

3. Results and Discussion

Above we have noted that Toll Road Project projects are capital intensive, complex, and sensitive to uncertainties and risks. Such characteristics need to be taken into account when selecting methods for analyzing risk in toll road projects.

3.1. Fuzzy

Fuzzy logic is a generalization of standard logic, where a concept can have a degree of truth anywhere between 0.0 and 1.0. Standard logic that applies to a completely true concept (has a truth level of 1.0) or completely false (has a truth rate of 0.0) [24]. Fuzzy logic should be used for reasons about concepts that are inherently vague, Fuzzy logic has emerged as an excellent tool in addressing complex problems [25].

3.2. System Dynamic

SD is a simulation method for viewing and learning the dynamic behavior of complex systems [26], [27]. The main purpose of the dynamic systems method is used to explain the system. The term system of terms on a set of interconnected elements is arranged in a way to achieve something [28]. n an SD perspective, complex systems are reverse or state and non-linear feedback structure [27]. The evolutionary behavior of a system is very important in SD, obviously in the terms of feedback loops and element status [26]. Thus, Thus, the interaction between system elements from one element to another resulting a dynamic behavior.

3.3. Decision Making Evaluation And Laboratory (DEMATEL)

The decision making trial and evaluation laboratory (DEMATEL) was first developed by the Geneva Research Center's Battelle Memorial Center to visualize complex causal relationship structures through a matrix or diagram [29]. As a kind of structural approach modeling, this method is very useful in analyzing the causes and effects of relationships between components in a system.

3.4. Analytic Network Process (ANP)

ANP is one of the MCDM techniques used to overcome the limitations of hierarchy structure [29], [30]. ANP is an extension of the analytical hierarchical process (AHP) developed by Saaty [31] as a useful tool for solving complex decision-making issues.

3.5. Conceptual Framework

The conceptual framework is formulated by combining the system dynamic- fuzzy dematel-anp (SD-FDANP) approaches. The combination is proceeded in four stages: factor identification, Developing delay behavior model, Build Relations map and priority weight matrix. Fig. 2 visualizes the schematic diagram of the conceptual framework.

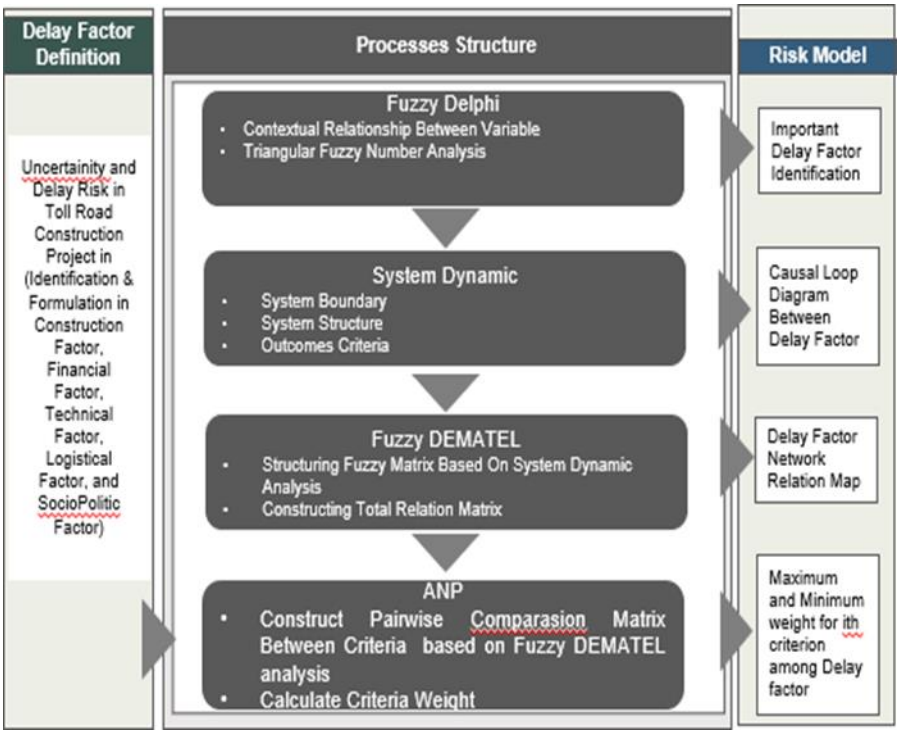

Fig. 2. Conceptual Framework

Drawing from the methods discussed in the previous section, they are combined to analyze the complexity and the dynamic risk of toll road projects. The combination proceeds an approaches, The use of system dynamics here to see the behavior of factors that are the cause of delays in a toll road infrastructure development because the method is very good at describing complex problems [32], [33], [34] The use of Fuzzy DEMATEL itself to create a network relation map as the basis for the assessment of both dependent and interpenden relationships which is a weakness of ANP [21], [35],

because DEMATEL method is the most suitable method with System Dynamic [23], [33], and ANP to support the weakness of DEMATEL in determining weight factors between variables.

This conceptual framework will solve those shortcomings to identify the factors that influence and are affected by delay through use System Dynamic (SD) with Fuzzy Decision Trial Making and Evaluation Laboratory and Analytic Network Process (FDANP) to determine the weight value of each factor and the weight change for each scenario, the proposed risk assessment method is called SD-FDANP. the results of the development of the SD-FDANP method can be used as a guideline that can help achieve behavioral knowledge of delays and the success of risk assessment in toll road infrastructure development projects.

4. Conclusion

Risk management is one of the keys to the success of infrastructure projects, especially toll road infrastructure The conceptual framework developed in this paper sets the stage for the realization of accurate risk assessment and becomes a system in Toll road construction projects. this case, the conceptual framework has offered systematic procedures for formulating a delay model by adjusting SD integration, find a diagram of causal-effect and relationship between factors using Fuzzy DEMATEL, and ANP into an approach called the SD-FDANP approach. This paper will be an important contribution to the application of the SD-FDANP approach in risk analysis studies on toll road development projects.

Preliminary as it is, the applicability of the conceptual framework should be challenged with real cases. Future work is therefore required to make the conceptual framework applicable for use to realize its purpose. That is, to deliver an delay model for toll road projects that can be useful for supporting the stakeholder faced with risk. The proposal is to do this by applying—testing and validating the conceptual framework in actual toll road project. To this end, the following research agenda is proposed.

Future work will discuss and outline further risk formulation in toll road construction projects. In particular, uncertainty related to the construction phase. Questions that may arise such as how uncertainty and relationships between factors can be known. For advanced risk analysis, a conceptual framework will be implemented to analyze the causes of delays in toll road construction in Indonesia. It will be used to explore accurate risk analysis and assess risks into an interconnected system.

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Declarations

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