Construction Management of Electronic Toll Gate Perspectives of Civil Engineering, Industrial Engineering, and Business Engineering on Sustainable Development Goals

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Abstract

Construction Management, in global perspective, are considered country's primary economic investment and deemed as augmenting factors for Infrastructure Development. This Infrastructure Development is deemed ubiquitous with the establishment of Electronic Toll Gate's Construction Management. The objective of this paper constitutes the elaboration among the Construction Management Risk (CMR) and Digital Technology (DT). Precisely, the elaboration is conducted through theoretical perspective and the Research Methodology of Multidisciplinary Trilogy of Civil Engineering, Industrial Engineering and Business Engineering. Construction Management in this paper constitutes centre stage of Systems Dynamic Modelling (SDM) including its critical review and future research. The aforementioned theoretical perspective is intertwined with the empirical perspective, in which Indonesia's Infrastructure is in the full swing along with the car ownership's growth in Indonesia is significantly needed to be aligned with the construction management of electronic toll gate. This paper analysis is using SmartPLS and its questionnaire for research model toward the payment willingness on an On-Board Unit (OBU). The questionnaire consists in particular variables of Gender, Education (Significant), Age, Income, Expense (Significant), Distance (Significant), Frequency (Significant) and Knowledge. Within quantitative approach as Research Methodology, then SmartPLS is further analysis the indicators toward decision making for empirical perspectives. The major indicators analysis both Distance Travel (DT) and Travel Frequency (TF), are investigated its impact on Willingness to Pay (WTP), through the following but not limited to Coefficient value of original sample, standard error, and T-statistics, including its correlation through Chi-Square Test Result.

Keywords

Construction Management, Systems Dynamic Modelling, Civil Engineering, Industrial Engineering, Business Engineering.

1. Introduction

Construction Management, within worldwide playing field is deemed as country's vital role within economic investment and as infrastructure development's escalating factors. The mentioned infrastructure is ubiquitous within Electronic Toll Gate, in particular in Indonesia. This phenomenon triggers the research need, to explore both theoretical and empirical perspectives.

Indonesia's Infrastructure is in the full swing along with the car ownership's growth in Indonesia is significantly needed to be aligned with the construction management of electronic toll gate. Given the aforementioned car ownership's growth, It is deemed indispensable for Indonesia to improve its toll fee collection system toward fast and secure for both user and the operator within optimal Service Level Agreement. Scholars of Karsaman et.al indicated that capacity of Electronic Toll Collection (ETC) system is currently deemed 40% higher as compared to the one of Manual Toll Collection (MTC) (Karsaman et al. 2014).

In Global Perspectives, the mentioned infrastructure is deemed indispensable within logistics and supply chain perspectives of United Nations' Sustainable Development Goals, known as UN's SDG. Figure 1 depicts the Construction Management on UN's SDG to relate both theoretical and empirical perspectives (Lazar et al. 2021), in particular in Industry, Innovation and Infrastructure.

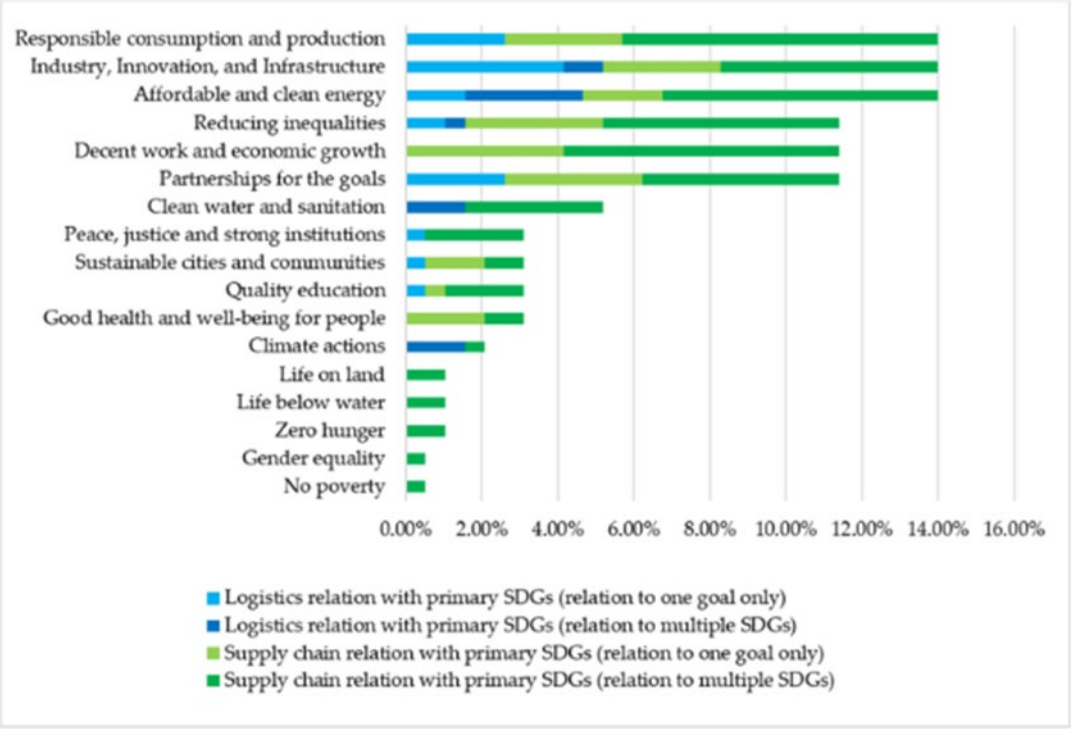

Figure 1. Construction Management on United Nations' Sustainable Development Goals

2. Construction Management Risk (CMR) and Digital Technology Systems (DTS)

Construction Management Risk (CMR) constitutes the primary leverage of developed countries, including Indonesia. This CMR generates fundamental aspects for sustainable development goals toward the ever-augmenting population and scarcity consideration. Thus, this augmentation and scarcity have to be considered in risk factor and its mitigation to be meticulously handled based upon the optimal precautions (Hessellund 2017). Eventually this consideration is managed for the fulfillment of involved stakeholders in the process.

Furthermore, the prior CMR is intertwined with the Digital Technology Systems (DTS). In the constellation of Industrial Revolution 4.0, DTS is part of dynamic capability of an organization to adapt and utilize its resource base. Precisely, this capability is intended to integrate, build, and reconfigure internal and external competences vis-à-vis swiftly revamping environments (Teece and Pisano 1994).

Eventually, the aforementioned DTS is intertwined with System Dynamics Modeling (SDM). This SDM has been implemented to provide agility competencies toward project complexity. This complexity constitutes the characteristics of construction management risk, including its system (Yuan et al. 2012 and Wu et al. 2020).

Within the perspective of the construction management throughout its industry, system dynamics modeling (SDM) has been ubiquitously utilized in construction management (CM) research to probe assorted complexity levels of construction management (Lee et al. 2009). SDM has augmented level into an indispensable domain in the construction engineering that intertwined systems theoretical simulation and computer perspectives (Moradi et al. 2015). It creates synergy on technical, organizational, human, and environmental factors within dynamic ecosystems (Liu et al. 2019).

The SDM Based Research is integrated within framework of Complexity versus Level of Analysis in Construction Management (Øien et al. 2011), and is depicted in Figure 2.

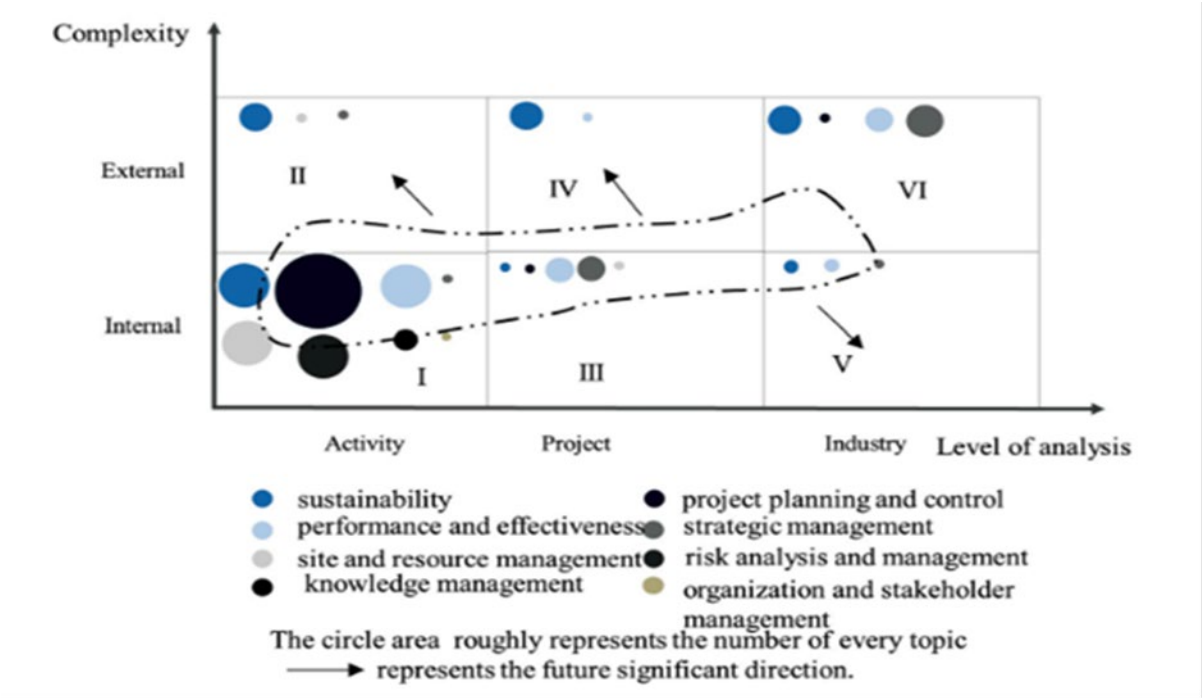

Figure 2. SDM Based Research and framework in Construction Management

3. Civil Engineering Perspective

Civil Engineering Perspective in this paper is highly relevant toward the Construction Management, as related to the Electronic Toll Gate. Precisely, this Electronic Toll Gate that relate to payment willingness on an On-Board Unit (OBU). In this situation, there are involvement on Key Performance Indicators (KPI) (Øien et al. 2011).
Furthermore, the Key Performance Indicator (KPI) is defined as the measurement of both quantitative and qualitative data. Both data refers to information on safety concern on construction management perspective, in order to maintain continuous improvement (Park et al. 2017).

4. Industrial Engineering Perspective

Industrial Engineering constitutes the Key Performance Indicators (KPI) and its Safety Dimensions (Mahmoud et al. 2020) in Construction Management (Lyneis and Ford 2007) within further lens of analysis. This analysis involves sustainable construction management through a risk matrix-based Monte Carlo Simulation approach. Precisely, this Monte Carlo Simulation approach and the hypothesis were tested through data related to construction projects within construction management.

It is deemed more suitable for sustainability-related risks to be implemented as the factor of inherent uncertainty within these risks (Goh et al. 2020). Furthermore, new risk metrics are generated to prioritize construction management risks that require significant decision-making process.

5. Business Engineering Perspective

Business Engineering Perspective in this paper is deemed indispensable, to bridge the Construction Management within the perspective of two other perspectives which are Civil Engineering and Industrial Engineering.

As overview and eventually as the source of future research, there are needs to relate business engineering with business enterprise on Construction Management (Simatupang et al. 2017). Precisely, the United Nations' Sustainable Development Goals, need to be aligned in this paper and its research model within SmartPLS. Table 1 depicts the overview of business engineering toward business enterprise.

Table 1. Disciplinary Perspective among Business Engineering and Business Enterprise

Revamped objects and methods to bridge engineering perspectives vis-à-vis business enterprises		Methods and Its Orientation	
		Technical Methods' Perspectives	**Social Methods' Perspectives**
Revamped objects' condition	**Structural Condition**	Enterprise Engineering, within techno structural lens	Business Engineering, within socio structural lens
	Processual Condition	Industrial Engineering, within techno processual lens	Engineering Management, within socio processual lens

6. Results and Discussions

Construction Management to implement of On-Board Unit (OBU) Infrastructure for Electronic Toll Collection (ETC) system was launched on 1st April 2012 until its full swing in 2018.

The SmartPLS is used to evaluate and analyze the research model and its indicators The aforementioned indicators are: 1. Drivers' Distance travels, identified as DT; 2. Willing to capitalize toll of distance travels less or equal than 30 kilometers, identified as DT1; 3. Willing to capitalize toll of distance travels more than 30 kilometers, identified as DT2; 4. Drivers' travels Frequencies, identified as TF; 5. Willingness to capitalize toll of single destination , identified as TF1; 6. Willingness to capitalize toll for two destination travels, identified as TF2, 7. OBU Payment Willingness, identified as WTP; 8. OBU Payment Willingness on amount of 450.000 IDR, identified as WTP1, 9. OBU Payment Willingness on amount of 500.000 IDR, identified as WTP2.

Furthermore, within the SmartPLS in Figure 3, then it generates the Table 1 on Coefficient Value, as the following:

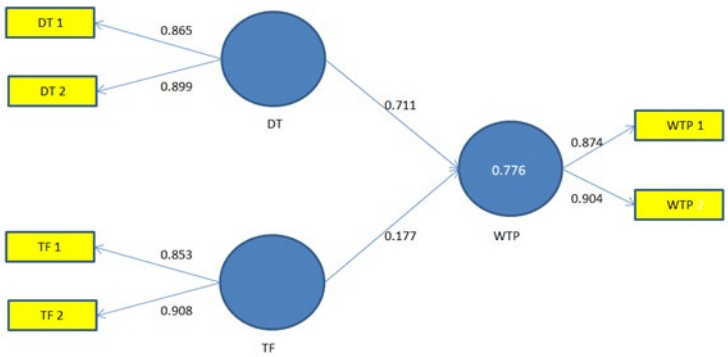

Figure 3. SmartPLS Research Model

Table 2. Coefficient value of original sample, standard error, and T-statistics

Coefficient Effect	Original sample (O)	Standard Error	T-statistics
DT → WTP	*0.711*	*0.227*	*3.131*
TF → WTP	*0.177*	*0.247*	*0.718*

From Figure 3 and Table 2, further discussion is elaborated. To begin with, the Figure 3 indicates that both indicators Distance Travel (DT) and Travel Frequency (TF) constitutes variable that generate impact on Willingness to Pay (WTP) with its measurement within research model in Figure 3. Furthermore, in term of Table 2; Major measurement of DT is among existing measurements are indicated by DT1 and DT2. Meanwhile, major measurement of TF is among existing measurements are indicated by TF1 and TF2. Both DT and TF generate, respectively 0.711 that results from the DT into WTP's Coefficient Effect. Subsequently, on the result of 0.177, these results represent the TF into WTP's Coefficient Effect.The prior SmartPLS is subsequently, elaborated with Chi-Square values that were obtained from cross-tabulation using SPSS. The summary of Chi-Square test results of driver's characteristics with willingness to pay is shown in Table 3.

Table 3. Chi-Square Test Result

Variable	Chi-Square Test		Correlation
	Value	Asymp.Sig. (2-sided)	
*Gender*WTP*	*2.008*	*0.156*	*Not Significant*
*Education *WTP*	*19.987*	*0.001*	*Significant*
*Age*WTP*	*6.969*	*0.073*	*Not Significant*
*Income*WTP*	*2.71*	*0.438*	*Not Significant*

*Expenses*WTP*	*16.396*	*0.001*	*Significant*
*Distance *WTP*	*25.929*	*0*	*Significant*
*Frequency*WTP*	*2.685*	*0.261*	*Significant*
*Knowledge*WTP*	*3.433*	*0.064*	*Not Significant*

Posterior to discussion on Figure 3 and Table 2, then this part discusses table 3, as the subsequent process of those two prior figure and table. Following the coefficient effect, then table 3 elaborates the correlations. Precisely, among 8 variables, the following variables constitute significant correlations which are Education*WTP, Expenses*WTP, Distance*WTP, and Frequency*WTP.

7. Conclusions

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Indonesia's Infrastructure is in the full swing along with the car ownership's growth in Indonesia is significantly needed to be aligned with the construction management of electronic toll gate.

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The elaboration in this paper is conducted through theoretical perspective and the Research Methodology of Multidisciplinary Trilogy of Civil Engineering, Industrial Engineering and Business Engineering. Construction Management in this paper constitutes center stage of Systems Dynamic Modelling (SDM) including its critical review and future research. The aforementioned theoretical perspective is intertwined with the empirical perspective, in which Indonesia's Infrastructure is in the full swing along with the car ownership's growth in Indonesia is significantly needed to be aligned with the construction management of electronic toll gate.

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Biographies

Hwi-Chie Ho is a professional engineer in Industrial Engineering and an associate professor in Industrial Engineering Department at Bina Nusantara University (BINUS). She currently serves as the Dean of BINUS ASO School of Engineering (BASE). Previously, she was the Dean of the Faculty of Engineering at BINUS University (2009-2014). Her research and lectures revolve around ergonomics, quality, and industrial psychology. As a professional member of Institute of Industrial and Systems Engineers (IISE), she has been dedicating her quality time to support the IISE BINUS University Student Chapter#716 as the faculty advisor, result in continual achievement of Chapter's Gold Award ever since its establishment (2012-2020). She received an outstanding faculty advisor award from the IISE, for Southeast Asia Regional Winner in 2016, 2018, 2019 and for Asian Regional Winner in 2017, 2020. She is also a fellow in Industrial Engineering and Operations Management (IEOM) society and actively involved in numerous IEOM conferences. Concurrently, her previous working experience as a notable CEO in automotive industry (Audi & Volkswagen Indonesia: awarded as one of 40 best executives in Indonesia in 2002, SWA Magazine) has led her to frequent invitation as special guest lecturer in various leading industries.

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Meilani earned her bachelor and master's degree in civil engineering from Tarumanagara University. She previously involved in various construction of buildings and houses when she served as project planner in contractor company. Her passion in education led her to Bina Nusantara (Binus) University where she serves as Deputy Head of Civil Engineering Department since 2010. She is actively involved in Institution of Civil Engineers (ICE) and currently serves as faculty advisor of ICE Student Chapter Binus University.