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The Influence of TOE Framework on the Readiness of Toll Road Business Entities (BUJT) in Implementing Multi Lane Free Flow (MLFF) Technology

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Abstract

The toll payment system in Indonesia has evolved using e-money since 2017. However, increasing vehicle populations and economic activities have caused congestion at toll gates, resulting in economic losses of up to IDR 4.4 trillion annually. To address this, the government plans to implement Multi Lane Free Flow (MLFF) technology, enabling transactions without stopping. The implementation requires thorough readiness, facing challenges such as recording accuracy between 80-99%, potential revenue loss for BUJT, regulatory uncertainties, delayed planning, and infrastructure needs. This study evaluates BUJT readiness using the Technology-Organization-Environment (TOE) framework, focusing on seven variables: Compatibility, Advantage, Complexity, Organization Readiness, Top Management Support, Government Support, and Vendor Quality. Using Partial Least Squares (PLS) and Structural Equation Modeling (SEM), data from purposive sampling of BUJT were analyzed. Results show only Advantage significantly affects readiness (t=2.496; p=0.013), with an R² of 0.24 indicating weak predictive power. The study contributes to understanding factors influencing BUJT readiness and recommends enhancing government support, stakeholder coordination, and technical and organizational preparedness evaluation.

Keywords: Toll Collection; Multi Lane Free Flow; TOE Framework; Partial Least Squares; Structural Equation Modeling

Abstrak

Sistem pembayaran tol di Indonesia telah berkembang menggunakan uang elektronik sejak tahun 2017. Namun, peningkatan jumlah kendaraan dan aktivitas ekonomi menyebabkan kemacetan di gerbang tol, yang mengakibatkan kerugian ekonomi hingga mencapai Rp 4,4 triliun per tahun. Untuk mengatasi hal ini, pemerintah berencana mengimplementasikan teknologi *Multi Lane Free Flow (MLFF)*, yang memungkinkan transaksi tanpa harus berhenti. Pelaksanaan teknologi ini memerlukan kesiapan yang matang dan menghadapi berbagai tantangan seperti akurasi pencatatan yang berkisar antara 80-99%, potensi kerugian pendapatan bagi Badan Usaha Jalan Tol (BUJT), ketidakpastian regulasi, perencanaan yang tertunda, serta kebutuhan infrastruktur. Penelitian ini mengevaluasi kesiapan BUJT menggunakan kerangka *Technology-Organization-Environment (TOE),* dengan fokus pada tujuh variabel: Kesesuaian (*Compatibility*), Keunggulan (*Advantage*), Kompleksitas (*Complexity*), Kesiapan Organisasi (*Organization Readiness*), Dukungan Manajemen Puncak (*Top Management Support*), Dukungan Pemerintah (*Government Support*), dan Kualitas Vendor (*Vendor Quality*). Dengan menggunakan *Partial Least Squares (PLS)* dan *Structural Equation Modeling (SEM),* data dari *purposive sampling* BUJT dianalisis. Hasil penelitian menunjukkan hanya variabel *Advantage* yang berpengaruh signifikan terhadap kesiapan (t=2,496; p=0,013), dengan nilai R² sebesar 0,24 yang menunjukkan kekuatan prediksi yang lemah. Penelitian ini memberikan kontribusi dalam memahami faktor-faktor yang memengaruhi kesiapan BUJT dan merekomendasikan peningkatan dukungan pemerintah, koordinasi antar pemangku kepentingan, serta evaluasi kesiapan teknis dan organisasi.

Kata kunci: *Toll Collection; Multi Lane Free Flow; TOE Framework; Partial Least Squares; Structural Equation Modeling*

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I. INTRODUCTION

Toll roads are a critical component of Indonesia's transportation infrastructure, serving as vital arteries for economic activities and mobility (Kamiliah & Wijaya, 2024). According to Government Regulation (PP) No. 15, 2005, toll roads are public roads that are part of the national road network and require users to pay toll fees. These roads are characterized by dedicated lanes, toll collection facilities, enhanced security, and maintenance standards. The operation and management of toll roads are entrusted to Toll Road Business Entities (Badan Usaha Jalan Tol, BUJT), which are limited liability companies established through competitive bidding to manage toll road concessions under the Toll Road Operation Agreement (PPJT) as regulated by the Ministry of Public Works (Permen PU No. 13, 2010). BUJTs are specialized entities responsible for the development, operation, and maintenance of toll roads in Indonesia. BUJTs generate revenue primarily from toll fees based on vehicle class and distance traveled, regulated by the government (Aditya, 2021). Additional income may come from commercial areas adjacent to toll roads, such as rest areas and fuel stations.

Problem Statement

Despite the adoption of electronic money for toll payments since 2017 (Permen PU 16/PRT/M/2017), congestion at toll gates remains a significant problem due to increasing vehicle volumes and economic activities (Santosa et al., 2023). This congestion results in substantial economic losses estimated at IDR 4.4 trillion annually (Roatex Ltd Zrt, 2020). The government aims to implement Multi Lane Free Flow (MLFF) technology, which allows toll transactions without stopping, to alleviate congestion and improve traffic flow. This system eliminates the need for vehicles to stop at toll booths by utilizing technologies such as Radio Frequency Identification (RFID), Global Navigation Satellite Systems (GNSS), and automatic number plate recognition. While the benefits of MLFF are widely recognized including reduced congestion, and lower emissions (Budiharjo & Margarani, 2019).

Despite being designated as a National Strategic Project (PSN) under the Coordinating Ministerial Regulation (Permenko) No. 6 of 2024, the implementation of the Multi-Lane Free Flow (MLFF) toll collection system in Indonesia has faced significant delays and uncertainties (Parikesit et al., 2024). Initially targeted for completion in mid-2022, the system has yet to be operational as of 2025 (Santosa et al., 2023). The Indonesian Supreme Audit Agency (BPK) has raised concerns regarding regulatory noncompliance and recommended a review of toll road management agreements and MLFF implementation (Yatun et al., 2024). From a technological standpoint, the application of GNSS-based MLFF via smartphones poses unresolved challenges related to system accuracy, with reported error margins ranging from 0.1% to 1%, which potentially translates to revenue losses for toll road enterprises (Parikesit, 2024). Moreover, the lack of physical barriers and enforcement mechanisms under MLFF increases the risk of toll evasion and revenue leakage, while full responsibility for toll data resides with government-appointed operators (Santosa et al., 2023). In addition to technological and regulatory risks, concerns remain regarding government support, system control, and the financial implications of inaccurate traffic data. Although public perception of MLFF is generally positive (Hermawan, 2023), toll road operators (*BUJT*) must evaluate their readiness from multiple dimensions technological, organizational, and governmental to ensure effective implementation.

Research Objectives

This study aims to evaluate the readiness of BUJTs in implementing MLFF technology using the Technology-Organization-Environment (TOE) framework. Specifically, it investigates the influence of seven variables: Compatibility, Advantage, Complexity, Organization Readiness, Top Management Support, Government Support, and Vendor Quality (Mahirah et al., 2022) on BUJT readiness.

II. LITERATURE REVIEW

Technology Adoption Theories

Technology adoption research has been extensively developed through various theoretical models. The Technology Acceptance Model (TAM) posits that perceived usefulness and ease of use influence technology adoption decisions (Davis, 1989). The Unified Theory of Acceptance and Use of Technology (UTAUT) integrates multiple models, emphasizing performance expectancy, effort expectancy, social influence, and facilitating conditions (Venkatesh et al., 2003). The Theory of Planned Behavior (TPB) explains behavioral intentions based on attitudes, subjective norms, and perceived behavioral control (Ajzen, 1991). These models provide foundational insights into individual and organizational technology adoption behaviors.

Technology-Organization-Environment (TOE) Framework

The TOE framework, developed by Tornatzky and Fleischer (1990), offers a comprehensive perspective on organizational technology adoption by considering three contexts: technological, organizational, and environmental. The technological context includes the internal and external technologies relevant to the firm. The organizational context encompasses the firm's size, structure, and resources. The environmental context involves industry characteristics, regulatory environment, and external support. This framework is particularly suitable for studying complex technology adoption in organizations such as BUJTs.

Multi Lane Free Flow (MLFF) Technology

MLFF technology enables toll collection without requiring vehicles to stop or slow down, using advanced sensors, cameras, and communication systems (Santosa et al., 2023). This technology promises to reduce congestion, enhance traffic flow, and improve revenue collection accuracy. However, MLFF implementation involves challenges such as ensuring data accuracy, infrastructure readiness, regulatory clarity, and stakeholder coordination (Parikesit et al., 2024).

Previous Studies on Technology Adoption in Toll Roads and MLFF

Prior research has examined technology adoption, highlighting factors such as perceived benefits, organizational readiness, and external support (Min & Kim, 2024). Studies on MLFF adoption emphasize the importance of technological compatibility, management support, and government policies. However, there is a research gap regarding the comprehensive assessment of BUJT readiness using the TOE framework in the Indonesian context.

Research Gap and Hypothesis Development

This study addresses a significant research gap by employing the Technology-Organization-Environment (TOE) framework to assess the readiness of *Badan Usaha Jalan Tol* (BUJT) in implementing the Multi-Lane Free Flow (MLFF) toll collection system. While various studies have applied the TOE framework to technology adoption in multiple industries, limited research specifically targets toll road operators in the Indonesian context. The TOE framework, introduced by Tornatzky and Fleischer (1990), provides a multidimensional approach to evaluating technological adoption based on technological, organizational, and environmental factors.

Compatibility refers to the degree to which the MLFF technology fits with the existing values, infrastructure, and workflows of BUJT. A high degree of compatibility reduces uncertainty and resistance, thereby increasing the likelihood of adoption. In the context of toll road systems, technologies that align with current operational procedures are more readily accepted and integrated (Rogers, 2003). Therefore, it is hypothesized that compatibility have a significant affects on BUJT readiness for MLFF implementation.
H1: Compatibility affects BUJT readiness in implementing MLFF significantly.

Perceived advantage represents the extent to which the MLFF system is seen to offer improvements over the existing system, such as reduced congestion, operational efficiency, and enhanced user convenience. The higher the perceived benefits, the greater the organizational motivation to adopt the technology (Min & Kim, 2024). In this study, perceived advantage is expected to serve as a significant affects predictor of BUJT readiness.
H2: Advantage affects BUJT readiness in implementing MLFF significantly.

Complexity describes how difficult the system is perceived to be in terms of understanding, usage, and integration (Qatawneh, 2024). Technologies that are perceived as too complex tend to face resistance from organizations due to the anticipated learning curve, training requirements, and implementation risks (Rogers, 2003). Hence, complexity is hypothesized to have a significant affects on BUJT readiness.
H3: Complexity affects BUJT readiness in implementing MLFF significantly.

Organizational readiness includes factors such as financial resources, technical infrastructure, and human capital available within the BUJT to support MLFF adoption. Organizations with greater readiness are better positioned to manage the transition and overcome challenges during implementation (Oliveira & Martins, 2010). Therefore, it is proposed that organizational readiness significantly affects BUJT readiness.
H4: Organizational readiness affects BUJT readiness in implementing MLFF significantly.

Top management support refers to the degree of commitment and involvement of leadership in the adoption of MLFF. In cases such as the adoption of Artificial Intelligence within companies, it has been found that

management support and organizational readiness are the most crucial factors within an organization (Min & Kim, 2024). Consequently, top management support is expected to significantly affects BUJT readiness.
H5: Top management support affects BUJT readiness in implementing MLFF significantly.

Government support includes regulatory guidance, policy incentives, and strategic direction provided by relevant authorities to facilitate MLFF implementation. In the toll road sector, government alignment is essential due to the public-private nature of operations. Supportive government interventions have been shown to enhance organizational adoption of new technologie (Naeem et al., 2024), and thus, government support is hypothesized to significantly affects BUJT readiness.
H6: Government support affects BUJT readiness in implementing MLFF significantly.

Vendor quality refers to the capabilities and reliability of the technology providers involved in MLFF implementation. A high-quality vendor offers strong technical support, system reliability, and post-implementation services, which reduce the perceived risk and uncertainty (Gui et al., 2020). Therefore, vendor quality is proposed to significantly affects BUJT readiness.
H7: Vendor quality affects BUJT readiness in implementing MLFF significantly.

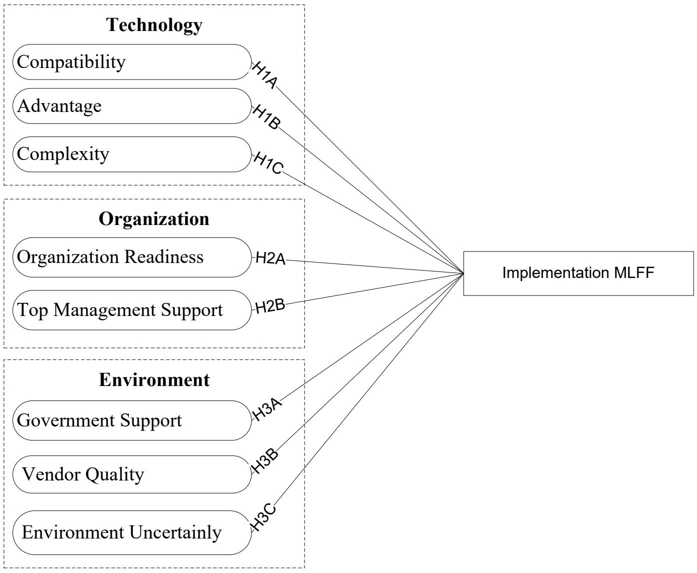

Figure 1 Research Framework

III. RESEARCH METHODOLOGY

Research Design

This study employs a quantitative research design to empirically test the relationships between TOE framework variables (see Table 1) and BUJT readiness for MLFF implementation. The approach allows for statistical analysis and hypothesis testing.

Table 1 Research Characteristic

No	Characteristic	Type
1	Method	Quantitative
2	Purpose	Evaluative
3	Strategy	Case Study & Survey
4	Paradigm	Positivism
5	Unit of Analysis	Organization
6	Time Frame	Cross-Sectional & Prospective
7	Research Involvement	Non-intervention in data collection

Population and Sample

The population in this study refers to all entities sharing specific characteristics relevant to the research (Amin et al., 2023). According to data from the Toll Road Regulatory Agency (BPJT) as of January 2024, there are a total of 58 BUJT. The sample is defined as a subset of the population that serves as the actual source of data for the study (Fadilah Amin et al., 2023). This research employs a non-probability sampling technique, meaning not all members of the population have an equal chance of being selected. Specifically, purposive (judgment) sampling is used, where the selection is based on specific criteria directly related to the research objectives (Azis & Irjayanti, 2024). To determine the minimum sample size required, G*Power software was utilized, the required minimum sample size is 77 respondents from the selected BUJT.

Data Collection Methods

Data were collected through structured questionnaires distributed to BUJT managers. The questionnaire items were developed based on operational definitions of the TOE variables and readiness constructs. Additionally, case studies were conducted to provide qualitative insights into BUJT challenges and practices.

Data Analysis Techniques

Partial Least Squares (PLS) and Structural Equation Modeling (SEM) were employed to analyze the data. PLS is selected for its flexibility and its suitability for studies with relatively small sample sizes. These techniques allow for testing complex relationships among latent variables and assessing model fit, validity, and reliability. The data analysis in this study comprises three main components. First, descriptive analysis is conducted using percentage scores from 77 respondents on a Likert scale to categorize responses into five levels: Very Poor to Very Good. Second, statistical testing using PLS-SEM includes evaluation of the measurement model (outer model) through indicators such as loading factor, AVE, HTMT, CR, and Cronbach's Alpha, and the structural model (inner model) using R-square, SRMR, and NFI to assess model fit and explanatory power. Lastly, hypothesis testing is carried out via bootstrapping to determine the statistical significance of relationships between variables, using t-statistics and p-values.

Table 2 PLS-SEM Model Evaluation Criteria

Test	Parameter	Rule / Threshold	Source
Convergent Validity	Loading Factor	> 0.70	Hair et al., 2017
	Average Variance Extracted (AVE)	> 0.50	Hair et al., 2017
Discriminant Validity	Heterotrait-Monotrait Ratio (HTMT)	< 0.90	Kline, 2016
	Fornell-Larcker Criterion	√AVE > correlation with other constructs	Fornell & Larcker, 1981
Reliability	Composite Reliability (CR)	> 0.70	Hair et al., 2017
	Cronbach's Alpha	> 0.60	Hair et al., 2017
Structural Model	R-Square (Cohen, 1988)	$R^2 < 0.02$ = Very Weak, $0.02 \leq R^2 < 0.13$ = Weak, $0.13 \leq R^2 < 0.26$ = Moderate, $R^2 > 0.26$ = Substantial	Cohen, 1988
	R-Square (Hair et al., 2017)	$R^2 < 0.25$ = Very Weak, $0.25 \leq R^2 < 0.50$ = Weak, $0.50 \leq R^2 < 0.75$ = Moderate, $R^2 > 0.75$ = Substantial	Hair et al., 2017
	Normed Fit Index (NFI)	< 0.90 = Poor Fit, ≥ 0.90 = Good Fit, ≥ 0.95 = Excellent Fit	Hu & Bentler, 1999
	Standardized Root Mean Square Residual (SRMR)	≤ 0.08 = Good Fit, ≤ 0.10 = Acceptable Fit, > 0.10 = Poor Fit	Kline, 2016
Hypothesis Testing	t-statistic ($\alpha = 5\%$)	> 1.96 = Significant	Hair et al., 2017
	p-value	< 0.05 = Significant	Hair et al., 2017

IV. RESULT/FINDING

Respondent Characteristics

The data shows that the majority of respondents have a relatively high educational background, with most holding a Bachelor's degree (72.73%), followed by high school/vocational school (15.58%), Master's degree (6.49%), and a small portion holding a Diploma. This educational level supports their understanding of MLFF technology and the TOE Framework. In terms of position, the majority are operational staff (45.45%), followed by low-level management (25.97%), mid-level management (22.08%), and top-level management (6.49%). With 54.55% involved in management roles, it indicates strong engagement in both strategic and operational aspects of technology implementation within BUJTs. Regarding work experience, most respondents have 5–10 years (42.86%) or more than 10 years (41.56%) of experience in toll road operations, while 15.58% have less than 5 years. This suggests that the respondents possess deep knowledge of toll operations and are well-positioned to assess BUJT readiness for MLFF adoption.

Table 3 Respondents Characteristics

Characteristic	Category	Number	Percentage (%)
Education	High School / Equivalent	12	15.58%
	D1/D2/D3	4	5.19%
	S1	56	72.73%
	S2	5	6.49%
	TOTAL	**77**	
Position	Top Level Management	5	6.49%
	Middle Level Management	17	22.08%
	Low Level Management	20	25.97%
	Staff	35	45.45%
	TOTAL	**77**	
Work Experience	< 5 years	12	15.58%
	5-10 years	33	42.86%
	> 10 years	32	41.56%
	TOTAL	**77**	

Descriptive Statistics of Variables

Descriptive analysis showed varying perceptions of TOE variables, with Advantage and Top Management Support rated relatively high, while Complexity was perceived as moderate.

Table 4 Descriptive Analysis

Variable	Mean	Std. Dev.
Compatibility	3.87	0.55
Advantage	4.12	0.48
Complexity	3.45	0.60
Organization Readiness	3.72	0.53
Top Management Support	3.90	0.58
Government Support	3.65	0.65
Vendor Quality	3.75	0.50
Readiness	3.80	0.52

Measurement Model Evaluation

Overall, the outer loading results indicate that all indicators meet the criteria for convergent validity. Indicators with loadings above 0.70 are considered highly valid, while those between 0.60 and 0.70, such as COMPX2 and MI2, are still acceptable as long as the construct's AVE meets the minimum threshold. The results show that all variables are valid, with Average Variance Extracted (AVE) values above 0.5. Thus, based on the convergent validity test using loading factors and AVE, all indicators and variables are deemed valid.

Table 5 Outer Loading & AVE

Variable	Code	Indicator	Loading	AVE
Advantage	**ADV1**	MLFF technology increases toll operational efficiency.	0,773	0,654
	ADV2	MLFF provides a better user experience for toll customers.	0,839	
	ADV3	Reduces waiting time in toll transactions.	0,813	
Compatability	**COMP1**	The MLFF system is compatible with existing toll collection workflows.	0,905	0,804
	COMP2	Ease of integration with existing toll collection systems.	0,888	
Complexity	**COMPX1**	MLFF implementation does not require special training for employees.	0,894	0,607
	COMPX2	BUJT (Toll Road Business Entity) easily understands the MLFF transaction process.	0,691	
	COMPX3	MLFF implementation requires easy and affordable technological infrastructure.	0,738	
Government Support	**GOV1**	The government has provided clear regulations for MLFF.	0,739	0,683
	GOV2	The government provides relevant technical support to support MLFF implementation.	0,921	
	GOV3	The government encourages road users to use MLFF technology (socialization).	0,808	
Top Management Support	**MGT1**	Top management understands the vision and mission to be achieved in MLFF implementation.	0,769	0,696
	MGT2	Management provides the necessary resources for MLFF implementation.	0,761	
	MGT3	Management is proactive in supporting the success of MLFF.	0,957	
MLFF Implementation	**MI1**	BUJT has a strong intention to implement MLFF technology.	0,903	0,578
	MI2	BUJT considers MLFF implementation the right choice to improve toll road operational efficiency.	0,607	
	MI3	BUJT has formed a positive attitude towards the MLFF Implementation plan.	0,743	
	ORG1	BUJT already has the necessary resources for MLFF implementation.	0,878	0,735

Variable	Code	Indicator	Loading	AVE
Organizational Readiness	**ORG2**	BUJT already has a workforce with adequate technical skills for MLFF implementation.	0,783	
	ORG3	BUJT's business processes support the implementation of the MLFF system.	0,906	
Vendor Quality	**VEND1**	The vendor provides reliable MLFF technology according to specifications.	0,911	0,815
	VEND2	The vendor provides responsive technical support during MLFF implementation.	0,898	
	VEND3	The vendor has strong experience and technical expertise in implementing similar technologies.	0,900	

Discriminant validity testing ensures that each latent variable is truly distinct from the others. The results show that all variables are valid, with HTMT values below the threshold of 0.9. In the second method using the Fornell-Larcker criterion, the square root of AVE for each variable is greater than its correlations with other variables. Therefore, based on both HTMT and Fornell-Larcker tests, all variables meet the minimum requirements and are considered valid.

Table 6 Heterotrait-Monotrait (HTMT)

	ADV	COMP	COMPX	GOV	MGT	MI	ORG	VEND
COMP	0,542							
COMPX	0,545	0,777						
GOV	0,549	0,502	0,633					
MGT	0,707	0,476	0,496	0,459				
MI	0,534	0,362	0,404	0,472	0,204			
ORG	0,396	0,381	0,653	0,324	0,739	0,36		
VEND	0,524	0,513	0,68	0,748	0,603	0,496	0,508	

Table 7 Fornell-Lacker Criterion

	ADV	COMP	COMPX	GOV	MGT	MI	ORG	VEND
ADV	**0,809**							
COMP	0,405	**0,896**						
COMPX	0,390	0,554	**0,779**					
GOV	0,405	0,384	0,441	**0,826**				
MGT	0,567	0,390	0,343	0,376	**0,834**			
MI	-0,368	-0,250	-0,270	-0,355	-0,176	**0,761**		
ORG	0,327	0,302	0,457	0,263	0,629	-0,241	**0,857**	
VEND	0,429	0,422	0,505	0,623	0,524	-0,380	0,444	**0,903**

Reliability testing is used to measure the consistency or dependability of a research instrument—specifically, how consistently the indicators within a construct produce similar results under the same conditions. In the context of PLS-SEM, construct reliability is evaluated using two key indicators: Cronbach's Alpha and Composite Reliability (CR). The results show that all variables are considered reliable, with Composite Reliability values exceeding 0.7, indicating high consistency among indicators in measuring their respective constructs. Cronbach's Alpha values are all above 0.6, suggesting adequate internal consistency, although some constructs are close to the minimum threshold.

Table 8 Cronbach's Alpha and Composite Reliability

Construct	Composite Reliability	Cronbach's Alpha
Advantage	0,850	0,735
Compatibility	0,891	0,756
Complexity	0,821	0,679
Government Support	0,865	0,773
Top Management Support	0,871	0,822
MLFF Implementation	0,801	0,628
Organizational Readiness	0,892	0,826
Vendor Quality	0,930	0,888

Structural Model Evaluation

The R-Square value for the dependent variable "MLFF Implementation Readiness" is 0.24, indicating a weak explanatory power. This means that 24% of the variance is explained by variables such as Compatibility, Advantage, Complexity, Organizational Readiness, Top Management Support, Government Support, and Vendor Quality, while the remaining 76% is influenced by other factors outside the model.

Table 9 R-Squares

Dependent Variable	*R-Squares*	*Interpretation*
MLFF Implementation Readiness	0.24	Weak

Although model fit is not the primary focus in PLS-SEM, it can still be assessed. The model's NFI value is 0.585, indicating that the model fits approximately 59% of the actual data.

Table 10 Model Fit

	Saturated model	Estimated model
SRMR	0,093	0,093
d_ULS	2,365	2,365
d_G	1,070	1,070
Chi-square	443,602	443,602
NFI	0,585	0,585

Hypothesis Testing Results

Hypothesis testing in PLS-SEM was conducted using the bootstrapping method. Based on the results, only H2 (Advantage → MLFF Implementation Readiness) was statistically significant, with a t-statistic of 2.496 (>1.96) and a p-value of 0.013 (<0.05). This confirms that perceived advantages of MLFF significantly influence BUJT readiness for implementation. The remaining hypotheses (H1, H3, H4, H5, H6, and H7) were not supported, as their t-statistics were below 1.96 and p-values above 0.05, indicating no significant effect of compatibility, complexity, organizational readiness, top management support, government support, and vendor quality on MLFF implementation readiness.

Table 11 Hypothesis Results

Hypothesis	T statistics (|O/STDEV|)	P values	Result
Advantage -> MLFF Implementation	2,496	0,013	**Accepted**
Compatablitiy -> MLFF Implementation	0,404	0,687	Rejected
Complexity -> MLFF Implementation	0,342	0,732	Rejected
Government Support -> MLFF Implementation	0,881	0,378	Rejected
Top Management Support -> MLFF Implementation	1,295	0,196	Rejected
Organizational Readiness -> MLFF Implementation	1,058	0,29	Rejected
Vendor Quality -> MLFF Implementation	1,202	0,23	Rejected

V. DISCUSSION

The study findings indicate that among the seven tested hypotheses, only one variable, Advantage showed a statistically significant effect on the implementation readiness of MLFF. This suggests that most initially assumed factors did not strongly influence MLFF adoption based on the available data.

Advantage had a significant impact (t = 2.496; p = 0.013), showing that the perceived benefits of MLFF (e.g., operational efficiency, reduced toll gate congestion, cost savings, improved service quality) are key drivers of BUJT's readiness. Therefore, implementation strategies should focus not only on technical infrastructure but also on increasing perceived value through pilot projects or case studies from other countries. This aligns with Mahirah et al. (2022) and Min & Kim (2024), who found that perceived relative advantage significantly influences technology adoption.

Compatibility was not significant (t = 0.404; p = 0.687). Although theoretically important (Rogers, 2003), it appears that in this context, alignment with existing systems is not a major concern. This aligns with UTAUT findings where adoption in public sectors is often driven more by external pressure and perceived benefits than technical fit (Venkatesh et al., 2012). Nonetheless, compatibility remains crucial to avoid operational disruptions, and technical assessments (e.g., gap analysis) should be conducted (Hermawan & Aruan, 2023).

Complexity showed no significant impact (t = 0.342; p = 0.732), though its small positive coefficient suggests it may still pose a potential barrier. High system complexity could hinder adoption unless addressed through simplified design and process flows (Rogers, 2003; McNerney et al., 2009). Implementation should prioritize minimizing technical complexity to facilitate user adaptation.

Top management support was not significant (t = 1.295; p = 0.196). This may be due to the passive role of BUJT in Cluster 3 Transjawa, which is not part of the MLFF trial phase (Rahayu, n.d.). Without direct involvement or incentives, senior management lacks urgency for transformation. Active engagement can be encouraged through regulatory mechanisms or incentives such as toll rate adjustments or SPM evaluations (Min & Kim, 2024).

Organizational readiness had no significant effect (t = 1.058; p = 0.290), possibly because BUJTs in Cluster 3 Transjawa are not yet involved in trials (Rahayu, n.d.). Despite this, internal readiness is essential for success and includes training, infrastructure upgrades, and promoting a culture of innovation (Min & Kim, 2024). Efforts such as annual innovation competitions reflect commitment to preparing all organizational levels.

Government support was not significant (t = 0.881; p = 0.378), possibly due to insufficient policy integration or support perceived by BUJT. Prior studies note coordination challenges in ETC implementation in Indonesia (Kamiliah & Wijaya, 2024; Hermawan & Aruan, 2023). Similarly, Naeem et al. (2024) found that lack of government regulation limited mHealth adoption. The government, through BPJT, should not only regulate but also actively support through incentives and technical guidance.

Vendor quality was also insignificant (t = 1.202; p = 0.230). This could be due to vendor selection (PT RITS) being government-appointed, limiting BUJT's perception of its importance. This finding aligns with Gui et al. (2020), who showed that in vendor lock-in situations, vendor quality has little impact on adoption. However, when organizations can choose vendors, quality becomes critical (Setiyani & Rostiani, 2021). Therefore, continuous performance monitoring through performance-based contracts is recommended.

VI. CONCLUSION AND RECOMMENDATION

This study aims to analyze the factors influencing the readiness of Toll Road Operators (BUJT) to implement the Multi Lane Free Flow (MLFF) system based on the Technology-Organization-Environment (TOE) framework. The results indicate that Advantage is the only factor significantly influencing the readiness for MLFF implementation, highlighting that the perceived benefits, such as increased efficiency, cost savings, legal certainty, and improved service quality, are the main drivers for organizations to adopt the system. Other variables, including Compatibility, Complexity, Government Support, Top Management Support, Organizational Readiness, and Vendor Quality, did not show statistically significant effects. However, these factors remain important in practical and managerial contexts. The readiness of BUJT is not solely driven by technological aspects but also requires synergy between internal organizational support and external ecosystems, including government policies and technology partners. Additionally, the complexity of the system can be a challenge that might impede implementation if not addressed with adequate human resources and infrastructure.

Based on these findings, several recommendations are provided. The government should enhance the socialization of MLFF to BUJTs by emphasizing its benefits through workshops, pilot projects, field visits to countries with MLFF experience, and sharing data-driven information. BUJTs should focus on internal organizational readiness, including continuous training, human resource development, and infrastructure updates, which can help in adapting to technological changes. Although Complexity did not show a significant impact, efforts to simplify the system and make it easier to use are essential, such as by streamlining procedures, providing hands-on training, creating system prototypes for BUJTs, and developing standard operating procedures (SOPs). Furthermore, Top Management Support needs to be reinforced through strategic communication, involvement in decision-making, and ensuring sufficient resources for the implementation of MLFF. The government should also provide supportive policies and legal certainty, enhance vendor selection transparency, and establish task forces dedicated to MLFF implementation.

Finally, this study acknowledges several limitations. The sample size was limited, and the research only focused on certain BUJT stakeholders, which may not fully represent the entire population of BUJTs in Indonesia. Additionally, the study's variables did not account for all potential influencing factors, such as organizational culture, resistance, prior technology experience, or public enthusiasm, which could also play significant roles in MLFF adoption. Data collection was conducted within a specific period, meaning it may not capture ongoing changes in traffic conditions or organizational readiness. Furthermore, this research was entirely quantitative, and future studies using qualitative approaches, such as interviews, could offer deeper insights into the challenges and perceptions faced by BUJTs during the MLFF implementation process.

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