Determinant Factors of Logistics Firm Performance Mediated by Optilog Adoption Using a Mixed Method with an Explanatory Sequential Analysis

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***Abstract*—Recently, trucking logistics service providers are focusing on adopting technology and Information Technology (IT) capability to improve performance. Hence, it is essential to investigate how the IT capability of the firm can enhance logistics performance and impact technology adoption on performance. Therefore, the research examines the determinant factors of logistics firm performance mediated by Optilog adoption. The research design is a mixed method with an explanatory sequential design using quantitative and qualitative data analysis. Quantitative data analysis uses Structural Equation Modeling (SEM), while qualitative analysis adopts in-depth interviews. The analysis population includes 41 Optilog users in the logistics firm in East Jakarta, with the experts adopting a census sampling method. For qualitative phase, the researchers also recruit four respondents holding supervisory positions or higher using Optilog for daily operations. The results show that logistics firm performance is influenced by service excellence and Optilog adoption. Additionally, perceived risk, traceability, and IT capability positively affect Optilog adoption, which mediates the effects on logistics firm performance. The results confirm the rejection of the hypothesis that Optilog adoption mediates IT capability on logistics firm performance. The thematic analysis further concludes that the system, implemented in March 2022, does not impact logistics firm performance significantly, according to the respondents. Consequently, IT departments depend on responsiveness to address users' needs and issues since when the vendor develops the system, it faces significant constraints due to the development and maintenance costs.**

***Index Terms*—Logistics Firm Performance, Optilog Adoption, Mixed Method, Explanatory Sequential Analysis**

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I. Introduction

TRUCK logistics service providers are playing a crucial role in addressing global concerns, such as the repercussions of the COVID-19 pandemic and the current confrontation between Russia and Ukraine [1]. The firm's Logistics Performance Index (LPI) serves as a metric to assess logistics systems' effectiveness and long-term viability. According to the 2023 LPI, Indonesia has received a cumulative score of 3.0, positioning it at the 61st level globally [2]. Despite observing a decrease in the ranking on the 2018 LPI, the country continues to surpass the average performance of upper-middle-income states [3]. However, Indonesia faces substantial challenges in enhancing performance compared to its regional counterparts in China, India, Singapore, Malaysia, and Thailand [2]. In Indonesia, the truck logistics performance statistics in 2022 showed several issues the industry faces [4].

Despite this industry's tremendous growth, several performance factors require additional attention. Furthermore, the significant issue of traffic congestion

in metropolitan areas, including Jakarta, remains a substantial barrier hampering its velocity and effectiveness [5]. The available statistical data also show that delivery delays and the escalation of operating expenses are significant, particularly when vehicles become immobilized due to prolonged traffic congestion [6].

In addition to the stated issues, statistical data on truck logistics performance in Indonesia suggest various administrative barriers faced by logistics businesses [7]. The presence of intricate and often sluggish administrative procedures, such as inspection and document processing, may cause disruptions in the supply chain and lead to a rise in total operating expenditure [8]. Furthermore, logistics sector stakeholders face uncertainty due to ever-changing rules and policies [9]. Logistics organizations may also incur increased expenses due to changes in tax legislation, limitations on operating time, and evolving technology requirements [10].

To address these challenges, the Indonesian government further anticipates digital transformation through the National Logistics Ecosystem (NLE). It is a digital platform that enables cooperation across ministries/agencies, corporations, and logistics entities [11]. Efforts to enhance overall logistics performance include continuously improving connecting infrastructure such as toll road systems, port facilities, railway networks, and airport networks [12]. Furthermore, Presidential Instruction Number 3 of 2023 pertains to the acceleration of increasing regional road connectivity as a commendable measure that warrants recognition and execution [13].

Examining the impact of digital transformation on logistics firm performance is important because the firm plays an essential role in supporting the national supply chain. An efficient and effective supply chain affects the national competitive advantage in the global economy. Furthermore, digital transformation in logistics companies also increases operational efficiency, timeliness of delivery, and ability to overcome the complexity of modern logistics. Any firm that cannot operate optimally can lead to business inefficiencies and fail to compete in the era of globalization.

The Technology Organization Environment (TOE) framework is a conceptual theory that explains the intricate interplay of technology, organizations, and the external environment within the domain of information technology adoption and use [14]. The TOE framework was first developed in the early 1980s and has since evolved as a significant theoretical foundation within information systems and technology management publications [15]. This theoretical framework significantly emphasizes comprehending the intricate interplay of technical, organizational, and environmental elements in shaping technology-related choices and behavior inside organizations [16]. Additionally, it comprehensively analyzes elements that facilitate or impede technology adoption by examining technical complexity, organizational structure, and environmental circumstances [14]. Therefore, the TOE framework is considered a helpful analytical instrument for academics to investigate the intricacies of information systems and the impact of technology on organizational performance in the digital world.

Moreover, numerous articles have assessed the adoption process of Transport Management Systems (TMS) in the logistics industry using the TOE paradigm [17–19]. Previous research analyzes the drivers and obstacles influencing technology adoption in the context of third-party Logistics Service Providers (LSPs) and industry experts [17]. It shows that internal organizational attributes, external influences, including the COVID-19 pandemic, and specific strategies used by LSPs enhance the efficiency of supply chain networks and maintain sustainable operations in a post-COVID-19 environment.

Another research further examines the impact of warehouse and inventory management systems on the supply chain performance of fast-moving consumer goods businesses in Nairobi County, Kenya [18]. It suggests that these systems significantly impact overall supply chain performance within the companies. In this context, the impact of technology access on the effective assimilation of technological advancements is studied, focusing on theoretical and managerial implications for logistics service providers [19]. It subsequently shows that technological access modes (make, buy, and ally) significantly influence the success of integration processes, with factors such as acceptance, quality, speed, and costs playing a role.

A drawback of prior research is the adherence to the original TOE structure, which fails to consider the interconnectedness of the antecedents. Behavioral intents further depend on the distinct attributes of each invention and the progression within each nation. Additionally, constructing TOE is subject to dynamism and contingent upon several contextual factors as well as the specific kinds of technologies and organizations included. Incorporating additional factors such as IT capability and traceability in the technology context, service excellence in the organizational context, and perceived risk in the environmental context can enhance the primary TOE antecedents, facilitating TMS adoption and improving business performance for logistics firms in Indonesia.

According to previous researchers [20], e-traceability and TMS in logistics businesses provide

a synergistic connection that significantly improves overall efficiency and performance. This integration includes continuously monitoring and tracking goods using Radio Frequency Identification (RFID), barcodes, or sensors, offering rapid visibility into the supply chain, and facilitating accurate transportation management [21]. Furthermore, Optilog is a software system known as TMS that aims to optimize and improve transportation operations [22]. Integrating e-traceability with TMS in logistics organizations may further provide a substantial and favorable effect [22] by offering immediate insight into the supply chain, enabling more precise transportation control [21]. The firm may also mitigate the risk of delays or loss of goods by using up-to-date information on the position and condition of the products, enabling adaptation to changing circumstances promptly [23]. In this context, the deployment of TMS offers a framework for consolidating data from e-traceability with transportation management information, allowing organizations to strategize routes, oversee transportation efficiency, and enhance resource adoption [24].

The relationship between e-traceability and TMS adoption creates a holistic framework to enhance efficiency and visibility in logistics firm operations [25]. By integrating this technology, firms can achieve a competitive advantage, enhance customer satisfaction, and improve overall performance in the competitive logistics industry [23]. The integration further reduces the risk of delays or loss of commodities by using current information on the location and state of items [22]. TMS provides a structure for integrating data from e-traceability with transportation management information, enabling firms to plan routes, monitor effectiveness, and optimize resource allocation [24]. According to previous research [25], this comprehensive framework generates a competitive advantage, fosters customer satisfaction, and promotes overall performance in the logistics sector. Based on this evidence, the research formulates the following hypotheses.

H1a: Traceability positively affects Optilog adoption,

H1b: Optilog adoption mediates the relationship between traceability and firm performance.

The correlation between the perception of financial data breaches, data security, fraud risk, and the implementation of TMS in logistics firms emphasizes the obstacles and strategies that need to be addressed in security and financial administration [26]. Initially, perceived financial risk associated with a breach of financial data can provide a substantial barrier to adopting TMS [27]. In this context, logistics organizations often oversee delicate financial data, comprising consumer information, payment details, and transaction particulars. The apprehension of potential data security breaches can also impede the use of TMS [28]. Therefore, it is essential to consider TMS integration, which comprises sophisticated security measures and adherence to security standards, to mitigate the potential for financial data leakages [29].

Ensuring financial data security is crucial in reducing perceived financial risk, as logistics firms should evaluate the security level of the selected TMS to guarantee the robust protection of financial information [30]. For a firm that mitigates risk and fosters confidence in implementing TMS, it is advisable to implement data encryption, enforce stringent access controls, and establish robust identity mechanisms [31]. In this context, the presence of fraud is also an essential component of perceived financial risk that requires critical attention [32]. Within the logistical operations, the risk of fraud can manifest via inaccurate data, fraudulent transactions, or the manipulation of financial data [33]. Based on this evidence, integrating intelligent TMS can enhance the ability to identify abnormalities and suspicious activities, mitigate the risk of fraud, and uphold the firm's financial integrity [34].

Establishing a favorable correlation between the perception of financial risk and adopting TMS further requires proactive risk management strategies [35]. The firm may also advocate for transparency in security policy, provide security training for staff, and ensure that the TMS systems adhere to industry security standards [30]. Furthermore, successfully managing perceived financial risk associated with TMS allows logistics firms to maximize advantages, enhance operational efficiency, and mitigate potential financial concerns [36]. Therefore, the research formulates the following hypotheses based on the discoveries.

H2a: Perceived risk positively affects Optilog adoption,

H2b: Optilog adoption mediates the relationship between perceived risk and firm performance.

The relationship between Information Technology (IT) capability and adoption of TMS in logistics firms creates a crucial strategic foundation for increasing operational efficiency and competitiveness [27]. IT capability includes the ability of the firm to manage, integrate, and use information technology to support business operations [37] and facilitate the implementation and adoption of TMS [38]. Logistics firms with

substantial IT capability can integrate TMS into the existing technology infrastructure more efficiently [20]. This capability includes data integration, compatibility with other systems, and capacity to manage the technological complexity of using a TMS, allowing for smoother and more efficient adoption [36].

In this context, IT capability plays a crucial role in maximizing the benefits of TMS, where a firm with high technological capability can optimize its use of advanced features [39]. It includes deeper data analysis, real-time monitoring, and artificial intelligence algorithms to improve route efficiency and resource allocation [40]. By leveraging the capability, logistics firms can achieve higher visibility and make more timely decisions [39]. IT capability also contributes to the firm adaptability to change technological developments continuously [41]. Therefore, the relationship between IT capability and TMS adoption in logistics firms fosters technological continuity that supports operational efficiency and competitive advantage [42]. Improved IT capability further facilitates TMS implementation and enables firms to adapt quickly to technological changes, achieve better operational visibility, and gain higher efficiency throughout the logistics supply chain [23]. Based on this evidence, the research suggests the following hypotheses.

H3a: IT capability positively affects Optilog adoption,

H3b: Optilog adoption mediates the relationship between IT capability and firm performance.

A relationship between delivering outstanding service and the overall success of a logistics firm is a crucial factor in enhancing competitiveness and long-term viability [43]. Service excellence, including the delivery of superior services and the ability to promptly address client requirements, greatly influences the success of a logistics firm [44]. It is also correlated with higher levels of customer satisfaction, which subsequently impacts customer loyalty and fosters firm expansion [45]. A logistics firm with exceptional delivery service can further establish strong client connections, generate favorable encounters, and fulfill or exceed customer expectations [46]. Satisfied clients will often establish and sustain commercial partnerships with logistics businesses, collaborate further, and even endorse services to other entities [44], which significantly enhances the revenue and profitability of the firm.

Service quality is regarded as a crucial factor in enhancing the operational efficiency of logistics firms [36]. By providing efficient and effective services, these firms can improve logistical operations, minimize operating costs, and enhance productivity [47]. Enhancing operational efficiency not only yields favorable cost outcomes but also fosters the capacity of the firm to contend in a progressively competitive market, augment competitive edge, and eventually enhance overall performance [48].

Attaining service excellence significantly contributes to establishing a favorable perception of the firm [45], where the public's impression of service quality directly impacts the firm's image [49]. A logistics firm that is renowned for exceptional service has a favorable standing in the market, instills confidence, and attracts a larger clientele and network of business associates [50]. By cultivating a favorable perception, logistics firms can achieve a lasting competitive edge and enhance their appeal in the market [51]. Therefore, the following hypotheses are suggested based on the discoveries.

H4: Service excellence positively affects firm performance.

Implementing TMS in a logistics firm is essential for optimizing overall performance [22]. TMS implementation has a beneficial impact on the operational efficiency of logistics firms, facilitating the mechanization of operations such as route optimization, inventory control, and transportation coordination [52]. Logistics firms can further enhance overall performance by streamlining processes, stimulating punctuality, reducing operating costs, and increasing productivity [42].

TMS further enhances visibility and transparency within the supply chain. By integrating data from different phases of the logistics process, logistics firms can achieve real-time monitoring of product movement, inventory tracking, and identification of possible impediments or delays [53]. Enhanced visibility further empowers management to expedite decision-making and facilitate well-informed choices, eventually enhancing operational efficiency and stimulating customer happiness [54]. Additionally, TMS enables logistics firms to enhance their ability to adapt to market fluctuations and meet consumer requirements promptly [23]. By harnessing the capabilities of TMS, firms can enhance the capacity to make precise forecasts, adapt transportation plans, address changes in demand, and manage inventory levels as necessary [20]. This adaptability allows logistics firms to respond to ever-changing market issues and enhance client service standards. In a logistics setting, TMS will significantly impact corporate performance, leading to improved competitiveness and sustainable development [42]. Based on this evidence, the research formulates the following hypothesis.

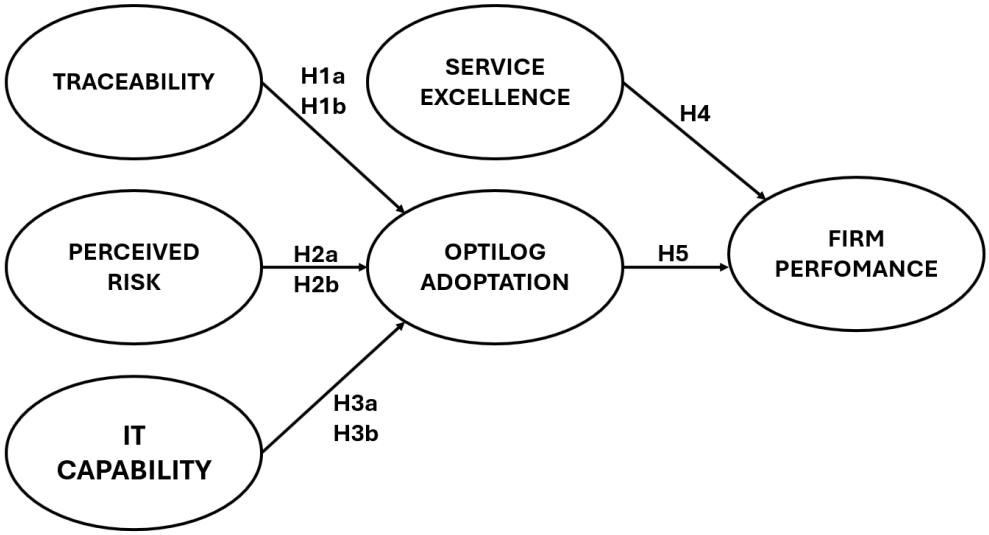

Fig. 1. Proposed conceptual framework.

H5: Optilog adoption positively affects firm performance.

Synthesizing previous research shows a gap in exploring potential obstacles and strategies related to integrating e-traceability and TMS in logistics firms. Therefore, the research addresses the limitations by examining security concerns, fraud prevention strategies within TMS adoption, the impact of IT capability, and the mechanisms through which service excellence influences operational efficiency. Previous research focuses on quantitative studies to examine the effect of digital transformation on logistics firm performance. It uses a quantitative method using cutting-edge Partial Least Squares - Structural Equation Modeling (PLS-SEM) protocol and follows a qualitative method to gain a deeper understanding and interpretation. Finally, addressing these gaps can provide valuable insights for experts and practitioners. Furthermore, Fig. 1 shows the proposed conceptual framework based on synthesizing previous results. The research aims to examine the determinant factors of logistics firm performance mediated by Optilog adoption. It also offers novel perspectives on integrating e-traceability and TMS, addresses security concerns and fraud prevention, emphasizes the strategic role of IT capability, explores the relationship between service excellence and logistics success, and provides a comprehensive view of the impact of TMS on logistics operations.

II. Research Method

The research design is an explanatory sequential mixed method [55] where quantitative data are collected from employees of a logistics firm in East Jakarta. Following this, the researchers interview selected respondents who have completed the questionnaire surveys for qualitative data collection and analysis [55]. The selection of the explanatory design is based on the rationale that the subsequent qualitative data explain the first quantitative results, providing a more comprehensive understanding of the studied question [56, 57]. Furthermore, ethical clearance from the ethics committee is not considered necessary since the research does not comprise substantial ethical hazards to the subjects. The primary focus is to examine the impact of technology adoption on firm performance using behavioral analysis. It is also important to understand that the research is purely observational and does not include the disclosure of any personal or sensitive information.

A. Quantitative Phase 1–Online Self-Administered Questionnaire Survey

During the quantitative phase of the research, an online questionnaire is administered to all personnel of logistics firm located in East Jakarta. This survey aims to assess the extent to which the firm has used the recently implemented TMS. Furthermore, the research focuses on a specific demographic of 41 workers hired in a logistics firm in East Jakarta. The sampling methodology used is a census method where the total number of required samples amounts to 41 respondents. Experts consider population size, practicality, level of accuracy, sampling bias, and in-depth analysis when selecting a census method [58].

The research includes measuring items about traceability [59], perceived risk [60], IT capability [61, 62], Optilog adoption [63], service excellence [43], and firm performance [64] derived from previous scholarly investigations. A total of 23 indicators are used to assess all variables using a five-point Likert scale ranging from strongly disagree (1) to strongly agree (5). The questions from the previous publications are translated into Indonesian with the guidance of an Indonesian expert proficient in English. The research further uses a cross-sectional method where the expert uses Google Forms to develop the questionnaire. This method has proven effective and is extensively used in quantitative publications to validate theories or models in technology adoption analysis.

The researchers further incorporate a pilot study to establish the face and content validity of the questionnaire [65]. The preliminary version of the questionnaire is assessed by a panel of four faculty members from a university, two executives from a firm, and one scholar holding a Ph.D. who specializes in technology adoption. The pilot research aims to evaluate the questionnaire's quality and identify possible concerns about the general structure, clarity of language, ambiguity, and format. In response to the experts' recommendations, the research makes modifications to enhance the comprehensibility of the questions, such as addressing terminology problems that may contribute to respondents' misinterpretation.

To facilitate the return of the completed questionnaire, the researchers have sent the questionnaire link through the firm's email with a cover letter explaining the study objectives, number of questions, estimated completion time, and assurance of confidentiality and privacy. The researchers have also offered a token of appreciation to all respondents after completing the questionnaire. Additionally, reminders and the questionnaire are sent to those who have not replied or answered after 14 days using email.

B. Qualitative Phase 2–Individual Semi-Structured Interview

A further qualitative phase is performed to understand better the influence of Optilog adoption and service excellence on firm performance. This phase includes individual semi-structured interviews with respondents who have previously completed a questionnaire to ensure quantitative outcomes. The analysis of the quantitative stage offers insights into significant factors needing enhancement to improve corporate performance. The phase also facilitates the identification of employees' attitudes using Optilog via semi-structured interviews. The respondents are carefully selected based on certain criteria. The research requires the subjects to hold supervisory positions or higher within the respective organizations. Additionally, the respondents are expected to possess a minimum of ten years of work experience and use Optilog in the firm's operations.

A purposive sampling strategy is further used for the qualitative research to recruit four respondents. In qualitative analysis, investigations using a single case study design often need a minimum of four interviews to achieve data saturation. The data collecting strategies include individual semi-structured interviews with participants using recommendations derived from the quantitative outcomes. Personal contact is adopted to extend an invitation and coordinate the interview schedule, considering the respondent's availability. Each interview session typically lasts between five to ten minutes and is facilitated by a single interviewer who leads the interview and documents the proceedings. The interviewer also uses audio recording with the participant's informed permission, allowing respondents to articulate their perspectives on the subject matter. A standardized methodology is devised and adhered to throughout the interview process to ensure uniform and best outcomes.

The researchers use twelve open-ended questions to get a comprehensive grasp of the impact of Optilog adoption and service excellence on firm performance. The interview questions include (1) What is the difference between the previous and Optilog systems? (2) What are respondents' experiences during Optilog adoption? (3) Does Optilog have good tracking capability, and how often do the employees use the system? (4) How is the IT capability currently? Explain the advantages and disadvantages, and (5) How can the current IT capability reduce financial risk? Furthermore, other open-ended questions used are (6) describe how the IT capability can increase the firm service excellence, (7) describe the benefit of Optilog feature on tracking the firm operation, (8) describe how the firm uses IT capability for preparing the emergency event, (9) describe the internal communication strategy and channel, as well as (10) describe the employee capability on using Optilog system.

The results obtained from the questionnaire survey are further analyzed using two software programs: Microsoft Excel and SmartPLS 4.0.9.6. Initially, descriptive statistics is used to examine the demographic characteristics of the respondents' profiles and the questionnaire questions using Microsoft Excel. Furthermore, a multivariate analysis is performed to assess the normality, common method bias, confirmatory factor, and path analysis with Smart PLS 4.0.9.6. The protocols are thoroughly explained in the subsequent

TABLE I
DESCRIPTIVE ANALYSIS OF RESPONDENTS' PROFILE.

Question	N	%
Gender		
Male	26	63.41
Female	15	36.59
Age (years old)		
31–40	16	39.02
21–30	11	26.83
41–50	10	24.39
Above 50	4	9.76
Education		
Bachelor's degree	27	65.85
Diploma	8	19.51
Master's degree	4	9.76
Senior high school or Equivalent	2	4.88
Job Level		
Staff	18	43.90
Supervisor	10	24.39
Manager	5	12.20
Assistant manager	5	12.20
General manager	2	4.88
C-level executive	1	2.44
Department		
Operation	22	53.66
Accounting and finance	11	26.83
Business excellence	3	7.32
Sales	3	7.32
Information Technology (IT)	2	4.88
Working experience (years)		
>5–10	14	34.15
>10	11	26.83
<1	7	17.07
>1–5	9	21.95

section dedicated to presenting the results.

For individual semi-structured interviews, the transcripts are analyzed using a thematic method. The audio is transcribed manually and further created in transcripts. Subsequently, the transcript is read, and the results are categorized for each theme. The theme is finally discussed and examined to identify the relationship among the recurrent themes.

III. RESULTS AND DISCUSSION

In Table I, the descriptive analysis of the profiles shows that most respondents are male and between 21 and 40 years old. They also possess a bachelor's degree as the highest level of education. Furthermore, job levels are predominantly staff and supervisors. Then, the departments include operations, accounting, and finance with over five years of working experience.

Before analyzing the confirmatory factor analysis, data screening and normality analysis are conducted. The results show that two respondents have filled out the questionnaire with straight-lining answers. After removing these unengaged respondents, 41 data sets are used for analysis, and the data normality is further inspected, as shown in Table II. Skewness and kurtosis values from SmartPLS software are also used to verify the data normality with cut-off values between -1 and +1 [66]. The data are considered excellent since the skewness and kurtosis values fall within the cut-off range.

The confirmatory factor analysis is further examined by evaluating individual, internal consistency reliability, convergent, and discriminant validity. Individual reliability is assessed using outer loading value, applying a minimum cut-off value of 0.7, as shown in Table II [67]. All indicators for each variable meet the criteria, with values ranging from 0.716 to 0.934. Subsequently, internal consistency reliability is inspected using Composite Reliability (CR) with a cut-off value of 0.7 [68]. The research concludes that all variables meet the criteria ranging from 0.857 to 0.950. Convergent validity is then inspected using the AVE with a minimum cut-off value of 0.5. Table II shows the convergent validity test results. All variables meet the criteria with values ranging from 0.601 to 0.825.

Then, discriminant validity is investigated using the Fornell-Larcker criterion. It requires the square root of each construct's AVE to be greater than the correlations with other latent constructs [66]. The proposed model in Table III shows no problems with discriminant validity analysis.

Following the confirmatory factor analysis, hypothesis testing, coefficient of determination (R^2), and predictive power are conducted to evaluate the structural model assessment. The bootstrapping procedure includes a subsample of 5,000, a bias-corrected and accelerated (BCa) bootstrap confidence interval method, a one-tailed test type, and a significance level of 0.025. The effect size (f^2) statistic measures the contribution of exogenous factors to endogenous variables with intervals defined as high effect ($f^2 > 0.350$), medium effect ($f^2 > 0.150$), and small effect ($f^2 > 0.020$) [69]. A combination of criteria, such as p-values and effect sizes, is also used to gain a comprehensive understanding of the results [70].

Based on the hypothesis testing results in Table IV, service excellence (β = 0.580; $p < 0.001$; high effect; BCI LL = 0.322; BCI UL = 0.711) and Optilog adoption (β = 0.394; $p < 0.01$; medium effect; BCI LL = 0.125; BCI UL = 0.600) influence firm performance. Additionally, perceived risk (β = 0.419; $p < 0.001$; high effect; BCI LL = 0.298; BCI UL = 0.565), traceability (β = 0.392; $p < 0.01$; medium effect; BCI LL = 0.131; BCI UL = 0.644), IT capability (β = 0.217; $p < 0.025$; small effect; BCI LL = 0.011; BCI UL = 0.457) affect Optilog adoption. The mediation analysis shows that Optilog adoption mediates the relationships between traceability and firm performance (β = 0.151; p-value = 0.017), perceived risk and firm

TABLE II
THE RESULTS OF OUTER LOADING, AVERAGE VARIANCE EXTRACTED (AVE), AND COMPOSITE RELIABILITY (CR).

Variable and Indicator	1	2	3	4	5	6
Firm Performance				0.779	0.857	0.601
The firm has the necessary resources to manage logistics to improve performance.	0.758	0.657	0.000			
The company knows what is needed to use logistics activities for company performance.	0.856	0.139	0.011			
We can get help from partners when we experience difficulties using logistics services.	0.716	0.513	0.354			
Firms are compatible with synchronizing data with all value chain partners to improve performance.	0.766	0.243	0.292			
Optilog Adoption				0.929	0.950	0.825
Optilog adoption makes it possible to promptly notify people about changes occurring in logistics schedules.	0.916	0.385	0.010			
The firm uses the latest version of Optilog to make traceability.	0.910	0.516	0.042			
Optilog allows firms to respond quickly to customers to improve logistics performance.	0.906	0.475	0.093			
Optilog can improve logistics efficiency with real-time communication and data transparency.	0.901	0.368	0.336			
IT Capability				0.934	0.950	0.793
IT enterprise can increase reliability and build productivity in logistics performance.	0.865	0.298	0.477			
The IT capability enables the company to improve business processes to support logistics performance.	0.923	0.181	0.435			
IT capability can improve service quality to improve logistics performance.	0.886	0.238	0.161			
Enterprise IT capability can lower barriers to communication and information transparency.	0.934	0.055	0.391			
The firm's IT capability can provide quality information.	0.840	0.226	0.005			
Perceived Risk				0.843	0.905	0.762
Optilog adoption can reduce the risk of financial data breaches.	0.893	0.459	0.373			
Optilog adoption helps the company to secure financial data.	0.912	0.162	0.437			
Optilog adoption can reduce the fraud risk.	0.810	0.217	0.381			
Service Excellence				0.822	0.880	0.648
The firm can identify customers' needs to improve the logistics process.	0.835	0.313	0.065			
The firm can analyze logistics problems to formulate the solution.	0.813	0.301	0.060			
The firm can ensure communication quality with its customers.	0.812	0.387	0.025			
The firm uses qualified employees to deliver the service.	0.758	0.366	0.381			
Traceability				0.863	0.906	0.708
The ability to track orders is more productive.	0.873	0.897	0.859			
The firm can track job orders.	0.880	0.931	0.767			
The firm can provide transparent information on delivery.	0.890	0.563	0.237			
Auto-generated delivery schedules are for internal and external users to meet logistical expectations.	0.709	0.505	0.391			

Note: 1= Outer Loading; 2= Kurtosis; 3= Skewness; 4= Cronbach's Alpha; 5= Composite Reliability; 6= Average Variance Extracted

TABLE III
DISCRIMINANT VALIDITY TEST USING FORNELL-LARCKER CRITERION.

	1	2	3	4	5	6
1. Firm Performance	0.775					
2. IT Capability	0.332	0.890				
3. Optilog Adoption	0.416	0.767	0.908			
4. Perceived Risk	0.545	0.597	0.812	0.873		
5. Service Excellence	0.575	0.042	0.037	0.206	0.805	
6. Traceability	0.340	0.753	0.826	0.654	0.120	0.842

performance (β = 0.169; p-value = 0.006), and IT capability and firm performance (β = 0.087; p-value = 0.056). The coefficient of determination (R^2) further shows how well an outside factor explains an inside element, which is anticipated to fall between 0 and 1. The results showing R^2 values of 0.75, 0.50, and 0.25 imply that the model is strong, moderate, and bad [71]. Perceived risk, traceability, and IT capability explain 82% of the variation of Optilog adoption, while service excellence and Optilog adoption show 46% of the firm performance.

These results establish that e-traceability is positively affected by Optilog adoption (H1a is accepted). Furthermore, Optilog adoption mediates the relationship between traceability and firm performance (H1b is accepted). The results correlate with previous studies

TABLE IV
HYPOTHESIS TESTING RESULTS.

Hypotheses	β	STDEV	T-Statistics	P-Values	BCI-LL	BCI-UL	F^2
H1a: TR → OA	0.392	0.140	2.633	0.004	0.131	0.644	0.301
H2a: PR → OA	0.419	0.073	5.963	0.000	0.298	0.565	0.616
H3a: ITC → OA	0.217	0.121	1.905	0.028	0.011	0.457	0.133
H4: SE → FP	0.580	0.099	5.650	0.000	0.322	0.711	0.612
H5: OA → FP	0.394	0.126	3.141	0.001	0.125	0.600	0.304
H1b: TR → OA → FP	0.151	0.068	2.132	0.017	0.047	0.302	
H2b: PR → OA → FP	0.169	0.068	2.532	0.006	0.053	0.309	
H3b: ITC → OA → FP	0.087	0.058	1.589	0.056	0.005	0.224	

Note: β= Path Coefficient, STDEV= Standard Deviation, BCI-LL= Bias Corrected Item Lower Level, BCI-UL= Bias Corrected Item Upper Level, ITC= IT Capability, OA= Optilog Adoption, FP= Firm Performance, SE= Service Excellence, and TR= Traceability.
R^2 of firm performance is 46%, and Optilog adoption is 82%.

conducted [20, 21, 23]. Implementing TMS in logistics firms substantially influences overall performance because it enables the mechanization of logistical procedures and enhances operational effectiveness and productivity. Additionally, it improves the clarity and openness of the supply chain, allowing for real-time monitoring of item flow and inventory tracking. It facilitates expedited decision-making as well as enhanced operational efficiency and consumer satisfaction. TMS also improves logistics firms' adaptability to market fluctuations and client requirements, enabling precise forecasting in transportation plans and inventory optimization. The correlation between the use of TMS and the performance of firms in the logistics industry establishes the basis for enhanced competitiveness and long-term growth.

Based on the results obtained, perceived risk positively affects Optilog adoption (H2a is accepted). Additionally, Optilog adoption mediates the relationship between perceived risk and firm performance (H2b is accepted). The results support previous researchers [26, 27, 30]. The research shows that logistics firms are more inclined to implement Optilog solutions when perceiving significant financial risk, including data breaches, security difficulties, and fraud. The results further discover that the implementation of Optilog has a beneficial effect on the correlation between perceived financial risk and the performance of logistics firms. By integrating Optilog, firms can optimize transportation operations, mitigate the risk of lost or delayed products, and improve supply chain visibility as well as transparency. Therefore, logistics firms should effectively identify and address financial risk concerns along with adopting technological solutions such as Optilog to stimulate competitiveness within the logistics industry significantly.

IT capability is further found to affect Optilog adoption positively (H3a is accepted), correlating with previous research [27, 36, 38]. Additionally, Optilog adoption mediates the relationship between IT capability and firm performance (H3b is rejected), which contradicts previous research [20, 37, 41]. The studies emphasize the importance of IT capability in implementing Optilog in logistics supply chain management. Firms with superior IT skills are more inclined to adopt Optilog as a complex and effective TMS. However, the adoption of Optilog does not directly influence corporate performance, emphasizing the complex and unpredictable relationship between IT capability, technology adoption, and corporate success in a logistics setting.

The research recommends prioritizing IT investments while considering other factors that impact overall performance. The results further suggest that while Optilog is used due to its advanced IT capability, the impact on firm performance should follow a complex pattern. It provides a basis for understanding how firms can maximize the benefits of IT expenditures while considering other factors that can influence overall performance.

The research further establishes that service excellence positively affects firm performance (H4 is accepted), consistent with previous studies [43, 44]. A good correlation is suggested between adopting service excellence and implementing Optilog in logistics supply chain management. Firms that value outstanding service highly are more inclined to implement advanced technological solutions such as Optilog to improve operational efficiency. The adoption of Optilog can also serve as an intermediary between higher service levels and the overall performance of a firm, leading to significant performance improvements.

The research provides valuable insights into how logistics firms can use better service methods and innovative technology such as Optilog to attain optimal performance. Comprehending the intermediary function of technology adoption can assist firms in formulating more efficient methods to enhance productivity and gain a competitive edge in intricate business contexts.

The results finally show that Optilog adoption pos-

TABLE V
PARTIAL LEAST SQUARES (PLS) PREDICT RESULTS.

Indicator	Q^2predict	PLS-SEM_RMSE	LM_RMSE	ΔPLS-LM_RMSE
The firm has the necessary resources to manage logistics to improve performance.	0.144	0.628	0.641	-0.013
The company knows what is needed to use logistics activities for company performance.	0.188	0.560	0.680	-0.120
We can get help from partners when we experience difficulties using logistics services.	0.187	0.624	0.761	-0.137
Firms are compatible with synchronizing data with all value chain partners to improve performance.	0.353	0.657	1.089	-0.432

Legend: PLS-SEM_RMSE= Partial Least Squares - Structural Equation Modeling_Root Mean Square Error, LM_RMSE= Linear Modeling_Root Mean Square Error, and ΔPLS-LM_RMSE= Aggregate of Partial Least Squares and Linear Modeling Root Mean Square Error.

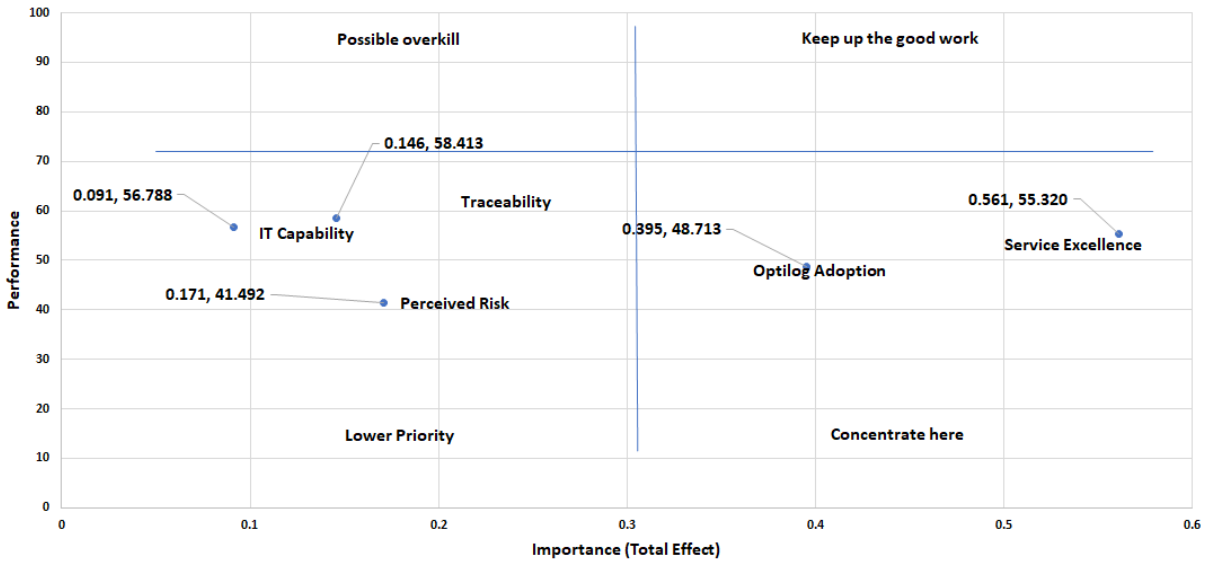

Fig. 2. Importance-Performance Matrix Analysis (IPMA) of firm performance.

itively influences firm performance (H5 is accepted), correlating with previous research [42, 52, 53]. Integrating Optilog as TMS into the firm's logistics operations dramatically improves overall performance by enhancing operational efficiency, optimizing route management, and facilitating improved transportation coordination. Optilog uses automation to further manage inventories and coordinate transportation, leading to streamlined operations, decreased operating expenses, and enhanced production. Furthermore, it enhances transparency in the supply chain by allowing instantaneous monitoring of product flow, tracking inventories, and identifying possible bottlenecks or delays. It allows firms to expedite and enhance the decision-making process, eventually leading to heightened customer satisfaction. Optilog further facilitates firms in promptly adjusting to market fluctuations and fulfilling customer requirements, which allow for precise forecasting, transportation scheduling, demand response, and inventory control. In summary, Optilog adoption is essential for enhancing firm performance, fostering competitiveness, and facilitating sustainable growth in the long run.

In the research, the PLS prediction feature assesses the predictive relevance of the PLS-SEM model and the naïve benchmark model or Linear Model (LM) [72]. A comparison of the Root Mean Square Error (RMSE) and Q^2predict, as observed in Table V, shows positive Q^2predict values and negative ΔPLS-LM_RMSE values for all indicators. The result suggests high predictive power for the model.

The IPMA is further used to enrich the PLS-SEM analysis in obtaining supplementary results by examining the critical variables and the indicators of firm performance as well as Optilog adoption. Figure 2 shows the IPMA of firm performance, suggesting that service excellence (0.561) and Optilog adoption (0.395) are essential for firm performance. Therefore, the research suggests that a one-unit increase in service excellence and Optilog adoption will increase the firm's perfor-

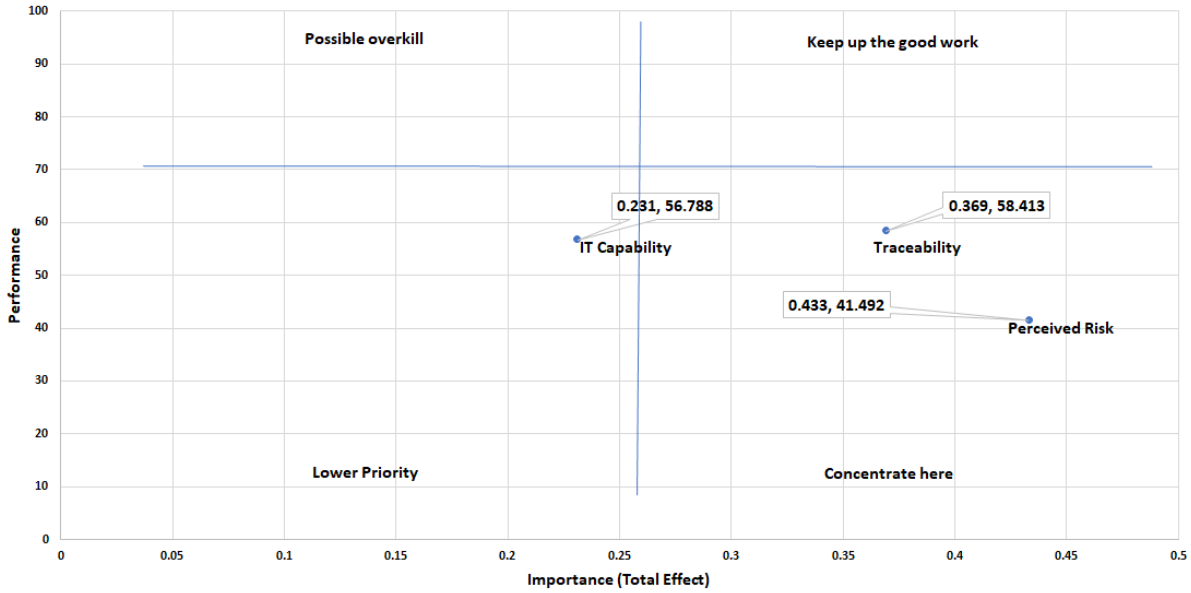

Fig. 3. Importance-Performance Matrix Analysis (IPMA) of Optilog adoption.

mance by 0.561 and 0.395, respectively.

In Fig. 3, Optilog adoption is also run as the target variable, showing that perceived risk (0.433), traceability (0.369), and IT capability (0.231) are identified as highly important for improving Optilog adoption. Therefore, the results suggest that a one-unit increase in perceived risk, traceability, and IT capability leads to increases in Optilog adoption by 0.433, 0.369, and 0.231, respectively. The IPMA results of Optilog adoption further strengthen the path analysis and provide critical suggestions for managerial implications. Based on these results, logistics firms aiming for performance improvement are advised to focus on service excellence and optimal adoption. Service excellence can be improved by effectively managing resources, identifying customer needs based on collected data, and improving business processes using Optilog. The operation department can also identify problems and formulate better solutions using Optilog. In contrast, the sales and operation groups can communicate more effectively with customers due to Optilog's information transparency and integration features.

It is recommended that top management in logistics firms consider perceived risk, traceability, and IT capability when upgrading old systems with Optilog. As a new system integrating tracking, job order, and TMS, Optilog running in the cloud requires the vendor to assure management of the ability to reduce potential fraud, secure financial data, and prevent data breaches. Consequently, the IT department should invest in security technology and educate employees about cybersecurity. IT executives need to bridge the firm's needs and features with the department's ability to evaluate vendor performance, system, and infrastructure based on business needs. Optilog adoption further offers job order tracking, real-time and transparent delivery information, and automated delivery schedules to internal and external parties. The traceability feature provides prompt information to operations regarding changes in delivery schedules and allows customers to receive real-time status updates on deliveries.

The results from hypothesis testing, PLS prediction, and IPMA are also supported by Focus Group Discussions (FGDs) with the firm representatives (TT, FR, YP, and MS) who use the new logistics system. The outcomes are presented in three themes: Optilog user experience, IT capability, and problem-solving. Regarding Optilog user experience, respondents state that Optilog integrates the Global Positioning System (GPS), Navision, and TMS. TT states that Optilog has been implemented for a year, and the system is found to be effective because job orders and the billing process can be handled within the same system. Furthermore, FR finds that the Optilog user interface and user experience are easy to use.

Concerning IT capability, FR and TT state that the IT department can handle in-house applications and respond effectively to user issues. However, several applications used in the firm are developed by vendors, causing difficulties when users want to increase the system's needs. Limited funds and dependence on vendor service-level agreements contribute to this

problem. YP further states that existing applications developed by IT departments and vendors help users to monitor sales, costs, and margins daily. MS also supports the idea that the application helps to control daily petty cash and billing.

In terms of problem-solving, FR states that all departments have key performance indicators and service level agreements to ensure that the targeted firm's performance is achieved. TT further reports that Optilog adoption helps the operation department to detect issues in daily operations and provide insights to top management for strategic decision-making. Additionally, FR states that the firm uses weekly meetings and WhatsApp groups to discuss operational issues, and top management also holds town hall meetings to communicate strategic directions.

IV. Conclusion

In conclusion, the synthesis of previous research identifies a gap in the challenges and strategies for implementing a new TMS in logistics firms. Therefore, the research proposes a conceptual model addressing the phenomena by accommodating service excellence, technology adoption, perceived risk, IT capability, and e-traceability. It aims to investigate factors determining the performance of logistics firms, focusing on the role of Optilog adoption as a mediator. The results confirm seven of eight hypotheses, showing that perceived financial risk significantly influences Optilog adoption. Furthermore, achieving excellent service quality has the most significant impact on the overall firm performance. Generally, Optilog adoption serves as a mediator with an R^2 value of 82%.

Existing research has suggested minimal adoption of the TOE theory in understanding the digital transformation process within logistics firms. A comprehensive investigation is conducted using a combination of qualitative and quantitative methods to elucidate the digital transformation of logistics firms through the lens of TOE theory. The results show that the perception of risk plays a crucial role in expressing the environmental setting for Optilog adoption. Additionally, implementing Optilog and committing to providing excellent service enhance firm performance. These results are crucial factors for scholars and professionals in the domain of digital transformation in the logistics business. Achieving digital transformation further necessitates careful consideration of environmental and organizational factors to design TMS that will positively impact firm performance effectively.

Last, the research has limitations, and future directions are proposed to address the problems. Initially, the qualitative investigation includes four respondents selected via convenience sampling with interviews constrained by limited time availability due to the busy season. Therefore, the qualitative results cannot comprehensively reflect the respondents' perspective on using Optilog and its impact on firm performance. Future publications should endeavor to use probability sampling, devise streamlined interview sessions adopting well-crafted question topics, and implement qualitative data processing tools. Another limitation is the focus on a single logistics firm specializing in trucking service, which can cause conclusions to vary due to the distinct characteristics of the technology. Future investigations should duplicate the research across other logistics services and nascent technology logistics firms. Additionally, only the TOE theory is incorporated to elucidate Optilog adoption in logistics firms, leading to a moderate level of variance for the coefficient of determination. Subsequent research should further adopt alternative strategic management and technology adoption theories to elucidate the digital transformation process in logistics firms. The research further proposes integrating TOE theory with the diffusion of innovation, open innovation, and institutional or organizational development theories.

Author Contribution

Writing—original draft by M. and A. M. S.; Methodology, M., A. M. S., I. G., R. W.; Formal analysis, A. M. S., R. W., and M.; Analysis result review, R. W., I. G., and A. M. S. All authors have read and agreed to the published version of the manuscript.

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