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Examining the Influence of Technological Innovation and Human Resource Capability on Competitive Advantage and its Implications for Operational Performance

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Abstract: This study addresses the suboptimal operational performance of the Special Terminal of PT Oleokimia Sejahtera Mas (OSM) in Dumai, reflected in service delays, limited technological innovation, and uneven human resource readiness amid rising demand and regulatory pressure. Although these constructs have been widely studied in general port and logistics settings, their joint influence within a single-commodity special terminal remains underexplored. This study examines the effects of technological innovation and human resource capability on competitive advantage and operational performance, positioning competitive advantage as a mediating mechanism. A quantitative, cross-sectional survey was conducted among 190 employees of the OSM Special Terminal, selected through purposive sampling from a population of 350, and analyzed using Partial Least Squares Structural Equation Modeling. The results show that technological innovation and human resource capability are positively associated with competitive advantage, which is in turn associated with stronger operational performance, and that competitive advantage significantly mediates both relationships. The novel contribution of this study is showing that technological innovation converts into performance mainly through customer-facing digital interaction, while human resource capability operates through a slower, relationally mediated pathway, offering an integrative resource-based explanation beyond prior single-antecedent studies.

Keyword: Technological Innovation, Human Resource Capability, Competitive Advantage, Operational Performance.

INTRODUCTION

The development of Special Terminals in Indonesia has become an inseparable part of industrial and agribusiness growth that requires efficient and integrated maritime logistics support. Special terminals are established as port facilities designed exclusively to support the internal activities of companies operating in strategic sectors, including oil and gas, mining, and palm oil-based industries that require specialized logistics systems. The existence of Special Terminals contributes significantly to improving supply chain efficiency and operational effectiveness, and these facilities ensure that loading and unloading processes are aligned with the characteristics of transported commodities. The operation of Special Terminals is also regulated under national maritime and port regulations to maintain safety and service standards.

PT Oleokimia Sejahtera Mas operates a Special Terminal in Dumai to support its oleochemical industrial activities and product distribution process. The terminal was developed and operated under Indonesian maritime regulations and government operational permits and consists of two main jetties designed for liquid cargo handling and general cargo operations. The terminal facilities include a Harbour Mobile Crane, container yard, liquid pumping systems, and safety infrastructure, while operational services include vessel berthing, cargo handling, pilotage services, and emergency response systems. The terminal operates continuously with a shift-based system to support uninterrupted industrial activities.

The operational performance of PT Oleokimia Sejahtera Mas Special Terminal plays a strategic role in supporting palm oil-based industrial activities in Riau Province. The terminal functions as an internal logistics center for handling crude palm oil, palm kernel oil, and derivative products such as biodiesel, fatty acids, glycerin, and soap noodles that support the company's production and distribution process. Operational performance is influenced not only by physical facilities but also by organizational capabilities and management practices; technological innovation and human resource capability have become important factors affecting terminal performance, and competitive advantage is considered essential in achieving sustainable operational performance improvements.

Operational performance generally reflects an organization's ability to achieve operational and financial objectives effectively and efficiently. Several indicators are used to evaluate terminal performance, including loading productivity, waiting time, berth utilization, and operational safety. Performance data indicate that the terminal experienced several operational challenges despite showing continuous improvements over time: safety performance improved through the reduction of lost-time incidents and better implementation of safety programs, and equipment downtime gradually decreased due to improvements in operational management and maintenance activities, yet loading productivity and inventory accuracy still showed unstable results in several operational periods.

Technological innovation in port terminals refers to continuous improvements in technology, operational systems, and management practices intended to increase efficiency, effectiveness, and added value for service users. At PT Oleokimia Sejahtera Mas, several challenges related to technological innovation were identified during operational processes. The Harbour Mobile Crane has experienced declining performance because of aging conditions and operational limitations, and the modernization of supporting equipment and real-time monitoring systems has not been fully implemented; as a result, operational efficiency remains highly dependent on human intervention and operator experience.

Human resource capability is considered a strategic factor in achieving operational success and maintaining organizational competitiveness. Employee capabilities include technical skills, communication abilities, and conceptual understanding of operational systems. Preliminary survey findings indicated that employee capability was relatively adequate but had not reached an optimal level, and some employees still experienced

difficulties adapting to technological developments and changing operational demands. Strengthening employee competence therefore becomes essential for improving operational effectiveness and organizational performance.

Competitive advantage represents an organization's ability to maintain superior performance compared to competitors through effective resource utilization. At PT Oleokimia Sejahtera Mas Special Terminal, competitive advantage plays an important role in ensuring operational sustainability; survey results showed relatively positive progress in maintaining operational competitiveness, although aspects such as flexibility, customer relationships, and operational responsiveness still require further improvement. The integration of technological innovation, human resource capability, and competitive strategies is therefore necessary to improve sustainable operational performance.

The relationships among technological innovation, human resource capability, competitive advantage, and operational performance have been widely examined in the general logistics and port-management literature, but most prior studies were conducted at multi-service commercial ports or container terminals serving heterogeneous cargo types and multiple stakeholder groups. Special terminals such as the OSM facility differ structurally: they serve a single parent industry, operate under a captive rather than competitive customer base, and integrate upstream production logistics with maritime operations. This research gap motivates the present study, which extends the technological innovation-human resource capability-competitive advantage-operational performance framework to this underexplored single-commodity setting.

The novelty of this study lies in three contributions. First, it examines the technological innovation-human resource capability-competitive advantage-operational performance framework in a single-commodity oleochemical special terminal, a context that differs from the public commercial ports and container terminals that dominate the existing literature. Second, by modeling technological innovation and human resource capability as joint antecedents of competitive advantage and testing competitive advantage as a mediator of both paths to operational performance, the study offers an integrative resource-based explanation of how technological and human-capital resources are jointly converted into performance outcomes, rather than treating these antecedents in isolation. Third, the study provides empirically grounded managerial implications for special-terminal operators in Indonesia, a segment of the maritime logistics sector that has received comparatively limited empirical attention relative to public container terminals.

Based on this description, the research questions of this study are formulated as follows:

1. Does technological innovation influence competitive advantage at the OSM Special Terminal?
2. Does human resource capability influence competitive advantage at the OSM Special Terminal?
3. Does technological innovation influence operational performance at the OSM Special Terminal?
4. Does human resource capability influence operational performance at the OSM Special Terminal?
5. Does competitive advantage influence operational performance at the OSM Special Terminal?
6. Does technological innovation influence operational performance through competitive advantage?
7. Does human resource capability influence operational performance through competitive advantage?

METHOD

This study employed a quantitative research approach using a survey method to collect and analyze numerical data objectively, since this approach allows relationships among variables to be examined systematically and empirically. A cross-sectional research design was adopted, in which the independent, mediating, and dependent variables were measured simultaneously at a single point in time. Because data on all constructs were collected at the same point in time from the same respondents, the design supports the identification of statistical associations and covariation patterns among constructs rather than strict causal inference; the direction implied by the hypothesized relationships follows from theory and prior empirical evidence rather than from the research design itself, and this is taken into account when interpreting the results in the following sections. The study focuses on examining the influence of technological innovation and human resource capability on competitive advantage and operational performance at the OSM Special Terminal.

The study used both primary and secondary data sources. Primary data were collected directly from respondents through questionnaires designed to measure the research variables, while secondary data were obtained from books, journals, articles, regulations, official publications, and company-related documents. The questionnaire used a five-point Likert scale ranging from strongly disagree to strongly agree. Because all constructs were measured through a self-administered questionnaire at a single point in time, procedural safeguards recommended by Podsakoff et al. (2003) were applied to reduce the risk of common method bias: respondents were assured of anonymity and informed that there were no right or wrong answers, item wording was kept concise and construct-specific to minimize ambiguity, and the predictor and criterion variables were separated within the questionnaire flow. A statistical assessment of common method bias, reported alongside the measurement model results, was additionally conducted to complement these procedural remedies.

The population of this study consisted of 350 employees working at the Special Terminal of PT Oleokimia Sejahtera Mas in Dumai, drawn from different operational departments. Based on the sample calculation method, a total of 190 respondents were selected as the research sample through purposive sampling, on the criterion that respondents had direct operational exposure to the terminal's technological systems and service processes. Because respondents were drawn through purposive sampling from a single organization, the sample reflects the operational and organizational characteristics specific to the OSM Special Terminal, which constitutes an important limitation of this study. Employees within one organization are exposed to a shared management culture, technology roadmap, and set of human resource policies, which reduces between-respondent variance relative to a multi-site or multi-organization sample and limits the extent to which the findings can be generalized to special terminals operating under different commodity types, ownership structures, or regulatory environments. A probability-based sampling frame across multiple special terminals was not feasible within the scope of this study, and the results should therefore be interpreted as evidence from a single-organization case rather than as a population-representative estimate for the broader special-terminal sector; replication across multiple special terminals with differing commodity profiles is identified as a priority for future research.

Data analysis was conducted using Structural Equation Modeling with Partial Least Squares (PLS-SEM) through SmartPLS software. The analytical process included testing the measurement model and the structural model to evaluate relationships among variables. Validity and reliability assessments were performed using loading factors, Average Variance Extracted, Composite Reliability, and Cronbach's Alpha values, while structural model evaluation involved examining R-square values, Q-square values, effect size (F^2), and hypothesis testing procedures. Hypothesis testing was conducted using t-statistics and

probability values with a significance level of 5 percent, allowing both direct and indirect relationships among variables to be examined comprehensively.

RESULT AND DISCUSSION

Result

The respondents in this study consisted of 190 employees of PT Oleokimia Sejahtera Mas Special Terminal in Dumai, and the questionnaires were distributed through Google Forms via WhatsApp Web. Based on gender characteristics, the majority of respondents were male with 138 individuals (72.6%), while female respondents accounted for 52 individuals (27.4%). Based on age characteristics, most respondents were between 21–30 years old with 94 individuals (49.5%), followed by respondents aged over 41 years with 51 individuals (26.8%) and respondents aged 31–40 years with 45 individuals (23.7%). Based on educational background, the majority had senior high school education with 75 individuals (39.5%), followed by undergraduate degree holders with 68 individuals (35.8%), diploma holders with 36 individuals (18.9%), and postgraduate degree holders with 11 individuals (5.8%).

Common Method Bias Assessment

Because all constructs were measured through a self-administered questionnaire at a single point in time, a full collinearity VIF test following Kock (2015) was conducted in addition to the procedural remedies described in the Method section. In this approach, all indicators are regressed against a single common marker variable, and full collinearity VIF values below 3.3 are taken as evidence that common method bias is unlikely to be a serious concern. A complementary Harman's single-factor test was also conducted, in which all 48 indicator items were entered into an unrotated principal component analysis, with the variance explained by the first factor used as an additional indicator; a value above 50% is conventionally taken to flag potential common method bias. The results of both tests are presented in Table 1.

Table 1. Common Method Bias Assessment Results

Construct	Full Collinearity VIF	Threshold (Kock, 2015)
Technological Innovation (X1)	3.551	< 3.3
Human Resource Capability (X2)	3.374	< 3.3
Competitive Advantage (Y)	4.362	< 3.3
Operational Performance (Z)	2.922	< 3.3

Source: Processed primary data (2026). Harman's single-factor test: first unrotated factor accounted for 58.1% of total variance (48 indicators).

The results show that three of the four constructs exceeded the 3.3 threshold, and Harman's single-factor test showed the first factor explaining 58.1% of total variance, above the conventional 50% benchmark. Taken together, these statistical indicators suggest that common method bias cannot be fully ruled out in the present data, which is a recognized risk in single-respondent, single-occasion perceptual surveys of organizational-level constructs. This risk is mitigated, though not eliminated, by the procedural remedies applied during data collection and is further addressed as a limitation of this study. Readers are therefore advised to interpret the magnitude of the structural path coefficients with appropriate caution, while noting that the overall pattern of results remains theoretically consistent with prior empirical literature on technological innovation, human resource capability, competitive advantage, and operational performance.

Evaluation of the Measurement Model (Outer Model)

The measurement model was evaluated prior to testing the structural relationships in order to assess the ability of the indicators to reflect their respective latent constructs. Convergent validity was examined through the outer loading values generated by the SEM-PLS analysis; following Hair et al. (2021), an indicator is considered convergently valid when its loading exceeds 0.70. The complete outer loading results are presented in Figure 1.

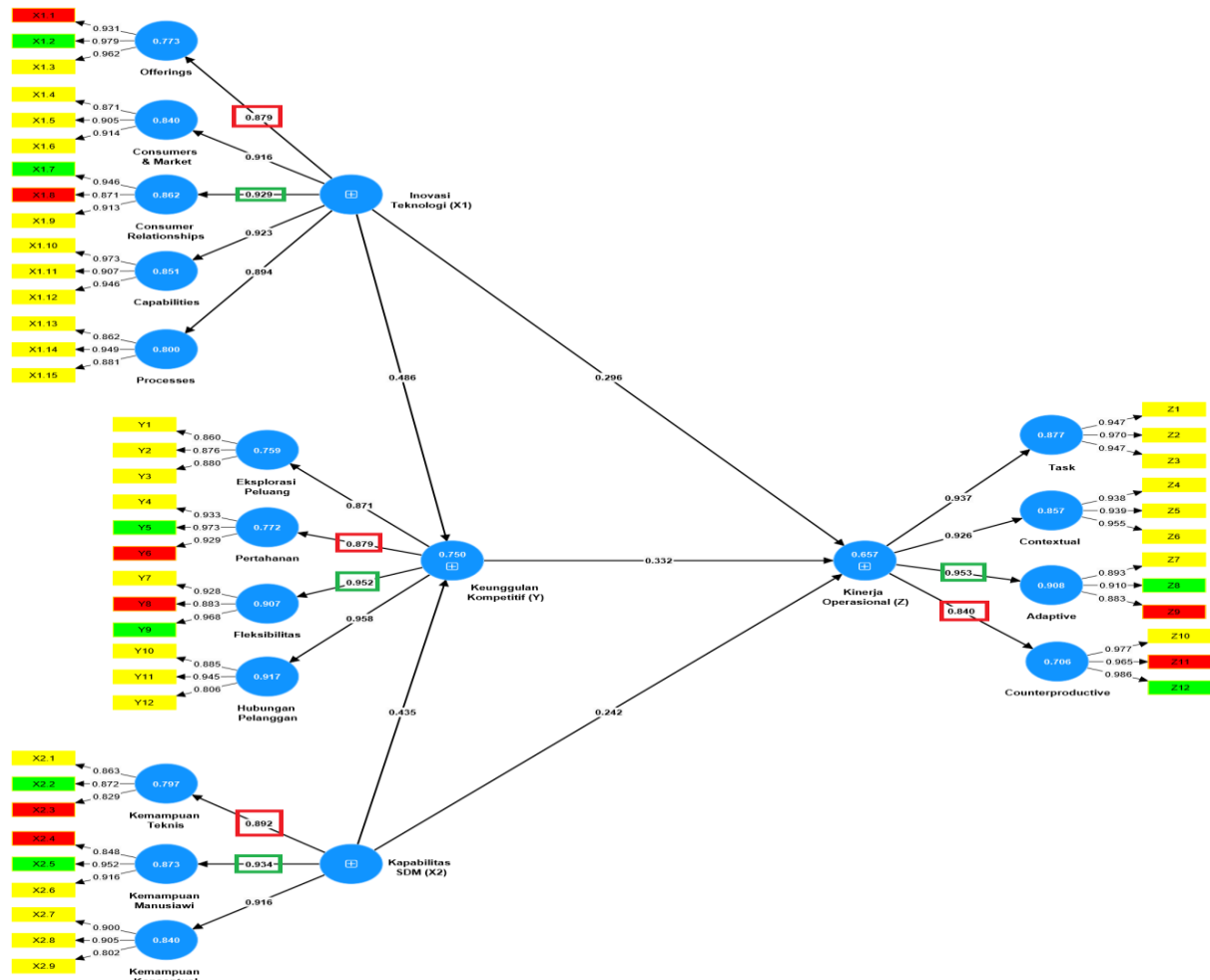


Figure 1. Outer Loading

All indicators demonstrated loading values above the required threshold of 0.70, indicating satisfactory convergent validity. For the Technological Innovation variable (X1), the highest loading dimension was Consumer Relationships (0.929), indicating that digital interaction and communication with customers are dominant factors shaping technological innovation at the terminal. Human Resource Capability (X2) showed Human/Social Skills as the strongest dimension (0.934), emphasizing teamwork and interpersonal communication among employees. Competitive Advantage (Y) had Customer Relationships as its highest dimension (0.958), while Operational Performance (Z) showed Adaptive Performance as the strongest dimension (0.953), suggesting that organizational adaptability to operational change contributes significantly to performance improvement.

Discriminant validity was evaluated using the Heterotrait-Monotrait Ratio (HTMT), which ensures that each construct measures a conceptually distinct concept. All HTMT values fell below the 0.90 threshold, ranging from 0.775 to 0.857; the relationship between Technological Innovation and Competitive Advantage produced the highest value (0.857), while Human Resource Capability and Operational Performance showed the lowest (0.775).

Although several values approached 0.85, they remained within acceptable limits, confirming adequate discriminant validity among the constructs.

Table 2. Combined Measurement Evaluation Results

Variable	AVE	Composite Reliability	Cronbach's Alpha	Description
Technological Innovation (X1)	0.699	0.972	0.969	Reliable and Valid
Human Resource Capability (X2)	0.642	0.942	0.930	Reliable and Valid
Competitive Advantage (Y)	0.687	0.963	0.958	Reliable and Valid
Operational Performance (Z)	0.741	0.972	0.968	Reliable and Valid

Source: SmartPLS Output (2026).

The combined AVE, Composite Reliability, and Cronbach's Alpha results indicate that all constructs fulfilled the requirements for validity and reliability. AVE values ranged from 0.642 to 0.741, exceeding the 0.50 minimum threshold; Composite Reliability values ranged from 0.942 to 0.972, exceeding the recommended 0.70 minimum; and Cronbach's Alpha values ranged from 0.930 to 0.969, exceeding the 0.60 criterion. These results confirm that all research variables possess strong reliability and validity and are appropriate for further structural model analysis.

Structural Model Test Results (Inner Model)

1. Variance Inflation Factor (VIF)

Table 3. Results of Variance Inflation Factor (VIF)

Relationship Between Variables	VIF	Description
Technological Innovation (X1) → Competitive Advantage (Y)	2.420	No multicollinearity (VIF < 5)
Technological Innovation (X1) → Operational Performance (Z)	3.366	No multicollinearity (VIF < 5)
Human Resource Capability (X2) → Competitive Advantage (Y)	2.420	No multicollinearity (VIF < 5)
Human Resource Capability (X2) → Operational Performance (Z)	3.177	No multicollinearity (VIF < 5)
Competitive Advantage (Y) → Operational Performance (Z)	3.998	No multicollinearity (VIF < 5)

Source: SmartPLS Output (2026).

Variance Inflation Factor (VIF) analysis was conducted to evaluate multicollinearity among predictor variables within the structural model. All VIF values were below the recommended threshold of 5.0, ranging from 2.420 to 3.998, confirming that the structural model does not suffer from multicollinearity problems and is appropriate for hypothesis testing.

2. Q-Square (Q²)

Table 4. Blindfolding Results

Variables	SSO	SSE	Q ² (=1-SSE/SSO)
Technological Innovation (X1)	2850.000	2850.000	0.000
Human Resource Capability (X2)	1710.000	1710.000	0.000
Competitive Advantage (Y)	2280.000	1116.605	0.510
Operational Performance (Z)	2280.000	1181.166	0.482

Source: SmartPLS Output (2026).

The Q-square (Q²) value was assessed through the blindfolding procedure to determine the predictive relevance of the structural model. Competitive Advantage (Y) and Operational Performance (Z) obtained Q² values of 0.510 and 0.482, respectively, both exceeding the 0.05 threshold, indicating that the structural model possesses strong predictive relevance for the endogenous variables.

3. Effect Size (F^2)

Table 5. Effect Size (F^2) Results

Relationship Between Variables	F-Square	Category
Technological Innovation (X1) → Competitive Advantage (Y)	0.391	Large
Technological Innovation (X1) → Operational Performance (Z)	0.076	Small
Human Resource Capability (X2) → Competitive Advantage (Y)	0.313	Medium
Human Resource Capability (X2) → Operational Performance (Z)	0.054	Small
Competitive Advantage (Y) → Operational Performance (Z)	0.081	Small

Source: SmartPLS Output (2026).

Effect size (F^2) analysis was conducted to determine the contribution of exogenous variables to the endogenous constructs. The largest effect was found for Technological Innovation on Competitive Advantage ($F^2 = 0.391$, large), followed by Human Resource Capability on Competitive Advantage ($F^2 = 0.313$, medium). Direct effects on Operational Performance were comparatively small (F^2 between 0.054 and 0.081), suggesting that most of the influence of the two antecedents on operational performance is channeled through competitive advantage rather than acting directly.

4. R-Square (R^2)

Table 6. R-Square Results

Variables	R-Square	Category
Competitive Advantage (Y)	0.750	Strong
Operational Performance (Z)	0.657	Strong

Source: SmartPLS Output (2026).

The R-square (R^2) analysis evaluated the predictive capability of the structural model. Competitive Advantage obtained an R^2 of 0.750, meaning 75.0% of its variance is explained by Technological Innovation and Human Resource Capability, while Operational Performance obtained an R^2 of 0.657, meaning 65.7% of its variance is explained by Technological Innovation, Human Resource Capability, and Competitive Advantage. Both values fall within the strong category, confirming substantial explanatory power.

Hypothesis Testing

Hypothesis testing was conducted using the bootstrapping approach in SmartPLS to evaluate the significance of relationships among variables. Following Hair et al. (2021) and Ghazali (2016), a hypothesis is supported when the T-statistic exceeds 1.64 and the p-value is below 0.05. The complete results are presented in Figure 2 and Table 7.

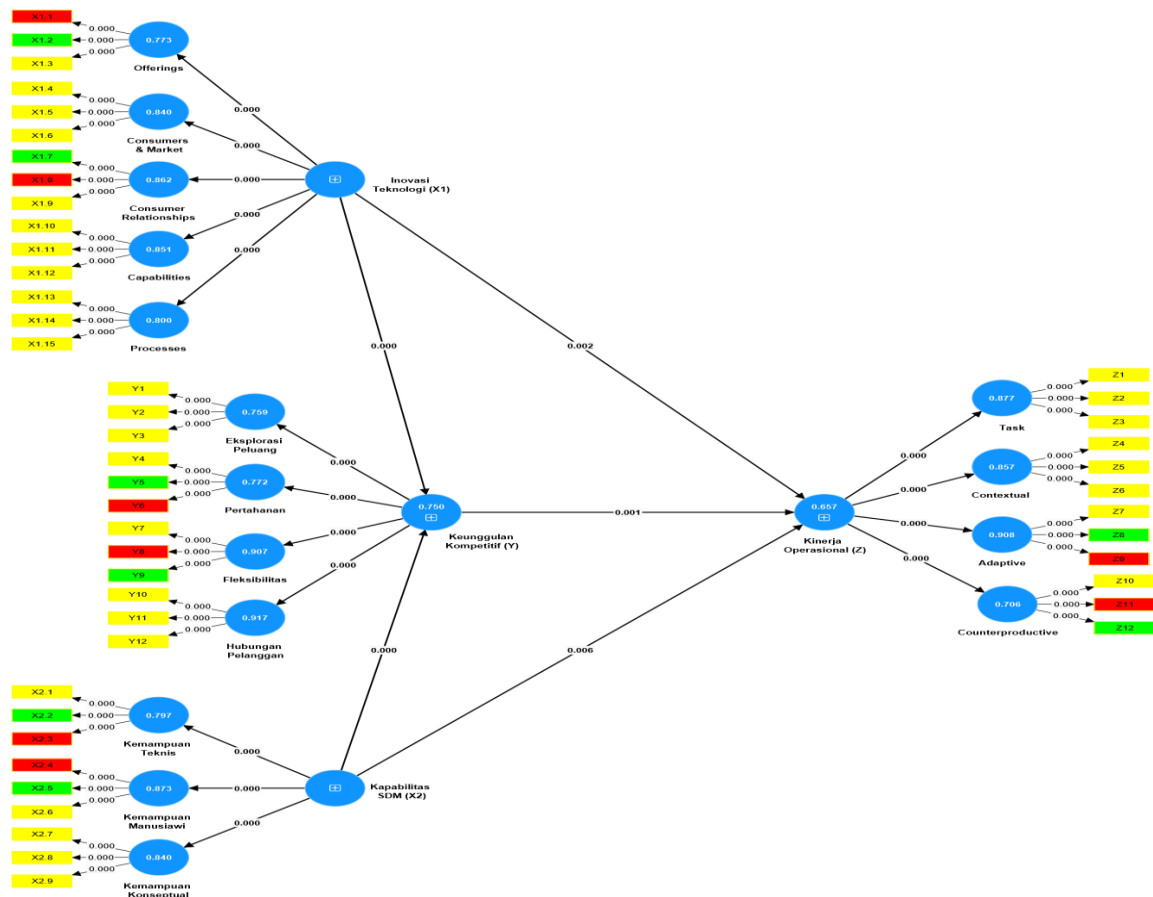


Figure 2. Inner Model Result (Bootstrapping)

Table 7. Direct and Indirect Effects of Hypothesis Testing Results

H	Relationship Between Variables	Original Sample (O)	T Statistics	P Values	Result
H1	Technological Innovation (X1) → Competitive Advantage (Y)	0.486	4.662	0.000	Significant
H2	Human Resource Capability (X2) → Competitive Advantage (Y)	0.435	4.551	0.000	Significant
H3	Technological Innovation (X1) → Operational Performance (Z)	0.296	2.845	0.004	Significant
H4	Human Resource Capability (X2) → Operational Performance (Z)	0.242	2.523	0.012	Significant
H5	Competitive Advantage (Y) → Operational Performance (Z)	0.332	3.240	0.001	Significant
H6	X1 → Competitive Advantage (Y) → Operational Performance (Z)	0.162	2.359	0.018	Significant
H7	X2 → Competitive Advantage (Y) → Operational Performance (Z)	0.144	2.896	0.004	Significant

Source: SmartPLS Output (2026).

Discussion

1. Direct Effect of Technological Innovation on Competitive Advantage

Technological innovation was found to have a positive and significant effect on competitive advantage ($\beta = 0.486$; $T = 4.662 > 1.64$), so Hypothesis 1 is supported. Higher levels of technological innovation are associated with stronger competitive advantage at PT Oleokimia Sejahtera Mas Special Terminal, suggesting that digital technologies, integrated systems, and technology-based communication with customers help improve the terminal's competitive position. This result aligns with Putra (2024), who found that information

technology improves port competitiveness through operational efficiency, and with Nunes et al. (2024), who emphasized that management and logistics innovation strengthen global port competitiveness. Jiang et al. (2025) similarly reported that port logistics service innovation enhances downstream business performance through information interaction mechanisms in cross-border e-commerce logistics chains. Winarni (2021) further concluded that technovation contributes significantly to business competitiveness, while Hutapea et al. (2021) and Mdanat et al. (2024) showed that service innovation, organizational flexibility, and innovation support improve organizational competitiveness more broadly.

The comparatively stronger effect of technological innovation relative to human resource capability (0.486 versus 0.435; F^2 of 0.391 versus 0.313) can be interpreted through the resource-based view (Barney, 1991) together with dynamic capabilities theory. At a special terminal serving a single industrial client, technological assets such as digital communication systems and integrated service platforms are directly and immediately observable by service users at every transaction, making their contribution to perceived competitiveness comparatively fast-acting. Human resource capability, by contrast, tends to shape competitive advantage through slower forming, relationally mediated pathways, such as trust and service consistency accumulated over repeated interactions; its effect in a single cross-sectional measurement may therefore appear more modest than the more immediately visible effect of technology. This interpretation is consistent with the loading pattern in the measurement model, where Consumer Relationships carried the highest loading for technological innovation, indicating that customer-facing digital interaction is the primary channel through which technological innovation is perceived and valued by terminal users.

2. Direct Effect of Human Resource Capability on Competitive Advantage

Human resource capability was also found to positively and significantly affect competitive advantage ($\beta = 0.435$; $T = 4.551 > 1.64$), supporting Hypothesis 2. Improvements in employee competencies, social abilities, and teamwork contribute meaningfully to strengthening the company's competitiveness, confirming that human resource capability functions as a strategic asset within the special-terminal industry. Competent employees create service differentiation that competitors find difficult to imitate, generating a more sustainable form of competitive advantage. This is consistent with Malau et al. (2021), who reported that competence significantly affects service performance, and with Herdian et al. (2022), Panjaitan et al. (2025), Yanling et al. (2024), and Bucak et al. (2020), who highlighted the roles of internal resources, service quality, organizational flexibility, and organizational learning in strengthening competitiveness.

3. Direct Effect of Technological Innovation on Operational Performance

Technological innovation was found to have a positive and significant effect on operational performance ($\beta = 0.296$; $T = 2.845 > 1.64$), supporting Hypothesis 3. Although this effect is smaller than its effect on competitive advantage, it remains statistically significant, indicating that digital systems, integrated services, and operational technology support smoother loading and unloading processes while reducing operational barriers. This finding is consistent with Barasa et al. (2018), who found that loading and unloading equipment significantly influences productivity, and with Gunawan et al. (2008), Selasдини et al. (2018), Aprilianty and Evander (2021), Karubaba (2025), and Danladi et al. (2025), who found that operational technology, automation systems, infrastructure quality, and technical efficiency contribute to improved port and terminal performance.

4. Direct Effect of Human Resource Capability on Operational Performance

Human resource capability was found to positively and significantly affect operational performance ($\beta = 0.242$; $T = 2.523 > 1.64$), so Hypothesis 4 is supported. Employees with strong teamwork skills and a solid understanding of operational procedures appear able to minimize operational errors and improve efficiency directly. This is consistent with Malau et

al. (2021), who found that competence improves service performance, and with Talkhokhet et al. (2023), Bucak et al. (2020), Herdian et al. (2022), Syafaaruddin (2015), and Fisu (2021), who reported that organizational learning, internal strategic capability, human resource investment, and workforce competence support operational and logistics performance.

5. Direct Effect of Competitive Advantage on Operational Performance

Competitive advantage was found to have a positive and significant effect on operational performance ($\beta = 0.332$; $T = 3.240 > 1.64$), supporting Hypothesis 5. Stronger organizational competitiveness is associated with better operational performance at the OSM Special Terminal; good customer relationships and active exploration of opportunities appear to contribute to customer loyalty and smoother operational activities. This finding is in line with Triningsih (2024), who found that container terminals play an important role in maximizing competitiveness and logistics efficiency, and with Maemunah et al. (2023), Yanling et al. (2024), Mdanat et al. (2024), Bucak et al. (2020), and Talkhokhet et al. (2023).

6. Indirect Effect of Technological Innovation on Operational Performance through Competitive Advantage

The results show a positive and significant indirect effect of technological innovation on operational performance through competitive advantage ($\beta = 0.162$; $T = 2.359 > 1.64$), so Hypothesis 6 is supported, confirming that competitive advantage mediates this relationship. Technological innovations such as integrated digital systems, technology-based customer communication, and service automation appear to improve operational performance more effectively once they have first established competitive advantage. This is consistent with Jiang et al. (2025), who found that logistics service innovation improves performance through stronger competitiveness mechanisms, and with Nunes et al. (2024), Putra (2024), Winarni (2021), Triningsih (2024), and Hutapea et al. (2021).

7. Indirect Effect of Human Resource Capability on Operational Performance through Competitive Advantage

Human resource capability was also found to have a positive and significant indirect effect on operational performance through competitive advantage ($\beta = 0.144$; $T = 2.896 > 1.64$), supporting Hypothesis 7. Improvements in employee competencies and teamwork capability strengthen organizational competitiveness, which in turn enhances operational performance; human resources appear to play both an operational and a strategic role in sustaining competitiveness and business continuity. This is consistent with Malau et al. (2021), Panjaitan et al. (2025), Herdian et al. (2022), Yanling et al. (2024), Bucak et al. (2020), and Talkhokhet et al. (2023).

The significant mediating role of competitive advantage in both indirect paths can be explained through resource-based and market-based perspectives taken together. The resource-based view holds that internal resources such as technological systems and employee competencies generate performance benefits only to the extent that they are converted into capabilities the market recognizes as distinctive; competitive advantage represents this conversion point, capturing how internal resources are translated into externally valued positioning such as stronger customer relationships and more responsive service. This is consistent with the effect-size pattern observed in this study, where both technological innovation and human resource capability showed substantially larger effects on competitive advantage (F^2 of 0.391 and 0.313) than their direct effects on operational performance (F^2 of 0.076 and 0.054), suggesting that much of their influence on performance is channeled through the competitive-advantage mechanism rather than acting directly on operational outcomes. From a market-based perspective, operational performance in a special-terminal context depends heavily on sustained cooperation and trust with the parent industrial client, which is essentially what competitive advantage, and particularly its Customer Relationships dimension, captures in this study.

Taken together, the novelty of this study lies in showing that, within a single-commodity special terminal, technological and human-capital resources do not translate into operational performance through a single uniform mechanism. Technological innovation converts into performance mainly through fast-acting, customer-facing digital interaction, whereas human resource capability operates through a slower, relationally mediated pathway; both, however, depend substantially on first being converted into competitive advantage before they meaningfully affect operational performance. This dual-pathway, resource-based explanation extends prior studies that examined technological or human resource antecedents of port performance in isolation and offers a more integrative account of how special terminals serving a captive industrial client base can convert internal resources into sustained operational gains.

CONCLUSIONS AND RECOMMENDATIONS

Conclusion

Based on the findings of this study, the following conclusions can be drawn:

1. Technological innovation has a positive and significant effect on competitive advantage, with the Consumer Relationships dimension as its strongest contributor, indicating that active digital communication and responsive service systems play an essential role in strengthening the terminal's competitive position.
2. Human resource capability has a positive and significant effect on competitive advantage, particularly through the Human/Social Skill dimension, which emphasizes teamwork, interpersonal communication, and collaboration among employees.
3. Technological innovation has a positive and significant effect on operational performance, although this direct effect is smaller than its effect on competitive advantage.
4. Human resource capability has a positive and significant effect on operational performance, indicating that employee competence contributes directly to reducing operational errors and improving efficiency.
5. Competitive advantage has a positive and significant effect on operational performance, especially through the Customer Relationships dimension, which supports customer satisfaction and service continuity.
6. Competitive advantage significantly mediates the effect of technological innovation on operational performance, indicating that technological innovation improves performance more effectively once it has first strengthened competitive advantage.
7. Competitive advantage significantly mediates the effect of human resource capability on operational performance, confirming that human resources play both an operational and a strategic role in sustaining competitiveness and business continuity.

Overall, organizations operating single-commodity special terminals should continuously integrate technological innovation with human resource development strategies, while recognizing that both pathways depend substantially on being converted into a recognizable competitive position before they translate into measurable operational performance gains.

Limitations

This study is subject to several limitations. First, the use of purposive sampling within a single organization means that the results describe conditions specific to the OSM Special Terminal and should not be generalized to special terminals with different commodity profiles, ownership structures, or regulatory contexts without further validation. Second, the cross-sectional design means that the statistical relationships reported here reflect associations among constructs measured at a single point in time rather than confirmed causal

sequences; longitudinal or experimental designs would be needed to establish temporal precedence with greater confidence. Third, the common method bias assessment indicated that full collinearity VIF values for three of the four constructs exceeded the conservative 3.3 threshold, and Harman's single-factor test showed the first unrotated factor accounting for 58.1% of total variance, above the conventional 50% benchmark; because all constructs were collected from the same respondents through the same self-administered instrument at a single point in time, some inflation of the observed relationships due to common method variance cannot be ruled out, notwithstanding the procedural remedies applied during questionnaire design. The findings should therefore be interpreted within the scope of this study.

Recommendation

Future studies are encouraged to replicate this model across multiple special terminals with differing commodity types and ownership structures, to incorporate longitudinal data collection, and to draw on multiple data sources, for example pairing employee-reported measures with supervisor-rated or archival performance indicators, to reduce common method variance. Examining boundary conditions such as terminal size, cargo type, or regulatory regime, and applying complementary analytical approaches such as multi-group SEM or longitudinal panel modeling, may also provide a deeper understanding of how technological and human-capital resources are converted into competitive advantage and operational performance in special-terminal settings. For practitioners, the results suggest that investments in digital systems should be paired with deliberate efforts to build customer-facing relationship quality, since the effect of technology on performance operates substantially through the competitive-advantage pathway rather than directly.

Author Contributions

Tegar Sangga Buana and Elza Ratna Perbata contributed to research conceptualization, data collection, and the initial drafting of the manuscript. Larsen Barasa contributed to the theoretical framework, data analysis, and revision of the manuscript in response to peer review. Marudut Bernadtua Simanjuntak and Vidya Selasdini contributed to the literature review and interpretation of results. Imam Fahcruddin contributed to methodological validation and manuscript proofreading. All authors have read and approved the final version of the article for publication.

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