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Analysis of Roll on/Roll off (RORO) Ship Strategy in Supporting Marine Transportation Infrastructure using the SWOT Method

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ABSTRACT

Indonesia, as an archipelagic country, places maritime transportation as the backbone of interregional connectivity. Roll-On/Roll-Off (RO-RO) vessels are a strategic mode of transportation due to their loading and unloading efficiency and flexibility. However, implementation at Sampit Port is still hampered by limited docks, load imbalances, and high operational costs. This article aims to review the literature related to RO-RO vessel development strategies using a SWOT analysis approach enriched with IFE/EFE and QSPM matrices. The research method uses a literature-based review by examining journals, institutional reports, and regulations related to maritime transportation. The analysis is carried out in three stages: (i) identification of internal-external factors within the SWOT framework, (ii) evaluation of factor weights using IFE/EFE, and (iii) prioritization of strategies using QSPM. Performance indicators such as Turnaround Time (TAT), Load Factor, and On-Time Performance (OTP) are used to assess operational effectiveness. The study results indicate that Sampit Port is in the WO (Weakness-Opportunity) quadrant, indicating that internal weaknesses can be addressed through external opportunities, particularly the maritime toll policy and logistics digitalization. The emerging priority strategies are the construction of a dedicated RO-RO dock and the implementation of digital systems for cargo management and service scheduling. In conclusion, improving RO-RO performance in Sampit requires synergy between operators, the government, and other stakeholders. This article contributes to the academic literature on SWOT-IFE/EFE-QSPM, provides practical recommendations for PT Dharma Lautan Utama, and emphasizes the urgency of a dedicated dock development policy and the integration of logistics digitalization.

Keywords: RO-RO ships, Sampit Port, SWOT, IFE/EFE, QSPM, sea transportation.

INTRODUCTION

Indonesia, as an archipelagic country with more than 17,000 islands, places maritime transportation as a vital sector for inter-regional connectivity, distribution of goods, and population mobility. The proportion of waters reaching approximately 3.27 million km² far exceeds the land area of 1.91 million km², confirming that maritime infrastructure is the backbone of the national economy as well as an instrument for equitable distribution of public services [1]. Within the national port network, Sampit Port in Central Kalimantan serves as a gateway for logistics and public mobility connecting Kalimantan with Java and other islands. However, operational reality is still marked by obstacles such as limited docks, suboptimal port facilities, and an imbalance in the flow of goods and passengers [2]. At the macro level, shipping activities do show an increasing trend (ship calls, loading and unloading, and passenger departures), but this growth has not been fully balanced by the quality of infrastructure, so that national logistics costs remain at around 17% of production costs, higher than a number of countries in the region [3].

The regulatory framework has laid the direction for maritime development through Law No. 17/2008, which affirms that sea transportation is part of the national transportation system, which must be integrated, safe, accessible, and sustainable. At the derivative policy level, KM 33/2001 defines the organization and operation of sea transportation as the activity of transporting

passengers, goods, and animals from one port to another. However, implementation gaps remain in the field, with operational efficiency, safety, and intermodal integration not yet uniform across regions [3]. In this context, the role of ports as nodes in the transportation infrastructure and service network is crucial: nodes (ports) and traffic spaces (shipping lanes) must be connected to ensure continuity of service [4]. In addition, aspects of water use governance and navigation safety require attention, considering the characteristics of Indonesian waters and their potential impacts on the environment.

In the transportation sector, Roll-On/Roll-Off (RO-RO) vessels are considered relevant because the ramp system allows vehicles to be loaded and disembarked horizontally without a crane, thus reducing loading and unloading time and increasing efficiency, especially on short-medium routes [5], [6]. The definition of RO-RO in classification and safety standards emphasizes the presence of one or more decks to accommodate vehicles and cargo loaded/unloaded horizontally, in line with IMO provisions and SOLAS amendments regarding stability, compartments, and watertight doors on passenger ships [7], [8], [9]. The history and diffusion of RO-RO technology show an evolution from short-haul ferry services to ocean-going car carriers, supported by advances in cargo management and multi-deck designs to speed up ship turn-arounds. However, in Indonesia, RO-RO operations still face limitations in dedicated docks, imbalanced round-trip cargo flow, and relatively high operational costs [10].

Literature on maritime transportation infrastructure emphasizes that logistics efficiency is greatly influenced by the availability and quality of ports, shipping lanes, fleets, and shipping information and management systems [11], [12]. Ports, as socio-economic spaces serving berthing, docking, passenger embarkation, and loading and unloading, need to be connected to the hinterland through road access and intermodal integration so that benefits are distributed evenly [13]. On the operational side, the effectiveness of RO-RO services is influenced by the adequacy of facilities and infrastructure, stakeholder coordination, and loading and unloading efficiency; indicators such as turnaround time (TAT), punctuality, and load factor are commonly used to assess performance [14]. A more strategic development perspective emphasizes the principles of connectivity–accessibility, efficiency–sustainability, safety, and intermodal integration; key components include port modernization, navigation improvements, strengthening the RO-RO fleet, and logistics digitalization [15], [16].

Previous research findings show a diverse landscape. [17] formulated a development strategy for Jayapura Port using SWOT and placed the port in the SO quadrant, emphasizing increased facility efficiency and logistics cooperation. [18] assessed the role of maritime transportation in inter-island connectivity and recommended policy encouragement and investment in the transportation sector. In terms of terminal productivity, [19] identified limited equipment as a dominant weakness and recommended a WT strategy (equipment improvement and queue digitization). In the safety-services sphere, [20] assessed that the implementation of RO-RO services was not optimal in accordance with the mandate of Law 17/2008; while a good governance study emphasized public-private-government collaboration to maintain service quality [21]. Policy research directed reforms towards a modern maritime highway and compliance with international standards [22]; a study on small island connectivity emphasized the importance of pioneer vessels and dock infrastructure [23]; and an economic study showed that transportation variables and road length had an impact on GDP [24].

From the review, research gaps are apparent: (i) many studies focus on ports or maritime transportation in general, without specifically measuring RO-RO performance through operational indicators such as load factor, TAT, and cost efficiency in the context of specific nodes such as Sampit; (ii) mapping of internal-external factors that influence RO-RO performance using the SWOT framework has not been systematically conducted to formulate operational strategies; and (iii) adoption of IFE/EFE and QSPM as RO-RO strategy prioritization tools is still limited to specific cases and is rarely directly linked to the objectives of reducing logistics costs and national intermodal integration [17]-[19].

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To clarify the direction of the study, the conceptual framework of the research can be visualized in Figure 1, which depicts the flow from the literature towards the identification of SWOT factors, quantification through IFE/EFE, to prioritization of strategies with QSPM.

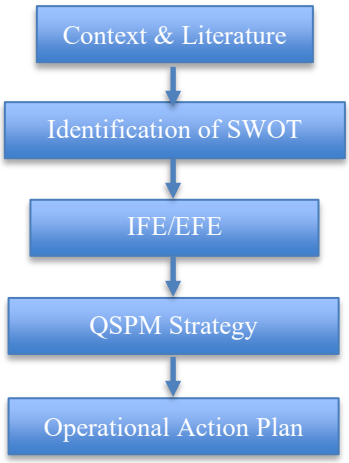

Figure 1. Conceptual Framework of the Study (SWOT–IFE/EFE–QSPM)

Additionally, Table 1 summarizes relevant previous research to show how this study positions itself within the maritime transportation research landscape.

Table 1. Summary of Relevant Previous Research

No	Focus/Object	Author (Year)	Method	Key Findings
1	Jayapura Port (T3P)	[17]	SWOT IFAS-EFAS	SO strategy: facility efficiency & sea toll.
2	Inter-island connectivity	[18]	Quantitative descriptive	Connectivity differences; need for central policy.
3	Container stacking productivity	[19]	SWOT	Tool limitations → WT strategy (enhancement & digitalization).
4	Ship electrical maintenance	[25]	Qualitative	Maintenance schedule → increased operational reliability.
5	Small port operations (Sukamara)	[26]	IFAS-EFAS-SWOT	WT quadrant; add ships & basic facilities.
6	RO-RO Services & Law 17/2008	[20]	Sociological juridical	Service is not optimal; issues with schedules, facilities, and safety.

Furthermore, the RO-RO performance indicators that will be used as a reference in assessing operational effectiveness also need to be clarified. Therefore, Table 2 below summarizes the main indicators widely used in the literature.

Table 2. Commonly Used RO-RO Operational Performance Indicators

Indicator	Operational Definition	Example source
On-Time Performance (OTP)	Percentage of trips departing/arriving on schedule.	[27]
Turnaround Time (TAT)	Docking time → completion of loading and unloading → undocking (minutes).	[11], [12]
Load Factor (vehicle/passenger)	Used capacity ÷ available capacity per trip.	[30]

Indicator	Operational Definition	Example source
Loading and unloading productivity	Vehicle units/hour or minutes/unit on ramp/pier.	[27]
Schedule availability (frequency)	Number of scheduled trips per period (week/month).	[3]
User satisfaction	Average score of service dimensions (Likert 1–5).	[21]

By presenting these figures and tables, the direction of this research becomes clearer. This review article aims to: (1) summarize and critique the literature related to RO-RO, port infrastructure, and operational strategies; (2) synthesize internal–external factors relevant to RO-RO performance in Sampit; and (3) propose a conceptual framework based on SWOT–IFE/EFE–QSPM as a basis for formulating strategies to improve efficiency, safety, and service connectivity in the future.

RESEARCH METHODS

This research method uses a literature-based review approach with a SWOT analysis framework enriched with the IFE/EFE matrix and QSPM. According to [28], review research is conducted to organize existing knowledge, evaluate previous research results, and develop a strategic conceptual framework.

The analysis process was carried out in three stages: (i) identification of internal–external factors from the literature, (ii) evaluation of factors using the IFE/EFE matrix, and (iii) prioritization of strategies using QSPM [17], [19], [29].

In addition, RO-RO ship operational performance indicators were also used as a reference for the analysis. These indicators were chosen because they are often used in previous research to measure service effectiveness [11], [12], [27], [30].

RESULTS AND DISCUSSION

Identification of SWOT Factors

Based on literature synthesis, the factors that influence RO-RO performance in Indonesia, particularly at Sampit Port, can be grouped as follows:

Table 3. SWOT Summary of RO-RO Ships in Indonesia

Internal Factors	Description	Source
Strengths	Efficient loading and unloading with ramp, multi-purpose capacity (passenger–vehicle–goods), DLU fleet support	[5], [6]
Weaknesses	Limited dedicated docks, load imbalance, high operational costs	[10], [20]
Opportunities	Increased shipping activities, maritime toll policy, logistics digitalization	[3], [22], [15]
Threats	Extreme weather, competition in transportation modes, bureaucratic regulations	[26], [14], [20]

As a visual complement to Figure 2 (SWOT Matrix), Table 3 displays strategies that can be implemented based on a combination of internal and external factors. This presentation is expected to provide a more systematic overview of the strategic direction of RO-RO development at Sampit Port.

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Table 4. Summary of SWOT Strategy of RO-RO Ships at Sampit Port

Strategy	Main Description	Implementation Example
SO (Strength–Opportunity)	Leveraging internal strengths to capture external opportunities	- Loading and unloading efficiency support the sea toll program [5] - DLU's new fleet expands connectivity
WO (Weakness–Opportunity)	Reducing internal weaknesses by taking advantage of external opportunities	- Construction of a special RO-RO dock with the support of the sea toll policy [2], [15 - Digitalization of cargo management to overcome current imbalances [19]
ST (Strength–Threat)	Using internal strengths to face external threats	- Diversification of routes to face extreme weather [26] - Fuel efficiency to be competitive with land modes [6]
WT (Weakness–Threat)	Minimize internal weaknesses so that they are not exacerbated by external threats	- Establish minimum service standards [20] - Improve stakeholder coordination to reduce bureaucratic barriers [22]

Discussion of Results

The literature review, mapped through a SWOT analysis, indicates that Sampit Port's strategic position in developing RO-RO ship services is quite unique. Overall, the port holds significant potential as a hub for logistics distribution and passenger mobility, but it also faces several fundamental challenges that must be addressed immediately.

Based on the IFE/EFE matrix, Sampit Port is estimated to be in the WO (Weakness–Opportunity) quadrant. This position indicates that the port has significant opportunities from national policy support, particularly the maritime highway program and digitalization initiatives for logistics services. However, it remains constrained by internal weaknesses such as limited dedicated docks and the phenomenon of imbalanced cargo flow. Therefore, the right strategy should not only strengthen existing strengths but also emphasize how external opportunities can be utilized to overcome internal weaknesses.

In assessing operational effectiveness, a number of previous studies have emphasized the importance of performance indicators such as Turnaround Time (TAT) and Load Factor as key measures of RO-RO vessel service efficiency [11], [30]. These two indicators are highly relevant to the Sampit context, where loading and unloading speed and vessel load levels directly impact logistics costs and operator competitiveness. Therefore, improvements in dock infrastructure and digitalization of cargo management will contribute significantly to achieving operational efficiency.

Furthermore, when viewed through the QSPM (Quantitative Strategic Planning Matrix) framework, strategies that prioritize improving supporting equipment and implementing digitalization have been proven to obtain the highest Total Attractiveness Score (TAS) in previous studies. [17] in the Jayapura Port study and [19] in the analysis of terminal productivity in East Kalimantan consistently show that technology-based strategies and facility improvements have the most significant impact. This is relevant to the context of Sampit Port, where critical weaknesses in the form of limited dedicated docks and weak cargo management can be overcome through infrastructure investment and service digitalization.

Thus, the discussion of these results confirms that efforts to improve RO-RO performance in Sampit must be directed at a combination of infrastructure-digitalization strategies that are aligned with national policies and accompanied by measurable performance indicators so that their implementation can be evaluated continuously.

Implications

The analysis and discussion have important implications for academic, practical, and policy purposes. Academically, this study contributes to the growing body of literature on the application of SWOT–IFE/EFE–QSPM analysis to maritime transportation, particularly RO-RO vessels. It also

emphasizes the need for measurable operational performance indicators, such as TAT and load factor, to objectively assess service effectiveness.

From a practical perspective, these findings provide direct recommendations for operators like PT Dharma Lautan Utama (DLU). Prioritizing strategies such as building a dedicated dock and implementing digital cargo management can serve as a guide for the company in strengthening its operations at Sampit Port. With these steps, DLU will not only improve internal efficiency but also expand its service competitiveness in the face of competition from other transportation modes.

Meanwhile, in the policy realm, the results of this study demonstrate that the government needs to pay special attention to regional ports, such as Sampit, which play a strategic role in interregional connectivity. Investment in the construction of dedicated RO-RO docks and the integration of digital logistics systems should be prioritized in national maritime transportation policy. This step will not only reduce national logistics costs but also strengthen the function of the maritime toll road as an instrument for equitable development.

Thus, the implications of this research can be an important foundation for academics, practitioners, and policy makers in developing strategies for more efficient, integrated, and sustainable maritime transportation.

CONCLUSION

This study confirms that Roll-On/Roll-Off (RO-RO) vessels play a crucial role in supporting interregional connectivity in Indonesia, particularly in the context of the Port of Sampit. This mode can improve loading and unloading efficiency and service flexibility, but still faces challenges such as limited dock space, load imbalances, and high operational costs. The literature analysis shows that Sampit Port is in the WO (Weakness–Opportunity) quadrant, where opportunities from the maritime toll policy and the development of logistics digitalization can be leveraged to address internal weaknesses. Performance indicators such as Turnaround Time (TAT), Load Factor, and On-Time Performance (OTP) have proven relevant as a basis for measuring service effectiveness. Within the IFE/EFE and QSPM frameworks, strategies emphasizing strengthening dedicated dock infrastructure and implementing digital cargo management are considered the highest priority. This strategy aligns with previous research findings that emphasize the importance of facility and technology investment in improving port competitiveness and national logistics efficiency. Thus, it can be concluded that improving RO-RO performance at Sampit Port requires synergy between operators, the government, and other stakeholders. For academics, this study enriches the literature on maritime transportation strategies based on SWOT-IFE/EFE-QSPM. For practitioners like PT Dharma Lautan Utama, the strategic recommendations can serve as guidelines for operational improvement. For the government, these results emphasize the need for the construction of dedicated RO-RO docks and the integration of digital logistics to reduce distribution costs and strengthen equitable national development.

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REFERENCES

[1] Rusnaedi, R., Sudarman, S., Murtafiah, A., Usman, A. F., & Talha, A. A. (2024). Strategi Peningkatan Volume Muatan Kapal RO-RO Trayek Makassar–Jakarta di PT Bumi Lintas Tama Kalla Lines. Jurnal Teknik Mesin, Industri, Elektro dan Informatika, 274–289.

[2] Yuda, R.H., & Sastra, M. (2024). Optimasi Kinerja Pelabuhan RO-RO Bandar Sri Junjungan Kota Dumai, Jurnal Inovtekser Iteknik Sipil Dan Aplikasi (Tekla), Vol.6 No.2, 76.

[3] Kementerian Koordinator Bidang Perekonomian. (2023, 14 September). Capai pertumbuhan ekonomi berkualitas, Menko Airlangga tegaskan logistik menjadi key driver utama. Siaran

pers. https://ekon.go.id/publikasi/detail/5380/capai-pertumbuhan-ekonomi-berkualitas-menko-airlangga-tegaskan-logistik-menjadi-key-driver-utama

[4] Jinca, M. Y. (2011). Transportasi Laut Indonesia, Analisis Sistem dan Studi Kasus. Brilian Internasional, Surabaya.

[5] Aswa, A. (2022). Optimalisasi proses bongkar muat minyak product secara ship to ship (STS) untuk mendapatkan efisiensi waktu pengoperasian di kapal MT. Success Total XXXI [Skripsi, Sekolah Tinggi Ilmu Pelayaran]. Sekolah Tinggi Ilmu Pelayaran, Jakarta.

[6] Syafri, M. (2020). Transportasi Laut Indonesia: Potensi dan Permasalahannya. Jakarta: Rajawali Pers

[7] International Maritime Organization. (1995, November 29). Amendments to the annex to the International Convention for the Safety of Life at Sea, 1974 (SOLAS): Chapter II-1 — Construction: subdivision and stability; machinery and electrical installations (including regs. 8-1 & 8-2). Conference of Contracting Governments to SOLAS, 1974. IMO Publishing.

[8] Barzach, A., & Kenasin. (2013). Suatu Pengantar Pelayanan Perairan Daratan. Jakarta: Rajawali Press.

[9] Suranto, S.E. (2004). Manajemen Operasional Angkutan Laut Dan Kepelabuhanan Serta Prosedur Impor Barang. Jakarta : PT Gramedia Pustaka Utama

[10] Wahyudi, A., & Rakhman, F. (2021). "Evaluasi Kinerja Operasional Kapal RO-RO di Pelabuhan Ketapang–Gilimanuk." Jurnal Transportasi Laut, 12(1), 15–25.

[11] Basuki, A. T., & Yulianto, E. (2020). "Peran Infrastruktur Transportasi Laut dalam Menunjang Konektivitas Wilayah di Indonesia." Jurnal Transportasi dan Logistik, 5(2), 120–130.

[12] Hadi, S., & Suryono, R. R. (2021). "Evaluasi Pengembangan Pelabuhan dalam Rangka Peningkatan Transportasi Laut Nasional." Jurnal Manajemen Transportasi dan Logistik, 8(1), 45–54.

[13] Palilu, A., & Suripatty, R. (2018). Pengaruh infrastruktur transportasi terhadap pertumbuhan ekonomi Kota Sorong Provinsi Papua Barat. Ekuivalensi Jurnal Ekonomi Bisnis, 4(2), 145–156.

[14] Yolanda Tira Malona Ginting, dkk, 2024. Tata Kelola Pelayanan Kapal RO-RO Dumai-Tanjung Kapal Provinsi Riau. Journal of Law Education and Business E-ISSN: 2988-1242 P-ISSN: 2988-604X Vol. 2 No. 2 Oktober 2024.

[15] Iskandar, A., & Nugroho, S. (2021). Kebijakan Pengembangan Infrastruktur Maritim dalam Mendukung Poros Maritim Dunia. Jurnal Transportasi Multimoda, 3(2), 45–57.

[16] Mulyono, A. T. (2019). Pemanfaatan Teknologi Informasi dalam Pengembangan Pelabuhan Cerdas. Jurnal Teknologi Transportasi Laut, 1(2), 65–74

[17] Fofid, WT, Pical, F., & Purnama, Y. (2019). The development strategy of Jayapura Port with SWOT analysis towards isolated, outermost, lagging, and border areas of Indonesia (T3P). Journal of Maritime Studies, 12(3), 44–59.

[18] Sappe, A. R., Abdullah, M., & Yusuf, L. (2020). Peran dan strategi transportasi laut terhadap konektivitas antarwilayah di Kabupaten Banggai Laut Provinsi Sulawesi Tengah. Jurnal Penelitian Transportasi Laut, 5(1), 33–47.

[19] Wirawan, MK, Hidayah, N., & Putri, DL (2025). Optimization of container stacking productivity at East Kalimantan container port using SWOT method. Journal of Port Management, 11(1), 44–59.

[20] Astuti, T. (2024). Implementasi pelayanan terhadap penumpang RO-RO (Roll On-Roll Off) di Pelabuhan Rupat–Dumai menurut Undang-Undang Nomor 17 Tahun 2008 tentang Pelayaran. Jurnal Hukum Maritim, 9(1), 77–89.

[21] Indera, E., Palit, A. R. R., Raharjo, T. E., & Purwasih, H. D. (2023). Pelayanan Transfortasi Laut Di Pulau Belakang Padang Kota Batam Sebagai Pendukung Pariwisata Daerah Dalam Kerangka Good Governance. Sigma Teknika, Vol. 6, No.1 : 202-213 Juni 2023.

[22] Kadarisman, M., Yuliantini, Y., & Majid, S. A. (2016). Formulasi Kebijakan Sistem Transportasi Laut. Jurnal Manajemen Transportasi Dan Logistik. Formulasi Kebijakan Sistem Transportasi Laut. Jurnal Manajemen Transportasi Dan Logistik.

[23] Na'im, L. O. A., Abdullah, R., & Sari, M. (2024). Implementasi kebijakan pemerintah terhadap konektivitas antar pulau melalui transportasi laut di Tambelan. Jurnal Kebijakan Maritim, 7(1), 55–70.

[24] Wicaksono, B., Triwahyuningtyas, N., & Aminda, R. S. (2021). Analisis pengaruh jumlah transportasi darat, infrastruktur dan jumlah penduduk terhadap Produk Domestik Bruto. Jurnal Ilmiah MEA (Manajemen, Ekonomi, dan Akuntansi), Vol. 5 No. 3, 2021.

[25] Nugroho, P. A. C., Santosa, R., & Lestari, D. (2024). Plan maintenance system (P.M.S) pada main switch board di kapal KM. Kirana III. Jurnal Teknik Maritim, 8(2), 77–89.

[26] Munthe, IAP, Rahman, T., & Sihombing, D. (2020). A SWOT analysis for enhancing port operations at Sukamara. Indonesian Journal of Maritime Studies, 4(1), 55–68.

[27] Wahyuni, R. E., Silvia, M., & Saidah, D. (2017). Produktivitas Bongkar Muat Kapal RO-RO PT ASDP Indonesia Ferry. Jurnal Manajemen Bisnis Transportasi dan Logistik, 183-184.

[28] Creswell, J., & Miller, D. (2000). Determining Validity in Qualitative Inquiry. Theory Into Practice, 39(3), 124-130.

[29] Rangkuti, F. (2019). Analisis SWOT: Teknik Membedah Kasus Bisnis. Jakarta: Gramedia.

[30] Riswanda, A., Saputra, H., & Lisya, M. (2024). Optimasi Kinerja Pelabuhan RO-RO Air Putih Bengkalis. Jurnal TeKLA.