

Analysis of Concession, Technology, and Service Implementation on Port Infrastructure Performance: A Case Study in DKI Jakarta and Banten Provinces

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Abstract

As an archipelagic country, Indonesia relies heavily on ports as the main infrastructure to support the national logistics system and international trade. Despite its importance, port management in Indonesia faces challenges such as lack of government support, corruption, bureaucratic inefficiency, and gaps between policy and implementation. This study aims to analyze the effect of concession implementation, technology utilization, and port services on the role of Port Business Entities (BUP) and their impact on port infrastructure performance in DKI Jakarta and Banten Provinces. The study used a quantitative method with a Likert scale questionnaire based on 31 indicators covering five variable constructs: concession implementation, technology utilization, port services, BUP role, and port infrastructure performance. Data were collected from 310 respondents selected through stratified sampling, consisting of users of port services managed by BUP from November 2023 to January 2024. Data analysis was carried out using SmartPLS 3.2.9 software to validate the relationship between variables through the Structural Equation Modeling (SEM) approach. The results of the study indicate that concession implementation, technology utilization, and port services significantly influence the role of BUP, which in turn improves port infrastructure performance. In addition, the indirect influence of these variables reinforces the importance of strategic management and technology utilization in port optimization. This study confirms that implementing good concession policies, integrating modern technology, and improving port services can significantly improve the performance of port infrastructure in Indonesia. These findings provide important implications for policymaking and strategy development to optimize port operations in the future.

Keywords: infrastructure performance, port business entities (BUP), port infrastructure, port management, structural equation modeling (SEM),

Abstract

Analisis Konsesi, Teknologi, dan Implementasi Layanan terhadap Kinerja Infrastruktur Pelabuhan: Studi Kasus di Provinsi DKI Jakarta dan Banten: Kondisi kepulauan Indonesia menjadikan pelabuhan sebagai infrastruktur penting yang mendukung sistem logistik nasional dan berfungsi sebagai pintu gerbang utama untuk perdagangan internasional, sehingga berdampak positif pada perekonomian nasional. Namun, manajemen pelabuhan di Indonesia menghadapi beberapa tantangan, termasuk dukungan pemerintah yang tidak memadai, korupsi, ketidakefisienan birokrasi, dan kesenjangan antara ekspektasi kebijakan dan pelaksanaannya. Penelitian ini bertujuan untuk menganalisis dampak implementasi konsesi, pemanfaatan teknologi, dan layanan pelabuhan terhadap peran Badan Usaha Pelabuhan (BUP) di provinsi DKI Jakarta dan Banten untuk meningkatkan kinerja infrastruktur pelabuhan. Metode penelitian kuantitatif digunakan, dengan menggunakan kuesioner skala Likert dengan 31 indikator untuk mengukur lima variabel: implementasi konsesi, pemanfaatan teknologi, layanan pelabuhan, peran BUP, dan kinerja infrastruktur pelabuhan. Survei didistribusikan kepada pengguna layanan pelabuhan yang dikelola oleh BUP antara November 2023 dan Januari 2024, dengan 310 responden yang dipilih menggunakan stratified sampling. Analisis data dilakukan menggunakan perangkat lunak SmartPLS 3.2.9, mengungkapkan dampak signifikan dari implementasi konsesi, pemanfaatan teknologi, dan layanan pelabuhan terhadap peran BUP, serta dampaknya terhadap kinerja infrastruktur pelabuhan. Selain itu, efek tidak langsung juga diamati, yang menekankan pentingnya faktor-faktor ini dalam mengoptimalkan operasi pelabuhan di provinsi DKI Jakarta dan Banten.

Kata Kunci: badan usaha pelabuhan (BUP), infrastruktur pelabuhan, kinerja infrastruktur, manajemen pelabuhan, structural equation modeling (SEM)

1. Introduction

Ports are critical infrastructure that supports Indonesia's national logistics system, particularly due to the country's archipelagic nature [1]. Ports significantly contribute to Indonesia's economic growth. As of 2023, there are 223 Port Business Entities (BUPs) registered with the Directorate General of Sea Transportation, Ministry of Transportation. These entities are categorized into three groups: the Association of Indonesian Port Business Entities (ASBUPI), the Association of Indonesian Port Business

Entities (ABUPI), and non-ASBUPI/ABUPI members (Ministry of Transportation, 2023). ASBUPI consists of twelve members, with four BUPs holding twelve concessions, while ABUPI has sixty-seven members, and five BUPs hold nine concessions [2]. Additionally, non-ASBUPI/ABUPI includes 144 BUP members, with only one BUP having secured a concession. The implementation of port concession agreements in Indonesia has been granted to only 10 out of the 223 BUPs [3]. The list of these ten BUPs that have obtained concession rights for ports in Indonesia is presented in Table 1.

Based on Table 1, it can be observed that only 0.4% of Port Business Entities (BUPs) have received port concession rights, indicating a lack of investment interest in port construction and/or expansion through concession agreements. A key issue underlying this limited participation is the relatively short duration of the concession periods. Furthermore, the imposition of concession fees is governed by the mandate of the 1945 Constitution, specifically, Article 23A, which stipulates that taxes and other compulsory levies for state purposes must be regulated by law. Additionally, Article 2 Paragraph (3) of Law No. 20/1997 concerning Non-Tax State Revenues (PNBP) outlines that PNBP types not explicitly included in Paragraph (1) are to be determined by government regulations. The management of PNBP within the Ministry of Transportation, including the application of PNBP types and rates, is further regulated by Government Regulation (PP) No. 15/2016, which has undergone revisions and updates over time. The following figure (Figure 1) presents the development and changes in the types and rates of PNBP within the Ministry of Transportation.

Table 1. BUP that obtains concession rights to ports in Indonesia [4].

No.	Port Business Entity (BUP)
1	PT Pelindo I (Persero) with the ports of Belawan and Kuala Tanjung.
2	PT Pelindo II (Persero) with Tanjung Priok Port for existing facilities and Kalibaru Terminal.
3	PT Pelindo III (Persero) with Tanjung Perak port and Teluk Lamong multipurpose terminal.
4	PT Pelindo IV (Persero) with Makassar port to facilitate the existing and Makassar New Port Container Terminal.
5	PT Krakatau Bandar Samudra (KBS) with KSOP Banten for the Cigading terminal and the transfer of piloting and delaying of the Tanjung Jati and Jepara PLTU Tersus vessels.
6	PT Wahyu Samudra Indah (WSI) with KSOP Talang Duku for the Muaro Jambi Container terminal.
7	PT Karya Cipta Nusantara (KCN) with KSOP Marunda.
8	PT Pelabuhan Tegar Indonesia with KSOP Marunda for the Marunda Center terminal.
9	PT Berlian Manyar Sejahtera (BSM) with KSOP Manyar.
10	PT Delta Artha Bahari Nusantara (DABN) with KSOP Probolinggo for the public terminal.



Figure 1. Development of changes in PP types and tariffs at the Ministry of Transportation [5]

In general, the primary considerations for implementing and amending the Government Regulation (PP) regarding the types and rates of Non-Tax State Revenues (PNBP) applicable within the Ministry of Transportation are as follows: (a) adjustments to the types and rates designed to support the nation’s financial conditions by optimizing revenue generation, which, in turn, helps fund the State Budget (APBN) to provide public services and ensure the availability of such services; (b) adjustments to the types and rates that consider the purchasing power or financial capacity of service users, in alignment with the services provided, while also taking into account the tariffs imposed by state-owned enterprises

and private companies offering similar levels of service; and (c) the introduction of new types and rates of PNBP to address emerging services that were not previously included in the existing regulations governing the Ministry of Transportation’s PNBP. Through the effective implementation of port concessions, Port Business Entities (BUPs) can facilitate the investment and development of port infrastructure in a more structured and efficient manner. By granting appropriate permits to private parties or investors, BUPs can stimulate investment in the port sector. With well-structured concession agreements, investors are more likely to be motivated to engage in port infrastructure development, thereby enhancing the port’s capacity to handle greater volumes of traffic, expand facilities, and improve operational efficiency. Furthermore, the integration of advanced technologies can significantly increase port operational efficiency, including improvements in cargo handling, security systems, and activity monitoring. Modern technologies such as logistics management systems, sensor-based monitoring, and process automation can boost productivity, reduce human error, and enhance the reliability and security of port services. By optimizing technology use, BUPs can also improve resource allocation, thus accelerating the growth and development of port infrastructure.

Good port services are a crucial factor in attracting the interest of both port users and potential investors. By providing efficient, user-friendly, and integrated services, Port Business Entities (BUPs) can enhance the port’s reputation as an effective logistics hub. Ensuring high-quality services allows BUPs to meet the needs of port users, increase customer satisfaction, and foster business growth in the surrounding area. This study, along with previous research, focuses on the variables employed, particularly the performance of port facility infrastructure, as well as the independent and intermediary variables. The majority of the research has concentrated on government-managed ports, with different data analysis methods and tools being used. Moreover, several studies have reported conflicting findings, with some journals indicating no positive and significant effects. The following Table 2 presents a mapping of the gaps, controversies, and inconsistencies identified in the existing literature.

Table 2. Novelty gap, controversy, and inconsistency (GCI).

Aspect	Gaps, Controversy, and Inconsistencies
Concession	The concession has been controversial in its application at national ports. There was a discrepancy in the interpretation of Article 344 Paragraph 3 of Law Number 17 of 2008 concerning Shipping by Pelindo and the Ministry of Transportation, which caused tension. The use of the concession by Pelindo has only been implemented in the last few years, even though it has been a positive law for ten years.
Conflict Between Actors	There are differences of opinion between Pelindo and the Ministry of Transportation who are at odds over concessions, as well as between the Nusantara Bonded Zone (KBN) of PT Karya Citra Nusantara (KCN). The feud between operators, regulators, and business actors with other business actors shows that the prlem is complicated.
Financial Condition	The Ministry of Transportation does not have sufficient budget to carry out its port obligations, and does not allocate Non-Tax State Revenue (PNBP) funds according to the provisions. It also does not have adequate monitoring mechanisms regarding the calculation and receipt of PNBP.
Data Inconsistencies	There are differences in concession revenue reports and BUP (Pension Age Limit) financial reports, as well as underpayment of concession PNBP and potential late payment fines. Invalid data and lack of reconciliation lead to inconsistencies in calculations.
Monopoly and Regulation	These findings point to issues with the concession’s execution. The port concession process has a monopoly tendency and a lack of regulation, particularly with regard to the evaluation of bidders and the determination of contract procedures.
Technology and Services	The use of advanced technology in port management is still limited, while service quality can still be improved. There is uncertainty in the criteria for monitoring port infrastructure performance and maintenance.
Research variable	The research gap with previous research lies in the use of port facility infrastructure variables, independent variables, and different data analysis methods. Several previous studies also showed inconsistent results.

The list presented in Table 2 encapsulates various aspects identified from the preceding analysis, including discrepancies in legal interpretation, conflicts between involved parties, financial challenges, data inconsistencies, regulatory issues, technological limitations, as well as variations in previous research and findings. This table offers a comprehensive overview of the multifaceted issues surrounding the implementation of concessions at national ports. In light of the identified research gaps and phenomena, it can be concluded that Port Business Entities (BUPs) play a critical role as intermediaries in facilitating the implementation of effective and appropriate concessions. The adoption of advanced technologies and the provision of high-quality port services are essential for the development of port infrastructure, particularly in the DKI Jakarta and Banten regions. Effective concession management, combined with

technological innovation and service improvements, will not only enhance port capacity and operational efficiency but also contribute to the growth of trade and the national economy. Furthermore, such improvements will bolster the performance of existing port infrastructure and generate significant benefits for the Port Business Entities involved, supporting their long-term sustainability and operational success [6][7][8].

The research framework built in this research is shown in Figure 2, where the independent variables consisting X1 as application of concessions, X2 as utilization of technology, and X3 as port services. Additionally, the intervening variable (Z) is the role of port business entities, and the dependent variable (Y) is port facility infrastructure performance. Figure 2 describes the following theories:

1. **Grand Theory - Transportation Management:** According to Salim, transportation is the activity of moving goods (cargo) and passengers from one place to another [9]. The same views were also stated by Kamaludin that transportation is transporting or carrying goods from one place to another, or, in other words, it is a movement of goods or people from one place to another.
2. **Middle Theory-Logistics Management:** According to Ghiani et al. (2014), logistics management relates to the planning and organization of the flow of materials and other supporting information, both from the general and special sectors [11]. The goal is to get the right materials, place, and time.
3. **Middle Theory-Port Management:** Management comes from the word to manage, which means to organize. Therefore, arrangements are carried out through processes and are arranged based on the sequence and functions of management [12]. Management is the process of planning, directing, and supervising the efforts of organizational members and the use of other organizational resources to achieve predetermined goals [13]. Management is also a science and art that regulates the process of utilizing human resources and other resources effectively to achieve a certain goal [14][15].
4. **Applied Theory-Application of Concessions:** Concessions are the private sector providing management services for part or all of certain infrastructure systems, including operation and maintenance of facilities, as well as providing services to the community and working capital [26][27].
5. **Applied Theory-Utilization of Technology:** According to Sutabri [28], Information technology is a technology used to process data, including processing, obtaining, compiling, storing, and manipulating data in various ways to produce quality information, which is information that is relevant, accurate and precise in time. This information is used for personal, business, and government purposes and is strategic for decision-making.
6. **Applied Theory-Port Services:** According to the American Marketing Association, quoted by Donal Nababan, et al. [29], service is an activity or benefit offered by one party to another and is essentially intangible. It does not result in ownership of something. The production process may not associated with a physical product. Lovelock, as quoted by Hardiyansyah, stated that service is an intangible product that lasts for a while and is felt or experienced.
7. **Applied Theory-The Role of Port Business Entities:** Port Business Entities can be used to determine the level of port service to port users (ships and goods), which depends on the ship's service time while at the port. A high port business entity shows that the port can provide good services [30][31][32].
8. **Applied Theory-Port Facility Infrastructure Performance:** Performance is the work results achieved by a person based on job requirements. A job has certain conditions that must be met to achieve goals, which are also known as job standards [33][34][35].

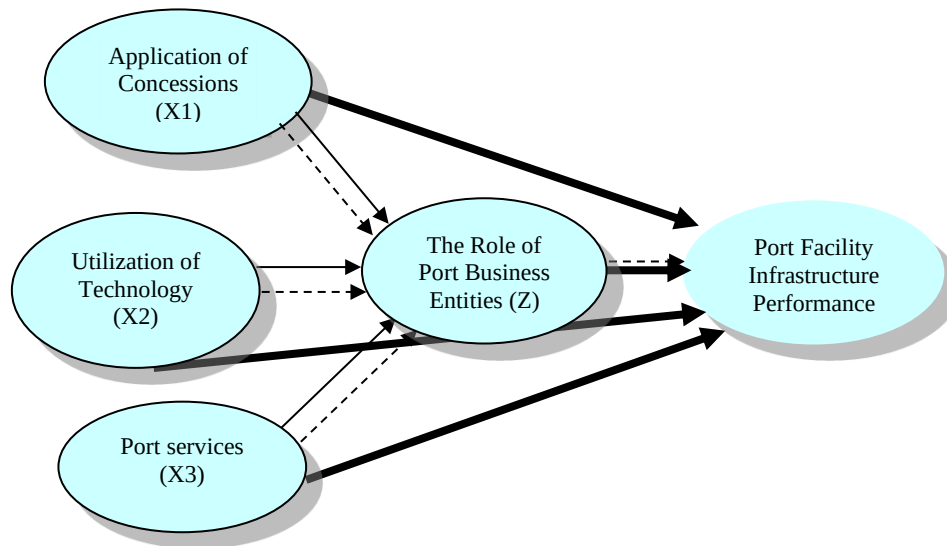


Figure 2. Conceptual Framework

Figure 2 also illustrates the relationship. The application of port concessions is the granting of rights by the port operator to the Port Business Entity (BUP) to carry out certain port service provisions and/or service activities within a certain period and with certain compensation (government regulation number 61/2009 concerning ports article 1 paragraph 30). The separation of governmental and business functions, as outlined in Law No. 17/2008 on Shipping, establishes that the government's role, represented by the port authority, is limited to its authority as a regulator, supervisor, controller, and overseer.

The implementation of concessions, both in Minister of Transportation Regulation Number PM 15/2015 concerning concessions and other forms of cooperation between the government and Port Business Entities in the port sector of 2.5% or existing port concession agreements, are not subject to study or other considerations. A concession period that is too long has the potential to be more profitable for the private sector, and conversely, this could be detrimental to the government. On the other hand, if the government wants a shorter concession period, the private sector will reject the contract or force the government to increase service fees in project operations to obtain a certain level of profit to compensate for investment losses.

Inaportnet is an internet network/web service-based system related to ship arrival and departure services as well as loading and unloading activities. A system has been developed to enable service users (such as shipping companies and loading/unloading companies) to submit service requests—commonly referred to in the shipping industry as clearance in/out—for ship arrivals, departures, or cargo loading/unloading activities without the need to visit government agencies in person. This system aims to minimize face-to-face interactions between service users and authorized government officials. This is in line with the Ministry of Transportation's commitment to eradicate illegal levies in the Transportation sector.

This is in line with the ASEAN Concord II Declaration in Bali on 7 October 2003, strengthening the Indonesian Government's determination to implement a system of export and import document services at ports through one door without direct face-to-face contact. The government then formed a team to handle the Indonesia National Single Window (INSW), where the portnet system was one of the main pillars, especially related to the port clearance process on ships services at ports [36].

Furthermore, according to Malisan, *Inaportnet* strives to integrate a standard port information system in physically serving ships and goods from all agencies and stakeholders. Currently, ports function not only as docking points for ships carrying thousands of passengers but also as critical hubs for economic and logistical activities. To ensure effective and efficient port operations, the port management system must be supported by a modern information system. This advancement is expected to enhance port performance, drive economic growth, and reduce national logistics costs [37].

From an external perspective, improved quality of Inaportnet services positively impacts the satisfaction levels of both users and service providers. The high level of satisfaction received by users and service providers will encourage users and service providers to fully support government programs. From an internal perspective, the continuous existence of Inaportnet requires governance and evaluation in terms of system facility infrastructure performance, system maintenance, application ability to adapt to technological developments, and reliable human resources to create optimal service quality [38].

The efficiency of port services, such as fast cargo handling, effective loading and unloading services, and reducing ship waiting times, contributes to improving the performance of port facility infrastructure. Good service quality will attract shipping companies to use the port repeatedly, which in turn can encourage further investment in port infrastructure.

The existence of an efficient and effective port business entity can improve port management as a whole. They can strengthen the governance of planning, management, and development of port infrastructure. Professional port business entities can increase transparency in financial management, enable better investment in port infrastructure development, and facilitate increased capacity and services.

With good service and efficient management, ports can develop better infrastructure, such as docks, warehouses, and other supporting facilities. Adequate infrastructure development can increase port capacity, reduce operational costs, and increase the speed of goods handling, all of which will increase port competitiveness in the global market.

From a regulatory perspective, Law No. 17 of 2008 on Shipping and Government Regulation No. 61 of 2009 on Ports govern the separation of government functions as regulators from business functions handled by BUPs. Despite this, the implementation of concessions remains controversial due to insufficient harmonization between government regulations and business interests.

Previous studies have examined the role of port concessions, but their findings are inconsistent. Most studies have focused on government-managed ports, using different variables and analytical methods, failing to provide a holistic view of the factors influencing port infrastructure performance under concession mechanisms.

Based on the theory and framework above, the following research hypothesis can be proposed:

- H1 It is suspected that there is a significant effect of the implementation of concessions on the role of Port Business Entities
- H2 It is suspected that there is a significant effect of the use of technology on the role of Port Business Entities.
- H3 It is suspected that there is a significant effect of the implementation of concessions on the role of Port Business Entities.
- H4 It is suspected that there is a significant effect of the implementation of concessions on the infrastructure performance of port facilities.
- H5 It is suspected that there is a significant effect of the use of technology on the performance of port facility infrastructure.
- H6 It is suspected that there is a significant effect of port services on the performance of port facility infrastructure.
- H7 It is suspected that there is a significant effect on the role of Port Business Entities on the performance of port facility infrastructure.
- H8 It is suspected that there is a significant effect of the implementation of concessions on the performance of port facility infrastructure through the role of the Port Business Entity.
- H9 It is suspected that there is a significant effect of the use of technology on the performance of port facility infrastructure through the role of the Port Business Entity.
- H10 It is suspected that there is a significant effect of port services on the performance of port facility infrastructure through the role of Port Business Entities.

2. Research methods

The research process in this study began with a pre-research survey, which involved observing and identifying various phenomena in the field. This stage was followed by a comprehensive literature review, focusing on the relevant theories used to define the grand theory, middle-range theory, and variable theory, as well as a review of prior research findings. Following the literature review, the next step was to identify the research variables and develop the corresponding indicators for each variable. Subsequently, a questionnaire was designed as the primary research instrument for data collection.

The population in this study consisted of users of Port Business Entity (BUP) services. The target population included service users at ports managed by the BUP in the DKI Jakarta and Banten provinces. Detailed information regarding the population can be found in Table 3 below.

Table 3. Port/Terminal managed by Port Business Entity (BUP)

Harbor	The Name of Managed Terminal by Port Business Entity (BUP)
Marunda	KCN Terminal managed by BUP PT Cintra Nusantara’s work Terminal Marunda Center managed by BUP PT Tegar HarborIndonesia(PTI)
Tanjung Priok	Kalibaru Terminal managed by BUP PT Pelindo JICT Terminal managed by BUP PT Pelindo Koja TPK managed by BUP PT Pelindo
Banten	Bojonegara Terminal managed by BUP PT Makmur Natural Stone (BAM) Cigading Terminal managed by BUP PT Krakatoa Bandar Samudra (KBS) Cidawan Terminal managed by BUP PT Pelindo

This study examined five variables, comprising a total of 31 indicators. The calculation for determining the sample size was as follows:

$$\begin{aligned} n &= (5 \text{ to } 10 \times \text{times Number of Indicators}) \\ &= 10 \text{ times } 31 \\ &= 310 \text{ respondents} \end{aligned}$$

(1)

Therefore, the minimum sample size required for this study was 310 respondents [39][40][41].

The sampling method was carried out using a non-probability sampling method using a purposive method. Sample selection in purposive sampling is bound and must be based on the objectives of the research. The required sample information must be obtained from certain people according to predetermined criteria [42]. The sampling criteria indicate that while the grouping of services at ports managed by Port Business Entities (BUP) in DKI Jakarta and Banten Provinces appears uniform externally, significant internal differences remain. Therefore, each group of companies that are divided into administrative area clusters can be randomly selected as a sample. Probability Proportional to Size sampling (PPS sampling) was used as a sampling procedure where the probability of selecting a sample unit was proportional to the size of the sample unit [43]. The sampling criteria were:

1. Service users at ports managed by Port Business Entities (BUP) in DKI Jakarta and Banten Provinces.
2. Service users registered with the INSA, APBMI, and ISAA Associations.
3. Service users consist of Shipping Lines (Shipping Companies), Freight Forwarders, EMKL (Sea Freight Expeditions), Trucking Companies, Exporters/Importers, and Consignees (goods owners).

Data analysis involves breaking down a whole into smaller components to identify the dominant elements, compare individual components with one another, and assess the relationship between one or several components and the whole [44][45][46][47]. Data analysis techniques were used to answer problem formulations or test hypotheses that have been formulated. Data management in this research employed SMARTPLS Software Ver 3.2.9., SEM-PLS software, SmartPLS 3.2.9, with the Partial Least Square (PLS) method, was applied to analyze the data.

3. Results and Discussions

3.1. Description of Research Data

3.1.1. Respondent Description

The characteristics of the respondents are presented in a tabulation of the identities of 310 participants, with questionnaire responses collected through the Google Form application. Several characteristics of respondents were obtained based on the type of origin of port users, frequency of use of port services, gender, age, and education, as shown in Figure 3:

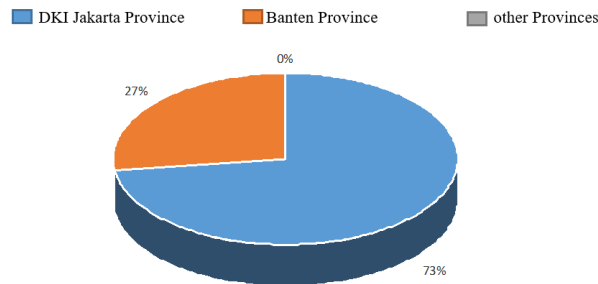


Figure 3. Respondents based on the origin of port users

Figure 3 indicates that the majority of port service users originate from DKI Jakarta. This can be attributed to several reasons:

1. **Population Density:** DKI Jakarta is the most populous province in Indonesia, with a dense population concentrated in urban areas. The high population density increases the demand for goods and services, resulting in more individuals utilizing port facilities for trade and transportation purposes.
2. **Economic Activity:** Jakarta serves as the economic and commercial hub of Indonesia, with numerous businesses, industries, and trading activities. The bustling economic activity generates a significant volume of cargo movements, leading to a higher number of port users from the region.
3. **Geographical Location:** Jakarta's strategic location as the capital city and its proximity to major shipping routes and international waters make it a crucial point for maritime trade activities. Ports in Jakarta serve as important gateways for domestic and international trade, attracting users from various regions.
4. **Infrastructure Accessibility:** The availability of well-developed transportation infrastructure, including roads, railways, and airports, enhances accessibility to port facilities in Jakarta. This accessibility facilitates the movement of goods to and from the ports, making them preferred choices for businesses and traders.
5. **Market Demand:** Jakarta's status as a center for commerce and industry creates a substantial demand for imported goods and raw materials. Additionally, the region's diverse economic sectors, including manufacturing, retail, and services, contribute to the demand for port services to support supply chains and logistics operations.

Overall, the combination of population density, economic vitality, strategic location, infrastructure accessibility, and market demand makes DKI Jakarta the primary source of port service users in the depicted scenario.

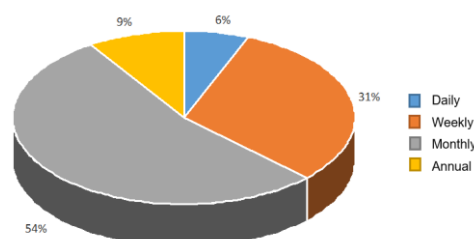


Figure 4. Respondents based on the frequency of use of port services

Based on Figure 4, which illustrates the data distribution of the characteristics of 310 respondents, the frequency of port usage is as follows: 19 respondents (6.1%) use the port daily, 96 respondents (31.3%) use it weekly, 167 respondents (53.9%) use it monthly, and 28 respondents (9%) use it annually. In summary, the majority of customers utilize port services every month.

Several factors explain the distribution pattern of respondent characteristic data, as shown in Figure 4, including the following:

1. **Ongoing Needs:** Monthly port use may be driven by business needs or trade activities that occur regularly each month. Certain businesses or industries may have a steady need to import or export significant volumes of goods each month.
2. **Production and Distribution Cycle:** Some businesses or industries may follow a monthly production and distribution cycle, where goods are produced, shipped, and distributed regularly every month. This can influence the frequency of port use by respondents involved in the supply or distribution chain.
3. **Conformity with Business Schedule:** Monthly use of the port may be in accordance with certain business schedules or operational activities that have been determined by the respondent. For example, some companies or individuals have consistent import or export activities every month according to market needs or demand.
4. **Logistics Efficiency:** Using ports every month can be considered as a strategy to increase logistics efficiency. By consolidating deliveries to once a month, responders can optimize resource use and reduce overall delivery costs.
5. **Limitations of Alternatives:** For some respondents, using the port every month may be the best or only option available to meet the needs of their business or trading activities. Other alternatives, such as using ports more frequently or less frequently, may not meet their needs or be practical for them.

Therefore, the distribution that shows the majority of respondents using ports every month reflects usage patterns that are influenced by factors such as business needs, production cycles, schedule suitability, logistics efficiency, and limited alternatives.

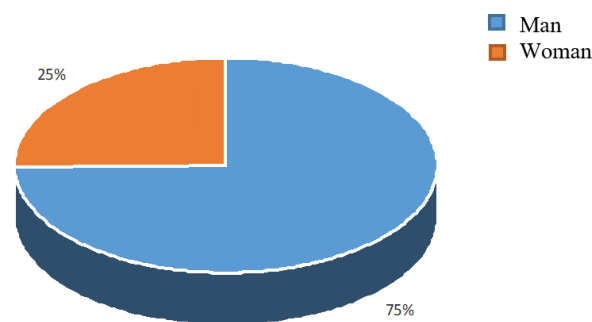


Figure 5. Respondents based on gender

This statement implies that the distribution of respondents based on their frequency of port usage, particularly the majority utilizing ports every month, indicates various factors shaping their usage patterns. These factors include:

1. **Business Needs:** Many respondents likely have regular business operations requiring frequent interactions with ports to import or export goods. Monthly usage aligns with the rhythm of their business activities.
2. **Production Cycles:** Industries with monthly production cycles may require consistent access to ports for receiving raw materials or shipping finished products. Therefore, their port usage coincides with their production schedules.

3. **Schedule Suitability:** Monthly port usage may be convenient for respondents due to its alignment with their operational schedules or shipping arrangements, allowing for efficient planning and execution of logistics activities.
4. **Logistics Efficiency:** Using ports monthly may optimize logistics operations by consolidating shipments and reducing the frequency of transportation activities, leading to cost savings and operational efficiency.
5. **Limited Alternatives:** For some respondents, monthly port usage may be the most viable option to meet their business needs, as other alternatives may be less feasible or practical.

Overall, the monthly usage pattern reflects a convergence of these factors, suggesting that respondents' port usage is driven by a combination of business requirements, operational considerations, and logistical efficiency. This understanding is derived from the processed data presented in Figure 5, which provides insights into respondents' usage behaviors based on gender.

In other words, the majority of port service users in the provinces of DKI Jakarta and Banten are male.

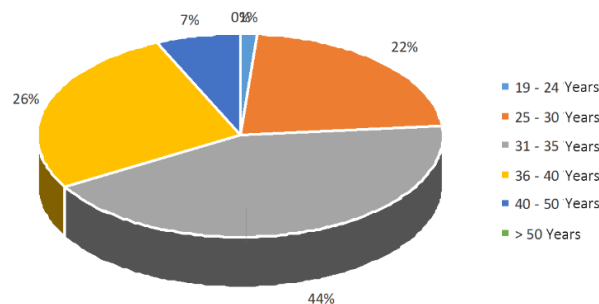


Figure 6. Respondents based on age

To put it differently, the processed data from 2024, as depicted in Figure 6, suggests that the predominant demographic among port service users in DKI Jakarta and Banten provinces is male. This observation implies that males constitute the majority of individuals utilizing port services in these regions.

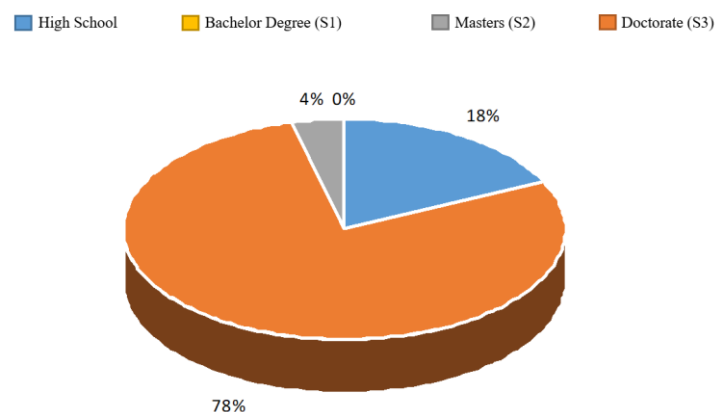


Figure 7. Respondents based on education

This statement indicates that the information provided in Figure 7 is derived from processed data collected in 2024. The figure specifically presents the characteristics of respondents categorized according to their level of education. In other words, it likely represents data on the educational backgrounds of individuals surveyed or analyzed within the context of the research.

3.1.2. Outer Model Hypothesis Testing

It was found that the correlation of each item to its variable had a greater value than the item's correlation to other variables. Indicators will be dropped some conventions (KON), such as KON2, KONS6, and KONS7, to obtain items categorized according to the rule of thumb for discriminant validity testing so that the data can be analyzed further.

3.1.2.1 Validity test

The outer model, or measurement model, was used to test and evaluate the relationships between indicators and their respective constructs (latent variables). This analysis was conducted using SmartPLS 3.3.9 software with the “Calculate PLS Algorithm” option in Stage 3.

Based on the processing of factor loading values displayed in the analysis, it can be concluded that all values meet the rule of thumb, exceeding 0.7. Therefore, all variables from the sample of 310 respondents are suitable for further analysis.

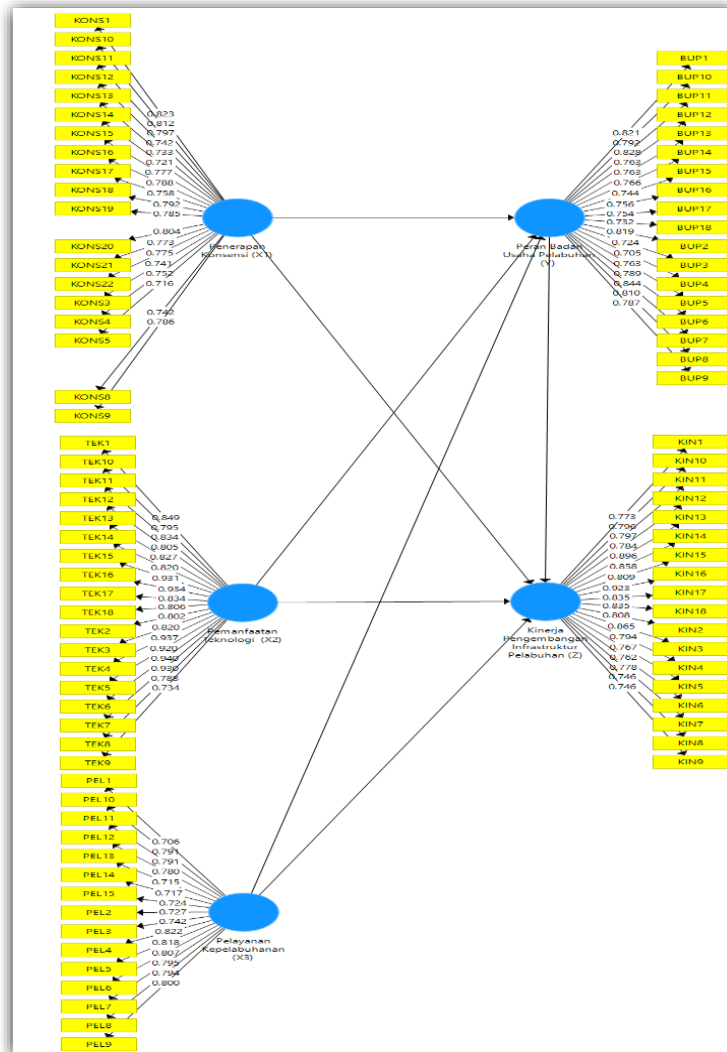


Figure 8. Measurement model

3.1.2.2 Pen Discriminant Validity test

Discriminant validity was used to ensure that each concept of each construct or latent variable was different from other variables. The next criterion in the discriminant validity test was to look at the Heterotrait-Monotrait Ratio (HTMT) value using the maximum HTMT value limit of 0.90. Table 4 is SEMPLS processed data, which shows the results of the Heterotrait-Monotrait discriminant validity test.

The data presented in Table 4 show that the variables used in this research have good discriminant validity in compiling their respective variables. The recommended measurement value for HTMT analysis in PLS has been set to be smaller than 0.85 to a maximum of 0.90, so it is still considered sufficient. Table 4 shows that the HTMT criteria are <0.9, so it has met the discriminant validity test criteria.

Table 4. Pen discriminant test with HTMT

Variables	Performance Development Infrastructure Harbor (Y)	Service Port (X3)	Utilization Technology (X2)	Application Concession (X1)	Body Business Harbor (Z)
Infrastructure Performance Port Facilities (Z)					
Service Port (X3)	0.624				
Utilization of Technology (X2)	0.609	0.444			
Implementation of Concessions (X1)	0.557	0.458	0.458		
Role of Business Entities Harbor (Y)	0.647	0.675	0.474	0.507	

3.1.2.3 Reliability Test Results

The reliability test can be carried out on data based on 310 respondents using the implementation of SmartPLS 3.2.9. This test employed Cronbach’s alpha (CA) and composite reliability (CR) value analysis. The rule of thumb for good CA and CR values was ≥ 0.6 and 0.7 . These variables can be said to be reliable and trustworthy. The results of the reliability test for each variable in this research can be seen in Table 5.

Table 5. Cronbahch’s alpha and composite reliability

Variables	Cronbach’s Alpha	Composite Reliability
Infrastructure Performance Port Facilities (Y)	0.969	0.972
Port Services (X3)	0.951	0.956
Utilization of Technology (X2)	0.977	0.979
Implementation of Concessions (X1)	0.962	0.965
Role of Port Business Entities (Z)	0.961	0.965

Based on Table 5, the CA and CR values exceed 0.6 and 0.7 , respectively, indicating that all variables meet the reliability criteria. Therefore, it can be concluded that all items and variables in the sample satisfy the validity and reliability requirements, allowing them to be further analyzed in the structural model evaluation.

3.1.3. Inner Model

The structural model (Inner Model) represents the causal interactions among latent variables. It can be evaluated using measures such as the Goodness of Fit (GoF) test and the coefficient of determination (R^2). Figure 9 presents a path diagram generated using PLS Bootstrapping calculations. Based on Ghozali and Latan [48], the inner model illustrates the causal relationships between variables as proposed by the underlying theory. This model analyzes the causal effects among variables to validate the theoretical framework. In this section, the following aspects will be tested:

3.1.3.1 Goodness of Fit Model (GoF) Evaluation

Apart from that, based on data processing that has been carried out using the SmartPLS program, the Model Fit values are shown in Table 6. The goodness of fit test results of the PLS model in Table 6 below show an NFI value of 0.550 . meaning that it fits. Therefore, from these results, it can be concluded that the model has a high goodness of fit and is suitable for use to test research hypotheses.

Table 6. Fit models

Variables	Saturated Model	Estimated Model
SRMR	0.068	0.068
d_ULS	18,338	18,338
d_G	15,672	15,672
Chi-Square	18394,137	18394,137
NFI	0.550	0.550

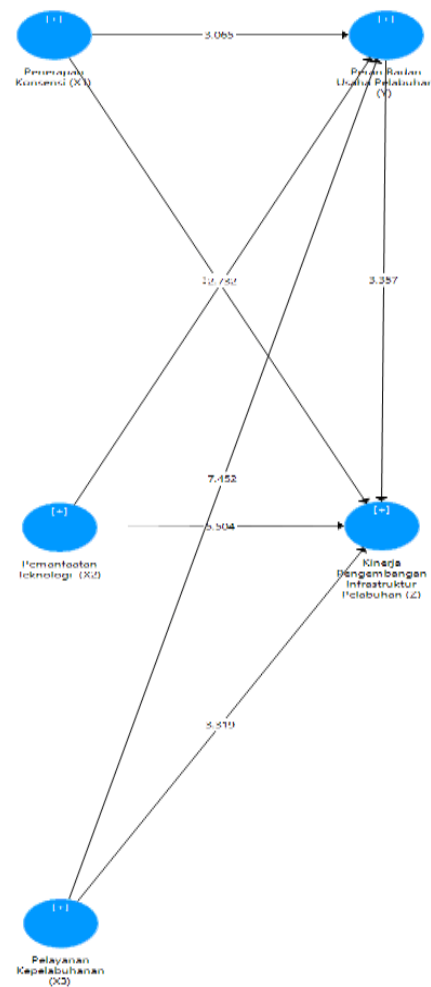


Figure 9. Bootstrapping

3.1.3.2 R-Square (Coefficient of Determination)

According to Hair et al. (2019), the R² or R-Square test is a way to find out how large a percentage of the endogenous construct can be explained by the exogenous construct. The coefficient of determination (R²) is expected to be between 0 and 1. Table 7 shows R² values of 0.75, 0.50, and 0.25, indicating that the model is strong, moderate, and weak.

Table 7. R-square test results (R²)

Variables	R Square	R Square Adjusted
Infrastructure Performance Port Facilities (Y)	0.572	0.567
Role of Business Entities Harbor (Z)	0.492	0.487

Table 7 shows that the variables of application of concessions, use of technology, and port services on the role of Port Business Entities have a large R² value. The R² value is 0.492, with an Adjusted R² value of 0.487, indicating that the variables—application of concessions, use of technology, port services, and the role of Port Business Entities—collectively explain 49.2% of the variance in the role of Port Business Entities. The remaining 50.8% is influenced by other variables not included in this study. Similarly, the variables of application of concessions, use of technology, port services, and the role of Port Business Entities collectively have a high R² value in explaining the performance of port facility infrastructure, with the remaining 8% attributed to other variables not accounted for in this research.

3.1.4. Hypothesis Testing (Bootstrapping)

Model evaluation was carried out by looking at the significance value to determine the effect of variables through a bootstrapping procedure. Hypothesis testing in this research was carried out by

looking at *t*-statistics and *p*-values. The hypothesis is declared accepted if the *t*-statistics value is > 1.96 (Table value) and *p*-values < 0.05 . Table 8 shows the results of Path Coefficients of direct and indirect effects.

Table 8. Indirect and direct effects

H	Indirect and Direct Effects	Coefficient Parameter	<i>t</i> -statistics	<i>p</i> -values	Results
H1	Implementation of Concessions (X1) -> Role of Port Business Entities (Z)	0.204	3,065	0.002	H1 is accepted
H2	Utilization of Technology (X2) -> Role of Port Business Entities (Z)	0.161	2,732	0.007	H2 is accepted
H3	Port Services (X3) -> Role of Port Business Entities (Z)	0.489	7,452	0,000	H3 is accepted
H4	Application of Concessions (X1) -> Performance Port Facility Infrastructure (Y)	0.179	3,087	0.002	H4 is accepted
H5	Technology Utilization (X2) -> Performance Port Facility Infrastructure (Y)	0.305	5,504	0,000	H5 accepted
H6	Port Services (X3) -> Port Facility Infrastructure Performance (Y)	0.229	3,319	0.001	H6 accepted
H7	Role of Business Entities Harbor (Z) -> Port Facility Infrastructure Performance (Y)	0.249	3,357	0.001	H7 accepted
H8	Implementation of Concessions (X1) -> Role of Port Business Entities (Z) -> Port Facility Infrastructure Performance (Y)	0.051	2,254	0.025	H8 accepted
H9	Utilization of Technology (X2) -> Role of Port Business Entities (Z) -> Port Facility Infrastructure Performance (Y)	0.040	2,085	0.038	H9 accepted
H10	Port Services (X3) -> Role of Port Business Entities (Z) -> Port Facility Infrastructure Performance (Y)	0.121	3,058	0.002	H10 accepted

Parameter coefficients, the regression model obtained is as follows:

$$(Z = a + 0.204 X1 + 0.161 X2 + 0.489 X3)$$

Model 1 Interpretation:

1. Concession Application Coefficient (0.204): The coefficient of 0.204 for the concession application indicates a positive unidirectional effect on the role of Port Business Entities (BUP). This means that if the value of the concession application increases by one unit, the role of Port Business Entities will increase by 0.204 units, assuming the utilization of technology and port services remains constant.
2. Technology Utilization Coefficient (0.161): The coefficient of 0.161 for technology utilization also shows a positive unidirectional effect on the role of Port Business Entities. This implies that if the value of technology utilization increases by one unit, the role of Port Business Entities will increase by 0.161 units, assuming that the concession application and port services remain constant.
3. Port Services Coefficient (0.489): The coefficient of 0.489 for port services suggests a strong positive unidirectional effect on the role of Port Business Entities. Therefore, if the value of port services increases by one unit, the role of Port Business Entities will increase by 0.489 units, assuming that the concession application and technology utilization remain constant.

Regression Model for Port Facility Infrastructure Performance (Y):

The regression equation for the performance of port facility infrastructure is expressed as follows:

$$(Y = a + 0.179 X1 + 0.305 X2 + 0.229 X3 + 0.249 Z)$$

Where:

- Y represents the performance of port facility infrastructure,
- X_1 represents the implementation of concessions,
- X_2 represents the utilization of technology,
- X_3 represents port services,
- Z represents the role of Port Business Entities.

This equation shows how the performance of port facility infrastructure is affected by the application of concessions, technology utilization, port services, and the role of Port Business Entities, with each variable contributing positively to the overall infrastructure performance.

Explanation of the Model:

- Concession Implementation (X1) has a positive effect on both the role of Port Business Entities (Z) and the performance of port infrastructure (Y), with a coefficient of 0.179.
- Technology Utilization (X2) also positively impacts the performance of port infrastructure with a coefficient of 0.305, as well as enhancing the role of Port Business Entities with a coefficient of 0.161.
- Port Services (X3) has the strongest positive effect on the role of Port Business Entities (Z), with a coefficient of 0.489, and also positively affects infrastructure performance, with a coefficient of 0.229.
- The Role of Port Business Entities (Z), acting as an intermediary, also positively affects port infrastructure performance with a coefficient of 0.249.

In summary, this model indicates that improvements in the implementation of concessions, technology utilization, and port services all contribute to the enhanced role of Port Business Entities, which in turn positively affects the performance of port infrastructure.

Model 2 Interpretation:

1. Concession Application Coefficient (0.179): The coefficient of 0.179 for the concession application indicates a positive unidirectional effect on the performance of port facility infrastructure. This means that if the value of the concession application increases by one unit, the performance of port facility infrastructure will increase by 0.179 units, assuming the technology utilization remains constant.
2. Technology Utilization Coefficient (0.305): The coefficient of 0.305 for technology utilization indicates a positive unidirectional effect on the performance of port facility infrastructure. Therefore, if the value of technology utilization increases by one unit, the performance of port facility infrastructure will increase by 0.305 units, assuming the role of Port Business Entities remains constant.
3. Port Services Coefficient (0.229): The coefficient of 0.229 for port services shows a positive unidirectional effect on the performance of port facility infrastructure. This suggests that if the value of port services increases by one unit, the performance of port facility infrastructure will increase by 0.229 units, assuming the role of Port Business Entities remains constant.
4. Role of Port Business Entities Coefficient (0.249): The coefficient of 0.249 for the role of Port Business Entities indicates a positive unidirectional effect on the performance of port facility infrastructure. This implies that if the value of the role of Port Business Entities increases by one unit, the performance of port facility infrastructure will increase by 0.249 units, assuming the concession application remains constant.

Hypothesis Testing Results:

Based on Table 8, the following conclusions can be drawn from the hypothesis testing:

1. H1: Concession Implementation $\rightarrow$ Role of Port Business Entities (Z): The effect of implementing concessions on the role of Port Business Entities is significant, with a p -value of 0.002 ($p < 0.05$). This indicates that H1 is accepted, and there is a significant direct effect of concession implementation on the role of Port Business Entities in the DKI Jakarta and Banten Provinces.
2. H2: Technology Utilization $\rightarrow$ Role of Port Business Entities (Z): The effect of technology utilization on the role of Port Business Entities is significant, with a p -value of 0.007 ($p < 0.05$). This means that H2 is accepted, and there is a significant direct effect of technology utilization on the role of Port Business Entities in the DKI Jakarta and Banten Provinces.
3. H3: Port Services $\rightarrow$ Role of Port Business Entities (Z): The effect of port services on the role of Port Business Entities is highly significant, with a p -value of 0.000 ($p < 0.05$). Therefore, H3 is accepted, and there is a significant direct effect of port services on the role of Port Business Entities in the DKI Jakarta and Banten Provinces.

4. H4: Concession Implementation → Performance of Port Facility Infrastructure (Y): The effect of concession implementation on the performance of port facility infrastructure is significant, with a p -value of 0.002 ($p < 0.05$). This means H4 is accepted, and there is a significant direct effect of concession implementation on the performance of port facility infrastructure in the DKI Jakarta and Banten Provinces.
5. H5: Technology Utilization → Performance of Port Facility Infrastructure (Y): The effect of technology utilization on the performance of port facility infrastructure is significant, with a p -value of 0.000 ($p < 0.05$). Thus, H5 is accepted, and there is a significant direct effect of technology utilization on the performance of port facility infrastructure in the DKI Jakarta and Banten Provinces.
6. H6: Port Services → Performance of Port Facility Infrastructure (Y): The effect of port services on the performance of port facility infrastructure is significant, with a p -value of 0.001 ($p < 0.05$). Therefore, H6 is accepted, and there is a significant direct effect of port services on the performance of port facility infrastructure in the DKI Jakarta and Banten Provinces.
7. H7: Role of Port Business Entities → Performance of Port Facility Infrastructure (Y): The effect of the role of Port Business Entities on the performance of port facility infrastructure is significant, with a p -value of 0.001 ($p < 0.05$). Hence, H7 is accepted, and there is a significant direct effect of the role of Port Business Entities on the performance of port facility infrastructure in the DKI Jakarta and Banten Provinces.
8. H8: Indirect Effect of Concessions on Performance of Port Facility Infrastructure through the Role of Port Business Entities: The indirect effect of concession implementation on the performance of port facility infrastructure through the role of Port Business Entities is significant, with a p -value of 0.025 ($p < 0.05$). Therefore, H8 is accepted, indicating a significant indirect effect of concession implementation on the performance of port facility infrastructure in DKI Jakarta and Banten Provinces through the role of Port Business Entities.
9. H9: Indirect Effect of Technology Utilization on Performance of Port Facility Infrastructure through the Role of Port Business Entities: The indirect effect of technology utilization on the performance of port facility infrastructure through the role of Port Business Entities is significant, with a p -value of 0.038 ($p < 0.05$). This means H9 is accepted, and there is a significant indirect effect of technology utilization on port infrastructure performance in DKI Jakarta and Banten Provinces through the role of Port Business Entities.
10. H10: Indirect Effect of Port Services on Performance of Port Facility Infrastructure through the Role of Port Business Entities: The indirect effect of port services on the performance of port facility infrastructure through the role of Port Business Entities is significant, with a p -value of 0.002 ($p < 0.05$). Therefore, H10 is accepted, and there is a significant indirect effect of port services on the performance of port infrastructure in DKI Jakarta and Banten Provinces through the role of Port Business Entities.

Summary:

1. All hypotheses related to the direct effects (H1 to H7) are accepted, showing significant positive relationships between the variables.
2. The indirect effects (H8 to H10) are also accepted, demonstrating the mediating role of the Port Business Entities in translating the effect of concessions, technology utilization, and port services into improved port infrastructure performance.

These results confirm that both direct and indirect factors play a critical role in enhancing the performance of port facilities in DKI Jakarta and Banten Provinces.

4. Conclusion

The implementation of concessions has a significant impact on the role of Port Business Entities (BUP), underscoring their critical function in port operations. The utilization of technology directly affects both the role of BUPs and the performance of port infrastructure, demonstrating the transformative potential of technological advancements. Port services also play a crucial role in influencing both the role of BUPs and infrastructure performance, highlighting the strong connection between service quality and port development. Additionally, the analysis reveals the direct effect of BUPs on infrastructure

performance. Indirect effects are also observed, with concessions, technology utilization, and port services impacting infrastructure performance through their effect on the role of BUP, emphasizing the interdependence of these factors. These findings highlight the complexity of port management and the importance of considering multiple factors to optimize operations and drive infrastructure development in the DKI Jakarta and Banten provinces.

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