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CONCEPTUAL DESIGN OF PORT DEVELOPMENT TO SUPPORT THE LOGISTICS SUPPLY OF INDONESIA'S NEW NUSANTARA CAPITAL CITY

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ABSTRACT

Indonesia is building its new capital city, Ibu Kota Nusantara (IKN), to create inclusive and more equitable economic growth by shifting the center of its economic gravity from Jakarta in Java to IKN in Kalimantan Island. Apart from aiming to become a new economic generator for equal distribution of the national economy, smart and sustainable IKN is expected to trigger new styles of learning, working, and living and encourage a change in Indonesia's development paradigm. IKN covers a total area of 256,000 hectares, with approximately 56,000 hectares of planned urban built areas will be conducted in five stages from 2022 until 2045. One of the challenges faced by the construction phase in IKN is that the existing seaports in Handil and Muara Samboja still cannot provide the support required for the logistics supply of construction materials. To support the development of the IKN, the current seaports and supporting infrastructure must be developed to allow the seamless operation of the logistics process. Therefore, this study aims to propose a conceptual design for logistic seaports in the Simpang Samboja and Muara Jawa areas. Case study is the method used in this study, using both qualitative and quantitative approach. This case study method references previous studies to obtain alternative value-added components. The results of this study show that the proposed logistic areas can facilitate logistic supply in IKN development with value for money.

Keywords: *Conceptual Design; Ibu Kota Nusantara (IKN); Logistic Supply; Seaport.*

1. INTRODUCTION

The President of the Republic of Indonesia decided on the new capital city on August 26, 2019, supported by Law No. 3 of 2022 concerning the State Capital. The new capital city area is developed in East Kalimantan Province, precisely in the North Penajam Paser Regency and Kutai Kertanegara Regency, with a total area of approximately 256,142 hectares and an area of seawater of roughly 68,189 hectares, as shown in Figure 1.

New city development is closely related to the city's economic growth and the economic equity of the region's inland. Furthermore, the role of the port in the city's development

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is crucial, as it has many functions in logistics and supply activities efficiently and connects inland areas (Mangani et al., 2016). The challenges of the logistics supply are the need to link the Nusantara Capital City or *Ibu Kota Nusantara* (IKN) area in North Penajam Paser, East Kalimantan, and the surrounding area to develop urban areas. Therefore, to address those challenges in the goods' traffic flow development, this research proposes a conceptual design of the port infrastructure development by expanding the existing port area through creative, alternative, and innovative ideas utilising Value Engineering (VE).

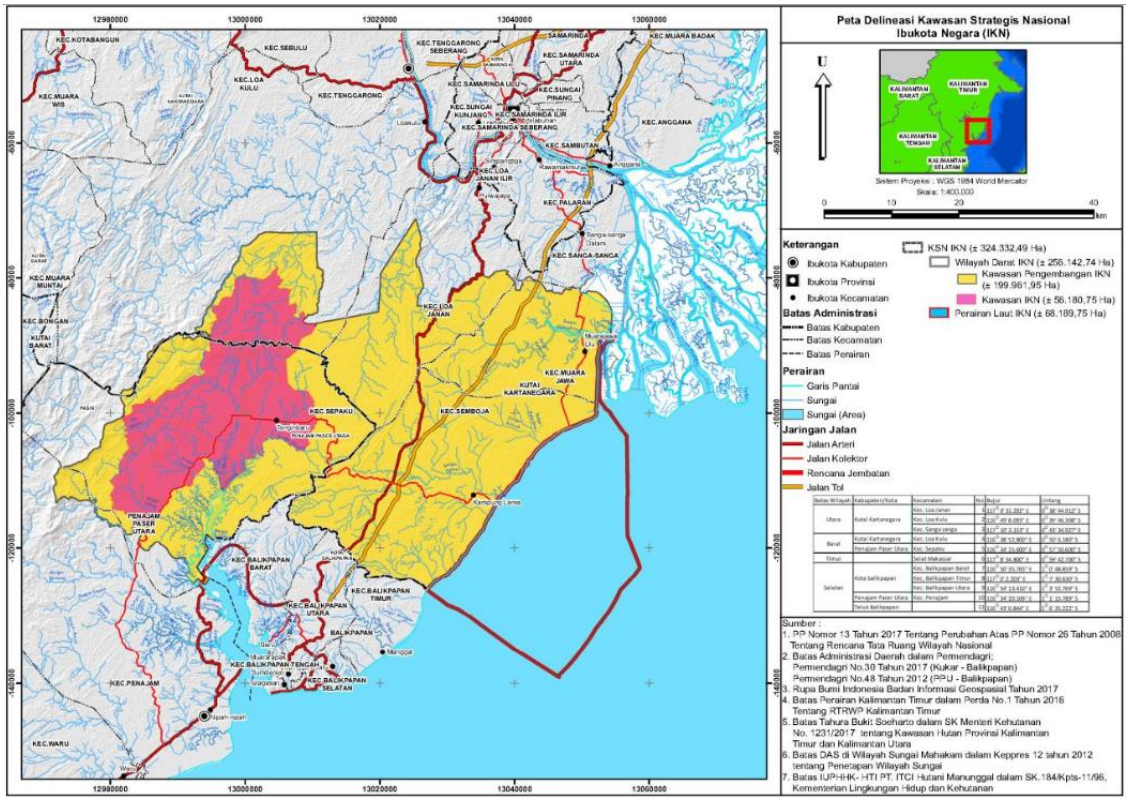

Figure 1: Delineation Map of National Capital City

Source: Law No. 3 Year 2022

2. LITERATURE STUDIES

2.1 PORT DEVELOPMENT

The plan to relocate the National Capital aligns with the vision of making Indonesia a world maritime axis. Infrastructure development in sea transportation is an important concern in planning a new state capital because it affects local economic aspects. Sea transportation is used for passenger transportation and is important in logistics distribution. The location of the new state capital is close to *Alur Laut Kepulauan Indonesia* (ALKI) II, strategic shipping lanes for world ships, so it has the potential to encourage the development of ports in East Kalimantan and eastern Indonesia. Equitable logistics distribution in Indonesia can encourage increased development, evenly distributed in each region (Chyntia et al., 2021).

Ports are protected against waves and equipped with infrastructure and technical facilities, including a pier allowing ships to load and unload (Roa et al., 2013). As a

supporting mode of transportation, the port is a hub for modal transportation transfers (land, sea, or air) to support goods supply activities. It is equipped with facilities for ships to sail and dock (Monteiro et al., 2021). Loading and unloading activities at the port create the port to support industrial development by providing checking facilities, warehousing, and local transportation networks in the port area, which impact the regional economy (Arcego et al., 2019).

Based on Indonesia's Government Regulation No. 61 of 2009 concerning ports, in the stipulation of the national port master plan, the hierarchy of port roles and functions is as follows:

a. Main Port is a port that has a function to serve domestic and international sea transportation activities, transhipments of domestic and international sea transportation in large quantities, and as a place of origin for passengers and/or goods, as well as ferry transportation with inter-provincial service coverage,
b. Collector Port has the function of serving domestic sea transportation activities in medium quantities, and
c. Regional and local feeder ports support domestic sea transportation activities in a limited number and act as the feeder of main ports and collector ports with service coverage within the province (regional feeder) or the district (local feeder).

Encourage the three main goals of IKN Development: as a symbol of national identity, a sustainable city in the world, and a driving force for the Indonesian economy in the future, the existence of a main port at IKN is needed as a service for domestic and international sea transportation activities.

2.2 VALUE ENGINEERING

Value engineering (VE), value management (VM), or value analysis were introduced by Lawrence D. Miles in 1961. Miles described value analysis as a problem-solving system implemented using a specific set of techniques combined with an organised, creative approach whose purpose is to generate cost-efficient projects. VE concept broadly focuses on how value can balance time, cost, and quality. Value can be generated from four combinations: (a) maintain function and quality while reducing costs, (b) keep costs low while increasing function and quality, (c) improve function and quality while reducing costs, and (d) improve function and quality while reducing costs (Latief, 2017). Other studies state that a project's or service's value methodology is conceptualised to increase the value of a project through an analysis of its functions (James & Antwi, 2020).

The purpose of the VE concept was to manage and increase systematic innovation to provide a competitive advantage for a product (Amran, 2019). This concept focuses on understanding the function of each product component to be developed using a combination of active verbs and measurable nouns expected to provide the beneficial characteristics of the product. Thus, the VE concept puts function analysis as the main key. The Society of American Value Engineers International (SAVE International) defines value as the ratio between functions and resources:

$$Value = \frac{Fanction\ Performance}{Resouce} \ldots\ldots (1)$$

Source: The Society of American Value Engineers International (SAVE International)

Where, the performance required by the customer can measure the function, and at the same time, resources are measured in the amount of material, labour, price, or time needed to complete the function.

In other words, three basic elements are needed to measure a value (Dell'Isola, 1997). The relationship between the three elements is as follows.

$$Value = \frac{Fanction+Quantity}{Cost} \ldots\ldots (2)$$

Source: (Dell'Isola, 1997)

Where, Function = Specific work that a design/item must do, Quality = Needs, wants, and expectations of the owner or user, Cost = Life cycle cost of a product/project

The VE study stage is a series of activities for an object (project, process, or product). These include defining functions and developing and evaluating ideas that produce VE proposals and are held in workshops (Terouhid, 2022). The stages of a VE study start with preparation, process, conclusions, and reports in the order shown in Figure 2 (Washington State Department of Transportation, 2022).

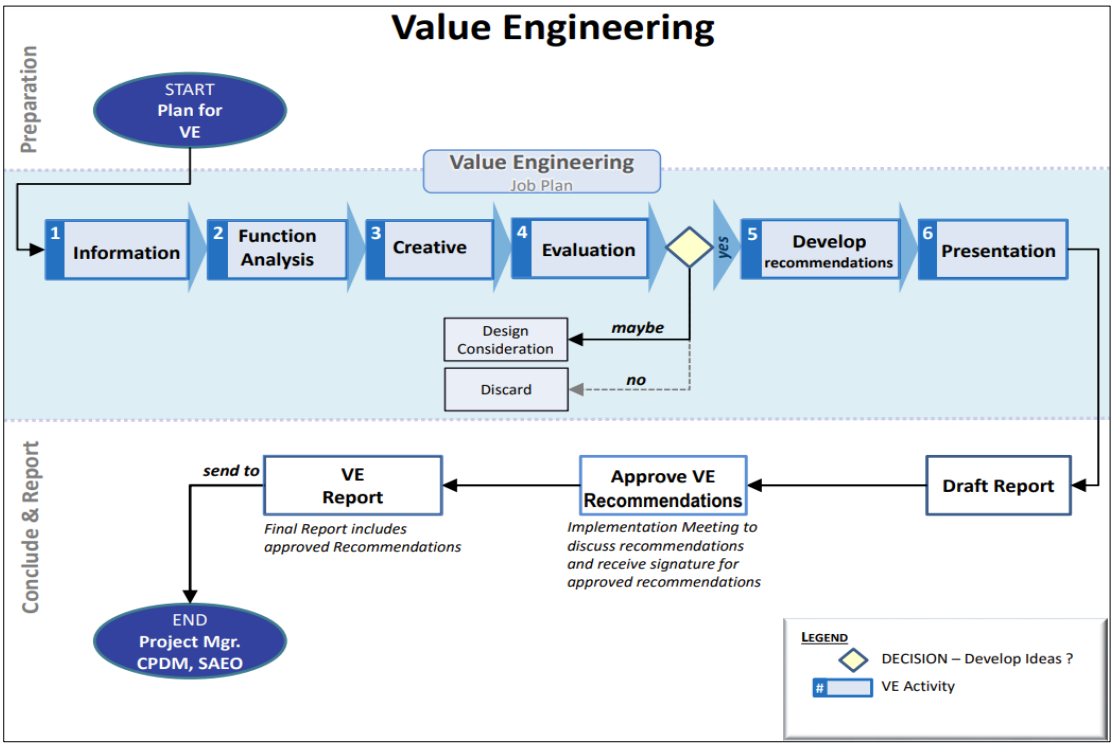

Figure 2: Value Engineering stages
Source: (Washington State Department of Transportation, 2022)

As a systematic process, VE focused on six identifiable steps, including information gathering and criteria setting for decision-making related to selected options (Berawi et al., 2019). While SAVE International is describes the step-by-step Value Engineering Methodology below:

1. Step 1: Information Gathering: This step is all about collecting data and includes the material and scope of the project to understand the project clearly.

2. Step 2: Function Analysis: analyse the functions of the elements identified in the previous step and evaluate their necessity for the project's goals. Once identified, the functions can be explored to be more creative and investigate solutions.
3. Step 3: Creative speculation aims to develop alternative solutions for delivering necessary building functions.
4. Step 4: Evaluation: This step would assess the alternative solutions by questioning the available options.
5. Step 5: Cost Analysis to count the allocation costs of the alternative solutions
6. Step 6: Development aims to develop alternatives with the highest likelihood of success.

The VE concept has resulted in various improvements to projects, systems, and products and the achievement of values widely used in the construction sector, with advantages such as risk reduction, time management, better schedules, quality improvement, and others. (Chen et al., 2010). Implementing VE in infrastructure projects provides many benefits, such as reducing project cost, increasing project performance and efficiency, and increasing project value. VE has also been applied in many developing countries and proven to increase optimal results for construction projects, especially for infrastructure projects with good quality, more advanced technology, and optimum efficiency to archive innovation (Berawi et al., 2019).

Several studies explaining the benefits of implementing VE are summarised in Table 1.

Table 1: Benefits of value engineering

Benefits	Sources
Produce project planning with a small Life Cycle Cost (LCC) by concerning cost efficiency	(Chen et al., 2013; Husin, 2022)
The formation of ideas, creations, and innovations derived from the analysis of functions	(Alwerfalli et al., 2021; Fartookzadeh et al., 2018)
Reducing construction costs that are deemed unnecessary.	(HORST Construction, 2020; Seyed Ali et al., 2014)
Application of value for money.	(CFI Team, 2022; Junjie, 2018)
Improving project performance and value.	(Landau, 2022; Terouhid, 2022)
Identify and evaluate construction needs and risks involved.	(Ali et al., 2013; Tong et al., 2022)

By observing the benefits of VE, the implementation of VE is carried out at one of these project development stages: the initial concept phase or the early design phase. During this research, VE was carried out in the early design stage.

3. RESEARCH METHODOLOGY

In order to meet the research objectives, the study will use a qualitative approach by involving experts' concepts, opinions, experiences, and previous studies to generate new research ideas (Cropley, 2023). The value engineering in the study follows the VE job plan and collaborates with a varied background in the process.

The research process commences with identifying the problems that require assessment and formulating research problems. Then the researchers studied related documents, literature, and benchmarking to obtain structural and operational variables for port design supporting regional development. Furthermore, the researcher continued the research

with the appropriate literature, standard, or policy study analysis method to achieve the research objectives. Researchers arrange the stages of research to be carried out so that research can be more effective and efficient in producing the expected output.

3.1 INFORMATION PHASE

In this stage, data gathering is practically used to identify the project's justification in more detail. The data and information are generated from the existing government-related port. A Citra Sabut port belongs to PT ITCI Hutani Manunggal (IHM). The port is closest to the core area of IKN, which known as *Terminal Kepentingan Sendiri* (Private Port), where the terminal is located within the scope of the company's work and is used to support all main business activities of the company only (Regulation of the Minister of Transportation Number PM 51 of 2011). With an area of approximately 4,600 m^2 and a 9–13.5-meter shipping depth, this port serves the flow of goods through heavy equipment and the delivery of the company's industrial products. The port is about 8.2 km from the IKN location, with the condition that the road is still a logging road. Existing port facilities include docks where ships dock, loading and unloading areas, and storage warehouses. However, basic facilities, navigation, and loading and unloading facilities are still inadequate (Refer to Figure 3).

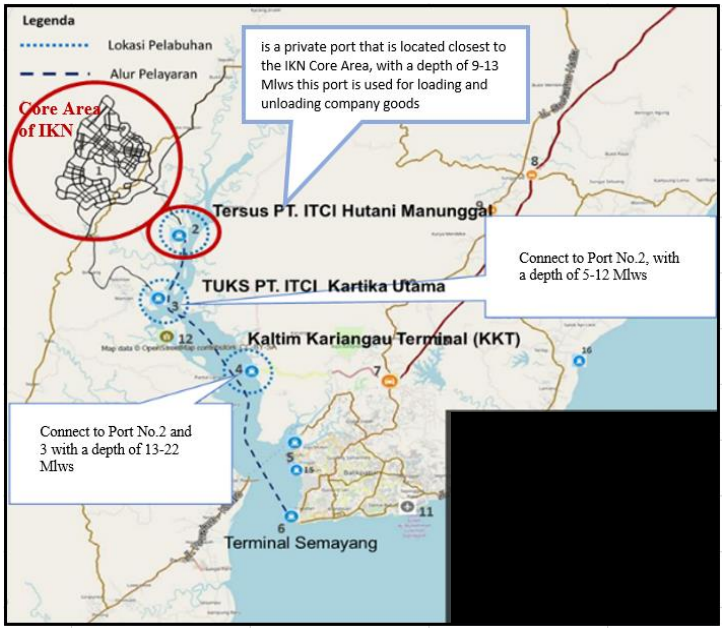

Figure 3: Location of Citra Sabut port
Source: IKN Plan by Ministry of Transportation (2022)

Apart from that, another existing port belongs to the government, which is named Samboja Port in Muara Samboja (Refer to Figure 4). This port would be the object of research because of its location in the development areas of Kuala Samboja and Muara Jawa, which is appropriate for its planning as an industrial center. Later, Kuala Samboja would be prospective as a centre for agro-industry and the food industry, as well as housing. At the same time, Muara Jawa was intended to be a public service centre for agriculture and fisheries as well as residential housing (Presidential Regulation Number 64 of 2022).

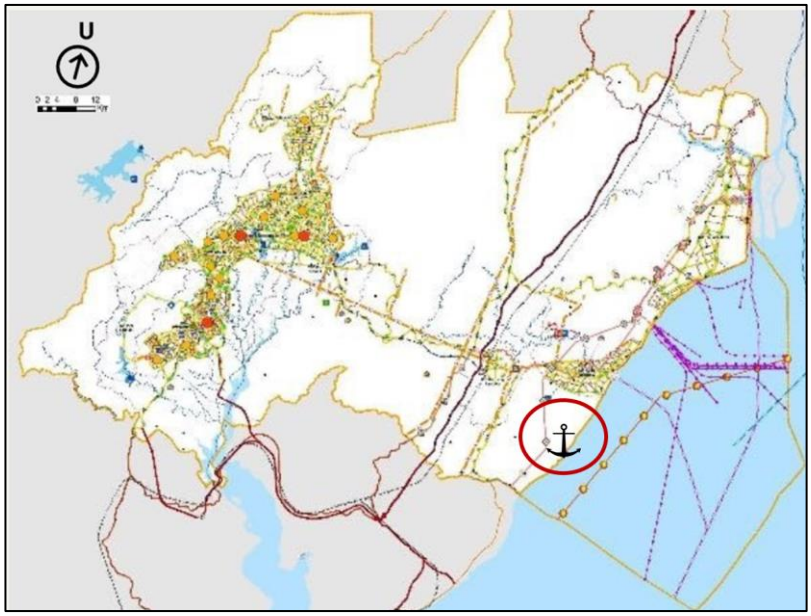

Figure 4: Location of Samboja Port
Source: IKN Plan by Ministry of Transportation (2022)

Samboja Port has a function to support the export and import of crude oil and gas by tankers. With the depth of the shipping lane at 22 meters, this port only has dock facilities and administrative offices, and there is no warehouse or sufficient loading and unloading stacking area (Refer to Figure 5 for actual condition).

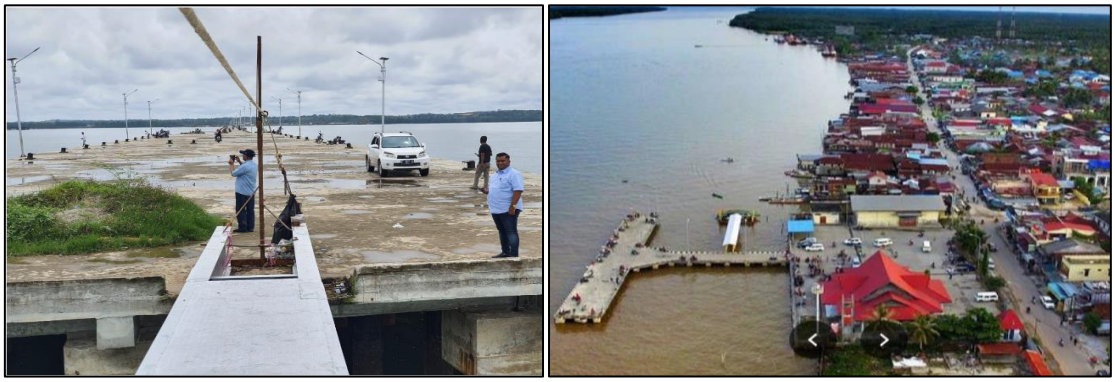

Figure 5: The existing condition of Samboja Port in 2022

3.2 FUNCTION ANALYSIS PHASE

Based on existing port data, functional analysis is developed to identify the most beneficial functions for conducting VE studies (Mandelbaum & Reed, 2006). The phase was completed by placing functions by setting up the scope of the problem and ordering functions through a Function Analysis System Technique (FAST) diagram. It is a logical model tool used to identify, classify, develop, and select tasks that contribute to higher value and benefit project development (Refer to Figure 6).

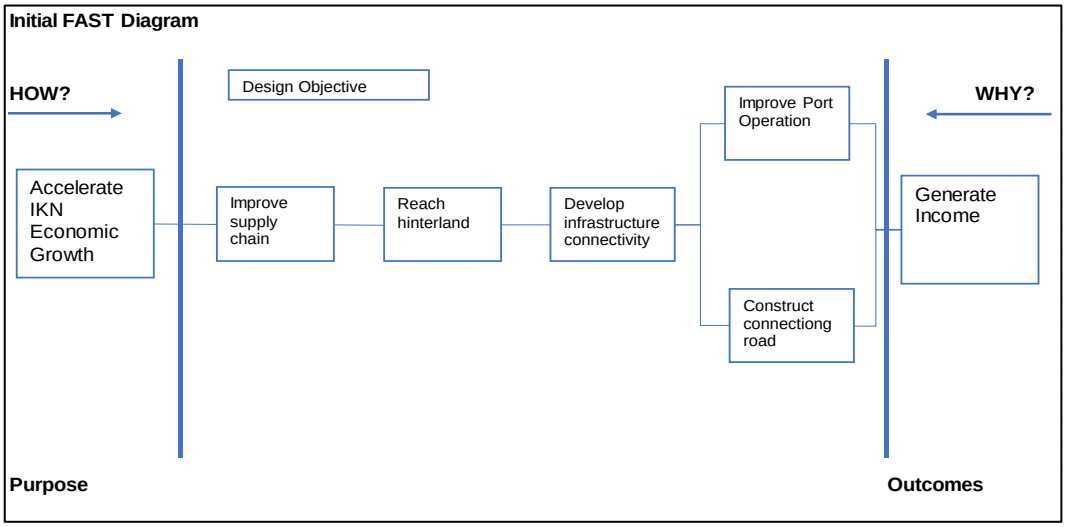

Figure 6: Initial FAST Diagram
Source: Authors (2023)

In the initial stages, researchers conducted a function analysis to accelerate the economic growth of IKN as a manifestation of the National Capital, particularly as a centre for national and international trade that can increase economic growth. To reach these goals, researchers seek to connect the contribution of the supply chain to economic growth in developing countries. Furthermore, it creates opportunities, increases productivity, improves technology and skills, increases employment, and diversifies exports (Solomon, 2013). A supply chain role involves the end-to-end delivery of a product or service. It includes every process from purchasing, manufacturing, inventory management, demand planning, warehousing, transportation, and customer service.

Additionally, efforts to improve the economy should not only be concentrated in certain IKN areas. So economic equality is needed in remote areas. A supply chain of goods or needs can be created if a connected transportation infrastructure supports it. The port is one of the transportation infrastructures with development potential and takes a key role in urban development, starting with local cultural resources and combining economic, logistics, and port industry activities (Louw & Daamen, 2017). Besides that, to reach the hinterlands, ports can be part of a logistics system that connects various logistics facilities and zones (Raimbault, 2019), including access roads. If transportation is built properly, as well as to increase state revenues.

3.3 CREATIVITY PHASE

To generate diverse and innovative ideas that provide the potential for better processes, methods, or services. In this stage, data gathering is practically used to identify the project's development in detail. The data and information are generated from journal articles on port development, as summarised Table 2.

Table 2: Port Facility

No.	Type of Data	Unit of Measurement	References
A	**Structure**		
1	Ship Type	DWT	(Samuel et al., 2009; Sergiu & Alecu, 2020; Yu et al., 2020)

No.	Type of Data	Unit of Measurement	References
2	Quay length	m	(de Boer et al., 2019; Parkison & Kempton, 2021) (Decree of the Director General of Sea Transportation RI, 2019)
3	Water depth	low water springs (lws)	(Decree of the Director General of Sea Transportation RI, 2019; Parkison & Kempton, 2021)
4	Cruise line	m	(Decree of the Director General of Sea Transportation RI, 2019; Pršić, et al., 2011; Samuel et al., 2009)
B	**Port Operational Management**		
5	Administration Building	m^2	(Basanu & Nukina, 2011; George, 2020)
6	Loading unloading area	m^2	(Basanu & Nukina, 2011)
7	Custom building	m^2	(Bichou et al., 2014)
8	Warehouse/storage area	m^2	(Basanu & Nukina, 2011)
9	Connecting Road	km	(Raimbault, 2019)

Following that, functional analysis in the previous stage by considering the project's potential in greater detail. It will update the last diagram of the FAST model by including extended functions and processes. Researchers would carry out creativity analysis to produce many diverse and innovative ideas. The revised concept design is shown in Figure 7.

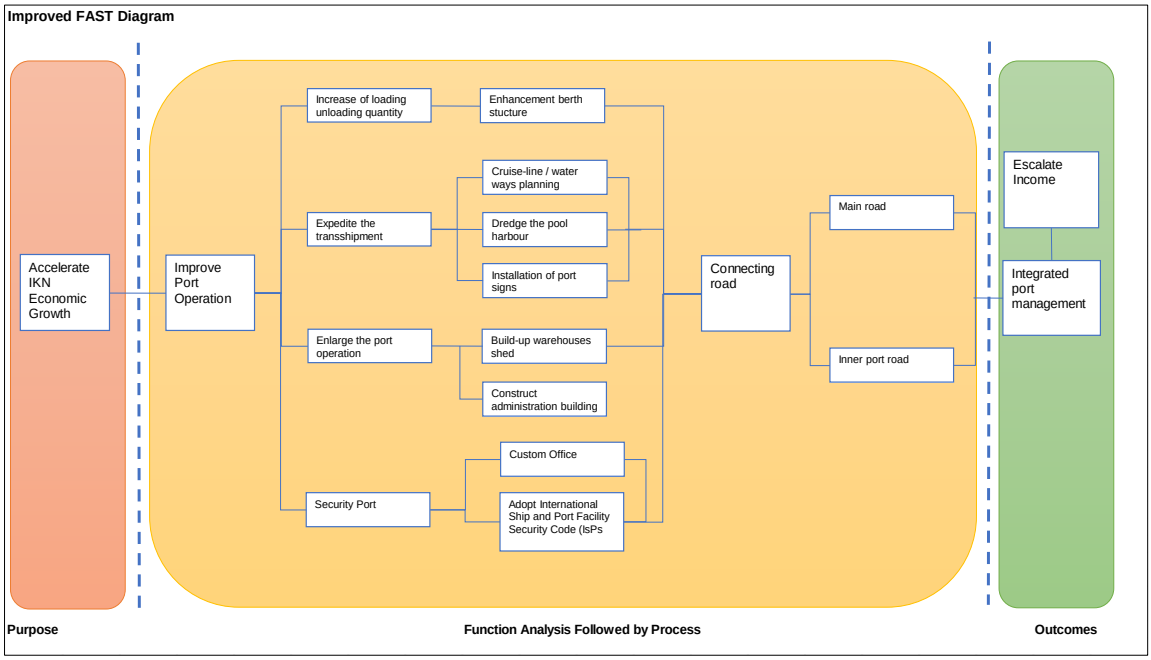

Figure 7: Revised FAST Diagram
Source: Author's processing

In line with the previous initial FAST diagram, in the creativity phase, the author explores by referring to previous research relevant to accelerating the economic growth of IKN related to the outcome of increasing income; it has been formed by the beginning of the

study. Based on Table 2, port facilities consist of structural and operational management aspects, both of which are essential to improving the operation of a port.

From these aspects, the researcher analysed the functional approach of each element. Beginning with the structural part, based on the literature, it is stated that the main port requires to be equipped with a quay, shipping lanes, and the depth of the port pool, which supports large ships entering the port smoothly. Then these elements are analysed based on their function to improve port operations that will be developed. The existing quay structure had to be strengthened; this is related to the function of the quay, which is a place for ships to dock and can increase the loading and unloading quantity. Planning for shipping lanes and dredging the water depth will speed up the flow of traffic (entry and exit) of ships and transhipments.

From an operational point of view, the port must also be equipped with several elements to improve port services. Constructing the administration building is expected to carry out the main tasks of office administration, such as recording incoming and outgoing data on transhipments, managing the ship documents, and storing them in a structured manner. Then the port needs to be facilitated by the warehouse. It has the role of storing and moving both raw materials and semi-finished and finished goods that will be sent or received through the port. A warehouse also supports the function of the port as a means of loading and unloading goods. The administration building and the port warehouse have the same function as the port, which is to expand the operation of the port.

The Main Port needs to improve port security in the operational aspect of its function as a national and international trade centre. For this reason, it is necessary to have a customs office to protect revenue and trade facilitation, safeguard society through border control, and provide import and export goods. In addition, adopt the International Ship and Port Facility Security Code (IsPs Code) to establish roles and responsibilities concerning maritime security for governments, local administrations, and ship and port industries at the national and international levels.

However, in terms of validation of the design, a researcher may receive a statement from another researcher and also do the expert judgment procedure, which is a method very often used in the area of risk assessments of complex systems or processes to fill in quantitative data. The expert will be a practical and academic expert with experience in port design and development.

4. DISCUSSION

The development of new marine infrastructure, according to Yu et al. (2020) is relevant to several factors related to sea traffic, such as the type of ship and the size of the structures that will support ship moorings. Another factor mentioned in research by de Boer et al. (2019) and Parkison and Kempton (2021) is that the pier is the most important place or part of the port. This is because the pier is a place to welcome ships to lean on, so there is a close relationship between ships and the pier. When viewed from the flow of sea traffic (Parkison & Kempton, 2021; Pršić et al., 2011; Samuel et al., 2009) shipping lanes are important where it is necessary to pay attention to the waters in terms of depth, width, and other navigational barriers that are considered safe and secure to be navigated by ships. The Port Services function includes: facilities for ship service activities from ships entering, docking, and returning to sail. To support ship service activities, George

(2020) and Basanu and Nukina (2011) state that an area or administrative area in the port is used to ensure that ship loading and unloading operations can be completed efficiently.

Besides that, Port infrastructure in its context supports the number of accommodated logistics, cranes, and terminal areas. In addition to the quality and effectiveness of information systems, the ability to integrate intermodal transportation (roads and rail) and port system management (Tongzon, 2007; Raimbault, 2019). If the volume handled exceeds the port's cargo handling capacity, it will result in port congestion and inefficiency, which can be detrimental to port users. Then the limited access to information on ship arrival will be related to poor information systems, which will slow down the documentation process and port functions. Without the availability of intermodal links, ship users cannot easily move cargo from the port, which can result in delays and high costs.

So that in the end, the entire infrastructure, both in terms of structure and operation, supports the port in its service as a place for loading and unloading goods to support regional logistics dan factor will increase the added value of the port.

5. CONCLUSIONS

The new capital city was decided by the President of the Republic of Indonesia on August 26, 2019, moving the new capital city to East Kalimantan based on Law No. 3 of 2022 concerning the State Capital. The location challenge is to become a logistics supply line connecting the National Capital City (IKN) area in North Penajam Paser, East Kalimantan, and the surrounding area to develop urban areas. By looking at the estimated development of the traffic flow of goods and materials that will occur during the construction and operation of the IKN, it is necessary to plan for the development of port infrastructure.

In the initiation phase, a conceptual design will be carried out. This phase needs to be carried out to understand the actual problems and find solutions for the existing port. This phase is one of the earliest development phases and usually involves creating a number of solutions so that the design direction can be narrowed down slowly (Derelöv, 2009).

Basically, the infrastructure at the port must be ensured so that it can distribute and receive goods effectively, efficiently, and safely because ships are always arriving (Munim & Schramm, 2018). As in the United States, the government is focusing investment on improving port infrastructure in America; this has resulted in the number of vessels doubling over the last 15 years, and tonnage at the top 25 ports grew by 4.4% from 2015 to 2019 due to large carrying capacity ports and harbour operations running efficiently (American Society of Civil Engineers (ASCE), 2021). Therefore, based on the management of previous studies (Table 2), expanding the port area by increasing the area of the warehouse, the length of the quay, and the storage yard would add value to the port.

In addition, to realise the goal of increasing economic growth in IKN, a supply chain development plan is needed that reaches all areas of IKN so that it is connected to a large number of domestic and international trading activities. To support this matter, it is necessary to develop further studies about the relationship between ports and supporting roads as distribution centres and the consolidation of goods according to their function as nodes in the transportation network. Certain activities that can be developed to support the port area include those in the warehousing, industrial, agricultural, or tourism sectors.

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