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ANALYSIS OF CENTRAL WAREHOUSE LOCATION AND LOGISTICS DISTRIBUTION LAND AND SEA MODES

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ABSTRACT
Distribution Center Warehouse has a very important role in logistics process and selecting the most strategic location is a must. Strategic location in Bali Province will give certain advantage to logistics company with travelling time as a point of view. Industrial Revolution 4.0 enable us finding such location with the help of computer simulation software such as AnyLogic. This research use AnyLogic capability to compare travelling time for 2 case of Distribution Center Warehouse: Mangupura and Negara. This comparison takes into account logistic process of delivering goods to Bali Province via sea transport (Gilimanuk Port). Result shows that Distribution Center Warehouse in Negara has an advantage compare to Mangupura in term of travelling time.

Keywords: anylogic; distribution center warehouse; gilimanuk port; travelling time

INTRODUCTION
The distribution center warehouse in the logistics distribution process traditionally functions as a place for receiving goods, storing commodities, dispatching outgoing commodities, and processing orders. The evolving role of the distribution center warehouse has transformed it into a facility for processing and adding value to commodities. This development is closely tied to the impact of the Industrial Revolution 4.0, which has led to the widespread adoption of technology, including in the warehousing sector (Politeknik Transportasi Darat Bali, 2020).The extensive use of technology during the Industrial Revolution 4.0 has significant impact on logistics sectors, such as in decision-making processes. The flow of goods, which subsequently generates the flow of information, has become a new area for decision-makers to explore (Schnetzler & Schönsleben, 2007). The expanding role of distribution center warehouse, which now includes planning, organizing, and controlling logistics, has made it a crucial factor for companies (Sadri, 2023). Therefore, decision-making related to the warehouse’s location cannot rely solely on a trial-and-error process.

The decision-making process can be aided by using modeling and simulation. Instead of building a real system with high costs and risks, companies can analyze through modeling (Mahmood et al., 2019). Modeling also helps companies avoid potential disruptions that may arise in real-world situations and environments (Borshchev, 2013). These disruptions are often due to factors of uncertainty, such as fluctuations in customer orders, supplier stock levels, and varying transportation times (Sterman, 2000). Therefore, business and economic activities are processes with certain amount of uncertainty, often referred to as stochastic (Wagner & Taudes, 1987). In a stochastic situation, deterministic modeling has the potential to produce high errors when trade-off analysis involves factors of uncertainty (Rushton et al., 2014). Therefore, we need a model that can be a better approximate, rather than relying on a deterministic approach. This is supported by the stochastic approach used in determining alternative values (Khodabakhshi & Ahmadi, 2021).

Province of Bali, which is the location of this research, consists of nine cities that serve as both population and economy centers. Modeling using location data derived from these cities will provide a good approach to the logistics distribution process in Bali. Another characteristic of Bali is that it receives supplies, including basic necessities and other commodities, from Java via sea routes (Banyuwangi – Gilimanuk).Based on the above description, we require a logistics distribution model with a hypothetical stochastic scenario. By applying location data from cities across Bali and supply data from sea vessels, this research will use AnyLogic simulation to support decision-making (Grigoryev, 2018). AnyLogic simulation will involve both land and sea transportation modes.

METHOD

The term GIS (Geographical Information System), according to (Panatagama, 2021), refers to a computer tool used for mapping and analyzing events and phenomena on Earth. The wide-ranging functions of GIS, such as those seen in Google Maps, have been utilized by various software applications like AnyLogic for analyzing models that involve location or building placement. An example of this utilization is demonstrated by Siahboomy et al. (2021), who integrated GIS maps into building modeling.AnyLogic is one of general purpose type simulation software according to (The AnyLogic Company, n.d.). This software supports three types of modeling : agent-based, discrete event and system dynamics. System dynamics research using AnyLogic for describing logistics demand dynamics in China can be seen in (Qiu et al., 2015). While discrete event research to forecast demand in supply chain is shown in (Gautama & Arifin, 2024). Combination of two types in one simulation is also possible such as shown in (Gautama N. W., 2023).

Several studies have previously been conducted using AnyLogic simulation and GIS. Research by Pratama et al. (2020) used the process flow of raw material procurement and translated it with the process modeling library in AnyLogic. The next step was to add a GIS map and agents, such as trucks transporting goods from the warehouse to home industry locations. The authors determined the fixed amount of raw materials to be supplied, estimated distribution costs, and calculated business revenue. Another research by Azizi et al. (2020) discussed modeling using distribution data of custom t-shirts from a t-shirt manufacturing company in Surabaya. Based on interview data, the authors then determined the distribution process flow in a 3-dimensional simulation with the help of the AnyLogic GIS map. The simulation aimed to determine whether the transport units were working effectively or not. A hypothetical scenario was used with one factory as the distribution center, five transport vehicles, and seven retail stores as destinations. The research found that an increase in the number of transport units to seven was necessary, even though consumer demand was not designed to be random in this model.

In Ramadhan et al. (2020), three entities were used: a factory entity, a warehouse entity, and a dealer. The researchers applied a supply chain case involving Honda-brand car commodities using AnyLogic's discrete process flow. This model was also equipped with a statechart and GIS map and used random statistical distributions to describe the car distribution process. The research aimed to assess performance based on the average time the car commodities remained in the system, rather than the distance traveled by the transport units. This research is a continuation of (Gautama N. W., 2022), which studied the distance comparison using GIS Map. The comparison is calculated with two different scenarios, the first scenario is using only one distribution center warehouse while the second one is using two. The researcher found that placing the distribution center warehouse in Mangupura had an advantage in terms of travel distance compared to other cities. In this research, the Mangupura location will be compared with Negara in a hypothetical case involving sea transportation modes.

RESULT AND DISSUCION

This research was conducted in several stages, as follows:

1. Literature Review

   In this stage, we began by studying the GIS map features, which involve maps of Bali Island and the eastern part of Java Island in AnyLogic. The next step was to add location points on the GIS map representing the crossing from Java to Bali (Banyuwangi-Gilimanuk route). The subsequent research involved designing the statechart concept in AnyLogic, representing the behavior of agents when receiving an order from a branch and when the commodity supplier ship arrives.

2. Concept Modeling (Abstraction)

   In this part, we developed a concept based on (Gautama N. W., 2022) that used a single distribution center warehouse. The addition includes the movement of a ship from Banyuwangi port to Gilimanuk, representing the supply of commodities from Java Island. The distribution center warehouse used is Negara, which is near the port. In the comparative scenario with the distribution center warehouse in Mangupura, there is an additional movement of two transport units to the port, and the distance covered is included in the total travel distance calculation. Additionally, the number of days in the modeling is limited to 100 days.

3. Data Collection

   Data collected includes the coordinates of the port and the frequency at which commodity supplies arrive from Java Island. This activity involves the participation of Poltrada's cadets in gathering data at predetermined locations.

4. Model Design

   The model design involves entering the port coordinates into the AnyLogic GIS map, while the supply frequency is set in the ship agent, which operates every 2 to 4 days. The frequency of orders by branches follows the same pattern as the previous model, which is 1 to 4 times a week. The average speed of the truck fleet is 20 km/h. Branch orders to the Distribution Center will be managed by AnyLogic using a random generator known as a seed. By using the seed method, we attempt to approximate the stochastic situation in the logistics distribution process. The addition compared to the previous model includes the movement of the ship as a commodity supplier. When the ship agent starts moving from Banyuwangi and reaches Gilimanuk, the process continues with sending two trucks from the Mangupura distribution center warehouse to collect the commodities and return them to Mangupura. The next process will be the same as the previous research, where branches order from the distribution center warehouse, and the distribution center warehouse fulfills the request. The flowchart for the logistics distribution process via land and sea modes can be seen in Figure 1.

5. Model Testing

   In this section, the author tests the AnyLogic model, and data from the model is collected if the model runs without errors for 100 days. The distance traveled by each truck unit will be stored in a variable called "distance2" located in the Main window.

6. Conclusion

   The author draws conclusions based on the experimental results (travelling time) collected earlier. The main conclusion answers the research question: whether the distribution center warehouse located near the port is more strategic than the distribution center warehouse location in the previous research, which was in Mangupura. This section also includes analysis based on calculations and other secondary data.

7. Documentation and Reporting

   In this section, the author completes the experiment documentation with screenshots and photos while finalizing the preparation of the final report.

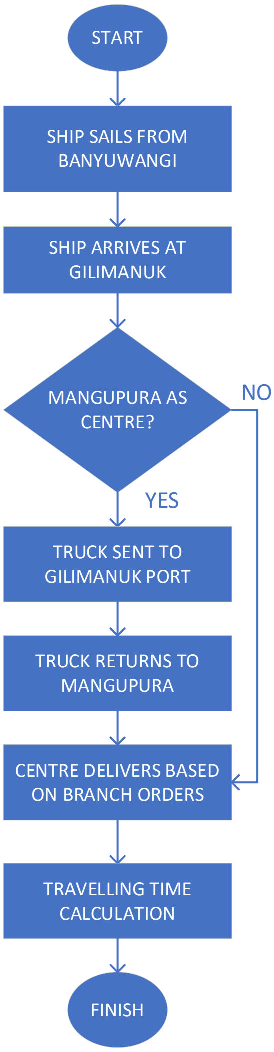

Figure 1. Flowchart for land and sea transportation mode

Based on methodology and flowchart of the process, we developed two additional components. These include ship movement from Banyuwangi to Gilimanuk to supply commodities and the transport fleet (truck) from Mangupura to Gilimanuk to collect goods arrived via sea. Therefore, the author designed the Source block in AnyLogic using an agent named KapalLaut. The configuration for the Source block is as follows:

a. Arrivals defined by: Interarrival time
b. Interarrival time: uniform_discr(2, 4) – days
c. First arrival occurs: At model start
d. Location of arrival: Network/GIS node
e. Node: gisBanyuwangi
f. Speed: 15 knots
g. New agent: KapalLaut

The next step was to create the movement of the ship from the Banyuwangi point to the Gilimanuk point using the MoveTo block. The parameters for this block are set as follows:

a. Node: gisGilimanuk
b. Set agent’s speed: checked

c. Speed: 20 kilometers per hour

The next business process step involves using the Delay block to represent the truck preparation process, which takes between half an hour to one and a half hours. The subsequent process is the collection of commodities by two trucks from the Gilimanuk port. In this process, we use the Split block with the following settings:

a. Number of copies: 2
b. New agent (copy): TrukGilimanuk
c. Location of copy: Network/GIS node
d. Node: Mangupura
e. Speed: 20 kilometers per hour (average speed)

Next, we design two Delay blocks to depict the loading and unloading process performed by the trucks at the port. We set the loading and unloading time as a triangular distribution with a time range from 3 to 5 hours. Finally, the last block we add is the MoveTo block, indicating the truck's movement from Gilimanuk to Mangupura, while also calculating the distance. The distance calculation is performed using the following code and the variable jarak3:

```
jarak3 = map.getDistance(Mangupura, gisGilimanuk);
```

The final result of the sea transport mode is shown in Figure 2.

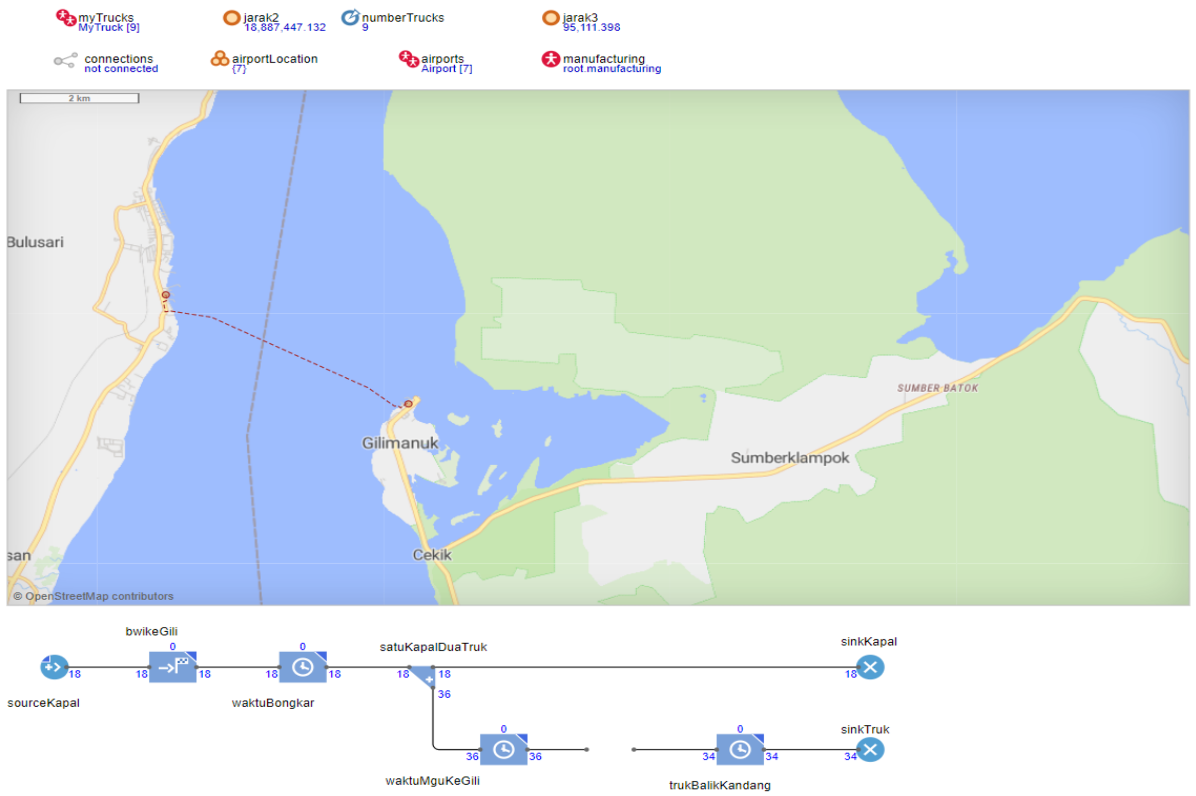

Figure 2. Adding sea transport mode

The average distance with the central warehouse located in Negara, as referenced in (Gautama N. W., 2022), were then converted into travel time. While the distance calculations with the central warehouse in Mangupura also converted into travel time, and both results are presented in Table 1. In this research, 10 additional seeds were added to provide more data, aiding in a more comprehensive analysis.

For the purpose of deterministic analysis, we use the GIS map calculations in AnyLogic. From calculations, it was found that the distance traveled by a single truck from Mangupura to Gilimanuk Port is 95.111 km. Assuming two trucks were used, the distance difference can be mathematically calculated as follows:

$$\Delta d = 2 \times 2 \times 95.111 \text{ km} = 380{,}444 \text{ km}$$

This distance is covered each time the ship arrives at Gilimanuk Port with a varying frequency, ranging from once to four times a week. During a 100-day simulation period, which is approximately equivalent to 15 weeks, if the ship arrives once a week continuously, the distance difference (denoted as S1) will be:

$$S1 = 380{,}444 \text{ km} \times 15 = 5{,}706.66 \text{ km}$$

Alternatively, assuming the ship arrives four times a week continuously, the distance difference (denoted as S2) will be:

$$S2 = 4 \times 5{,}706.66 \text{ km} = 22{,}826.64 \text{ km}$$

Thus, for Mangupura to remain the optimal choice for the distribution center warehouse, the total distance covered by the entire fleet in the simulation, plus the distance difference, must be smaller than Negara. There is still a possibility that when Negara is the distribution center, the total distance covered by the fleet is greater than Mangupura. It happens when the distance difference exceeds the value of S2. And it is possible because both Negara and Mangupura distribution center warehouse still need to do deliveries to other eight cities, thus adding travelling time.

For the stochastic analysis, we use the simulation and results are shown in Table 1. Results show that the average total travel time if the center is located in Mangupura is 2,007 hours, while the average total travel time of the fleet if the center is located in Negara is 1,606 hours.

From calculations, it is concluded that the average travel time of the fleet with the distribution center warehouse in Negara is shorter than that in Mangupura by 401 hours. If this time difference is converted into distance, the distance difference in favor of the Distribution Center in Negara is 8,002 km per simulation. According to deterministic analysis the calculation is valid because it lies between the value of S1 and S2.

CONCLUTION

This research has designed an application to determine the distribution center warehouse location by incorporating a shipping scenario from Java Island. Based on the designed scenario and calculations using the total travel time of the entire fleet, it was found that the location in Negara offers an advantage over Mangupura. This research can be further developed by including the eastern entry point for goods to Bali Province, specifically at Padangbai Port. This would bring a more realistic scenario approach in Bali Province, where goods travel from Java to Bali Island and Bali to Lombok Islands vice versa.

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