



Locating a Hub Port in Eastern Indonesia Using Network Analytics

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Abstract

Locating a Hub Port in Eastern Indonesia Using Network Analytics; The main, current challenge to the maritime logistics system of Indonesia is the low level of freight transport from its eastern region. The transportation of goods to and from the eastern and western regions of Indonesia must be balanced to enhance efficiency and reduce costs. One remedy to the current imbalance is increasing the existing economies of scale. This could be achieved by developing a hub port to enable goods to be consolidated and transported efficiently. The present study employs network analytics to determine the best site for a hub port in the eastern region of Indonesia. The coordinates of the ports in that region were analyzed using centrality algorithms and the NetworkX library. Based on analysis result, in perspective of relative distance between ports then Bitung port will be recommended as hub port in eastern Indonesia. **Keywords:** centrality; hub port; maritime logistics; network analytics

1. Introduction

A central problem for Indonesia's maritime logistics performance is posed by the disparity in goods production and transit between the western and eastern parts (see figure 1) of Indonesia and the related imbalance in the amount goods transported from one region to the other. This imbalance increases the east–west transport costs (van der Baan, 2015). Previous work in Indonesian Liner Network models (A. O. Moeis, 2017) have shown that for shipping companies to achieve sufficient profit, they must restrict themselves from accepting all possible freight.

It is the policy of the Indonesian government to implement universal access to maritime logistics services. To mitigate the problem of imbalance, the Indonesian government has implemented a Public Service Obligation (PSO) program for shipping services in the form of subsidies. The result of this policy has been a relative balance in transport, in accessibility and connectivity to be exact, between the western and eastern parts of the country.

In addition to the PSO and subsidies policy, another possible approach would be to increase the economies of scale of freight transportation from east to west (J. Zheng, 2017). This has been accomplished in other countries with significantly positive outcomes (A. J. Baird, 2006), (S. W. Lee, 2008). It can be achieved by increasing the output numbers of goods (creating new production centers) in the eastern region and creating a hub port to function as a collector or liaison with other ports in Eastern Indonesia. The present research examines the latter.

2. Methods

The methods of network analytics are used in this study. One of the core principles of network analytics is centrality, which measures how central a node is in a network and therefore estimates the most important node in a network (K. C. Spyridoula, 2019), (M. Needham, 2019). In this study, the node will be a hub port in Eastern Indonesia. Three types of centrality algorithms can be used to determine such a hub: degree centrality, closeness centrality, and betweenness centrality. Closeness centrality is a method of detecting the nodes that are capable of efficiently spreading

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3. Analysis and Discussion

Data processing through NetworkX provides consistent results. Bitung is considered the most suitable candidate for the hub port because of its high degree of centrality, closeness centrality, and betweenness centrality (Pelindo, 2021). The values of the aspects above are in Table 1. Figure 2 shows how these results are in NetworkX, and Figures 3 and 4 show the results in a graphical format, as rendered by NetworkX. Note that in Table 1, zero value means that the ports were not part of the prevailing sea routes (Directorate General of Sea Transport, 2016).

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Centrality

In [40]: degree centrality = nx.degree_centrality(G)
         betweenness centrality = nx.betweenness_centrality(G)
         closeness centrality = nx.closeness_centrality(G)

In [41]: ## Highest Degree Centrality
         >>> max(degree_centrality.items(), key=operator.itemgetter(1))

Out[41]: ('Bitung', 0.34782608695652173)

In [42]: ## Highest Betweenness Centrality
         >>> max(betweenness_centrality.items(), key=operator.itemgetter(1))

Out[42]: ('Bitung', 0.4051383399209486)

In [43]: ## Best Closeness Centrality
         >>> max(closeness_centrality.items(), key=operator.itemgetter(1))

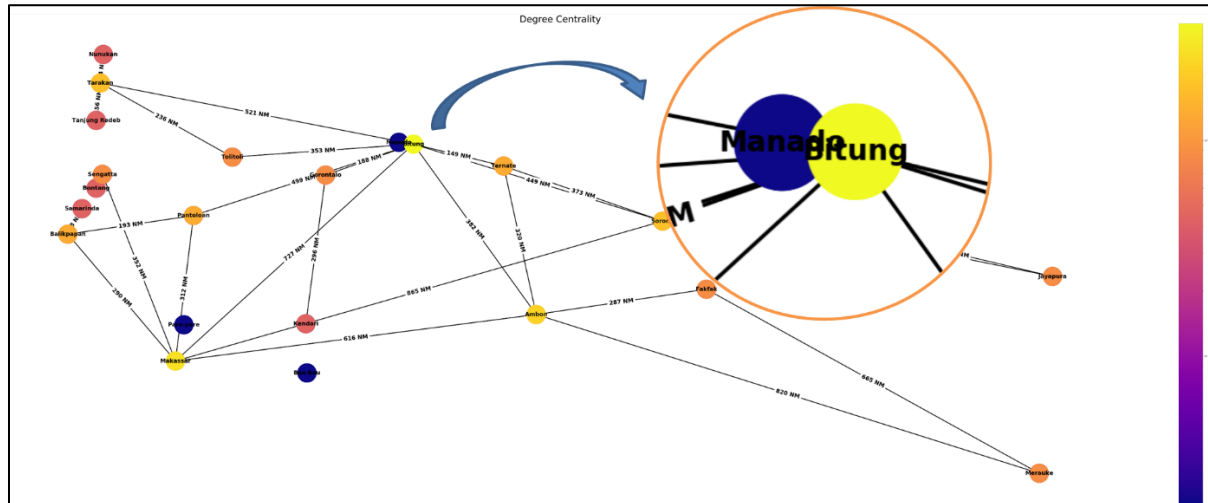
Out[43]: ('Bitung', 0.4830917874396135)

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Figure 2. Analysis Results in NetworkX

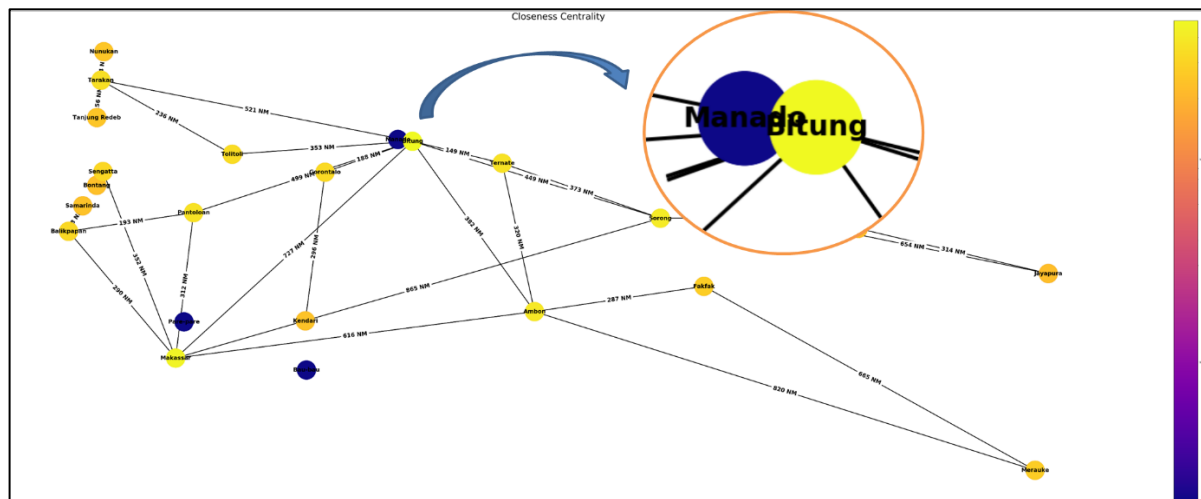
Table 1. Centrality calculations

No	Port	Degree Centrality	Closeness Centrality	Betweenness Centrality
1	Gorontalo	0.086956522	0.328137818	0.075098814
2	Makassar	0.260869565	0.445930881	0.260869565
3	Pare-pare	0	0	0
4	Kendari	0.043478261	0.241545894	0
5	Pantoloan	0.130434783	0.362318841	0.029644269
6	Tolitoli	0.086956522	0.334448161	0
7	Manado	0	0	0
8	Bitung	0.347826087	0.483091787	0.40513834
9	Bau-bau	0	0	0
10	Jayapura	0.086956522	0.228832952	0
11	Biak	0.086956522	0.228832952	0
12	Merauke	0.086956522	0.27605245	0
13	Balikpapan	0.130434783	0.316205534	0.075098814
14	Samarinda	0.043478261	0.235017626	0
15	Bontang	0.043478261	0.231884058	0
16	Sangatta	0.086956522	0.310559006	0.075098814
17	Ambon	0.217391304	0.38647343	0.148221344
18	Nunukan	0.043478261	0.252047889	0
19	Tarakan	0.173913043	0.347826087	0.146245059
20	Tanjung Redeb	0.043478261	0.252047889	0
21	Sorong	0.173913043	0.404448938	0.207509881
22	Manokwari	0.130434783	0.299850075	0.14229249
23	Fakfak	0.086956522	0.27605245	0
24	Ternate	0.130434783	0.362318841	0.015810277



Source: Analysis, 2021

Figure 3. Degree centrality



Source: Analysis, 2021

Figure 4. Betweenness centrality

Discussion

A previous study on the determination of hub ports for eastern Indonesia, which was conducted using the gravity method, produced different results: Sorong was chosen as a hub port (Pelindo, 2021). We argue that the use of the gravity method is more suitable for determining a hub port in developed area (many cargoes already available), as that method does take the number of available cargoes in ports into account.

The centrality method is compatible with the eastern Indonesian characteristic, where it considers the shortest shipping routes available in the network, without taking into account the available cargoes (suitable for developing regions). In other cases, similar studies have been performed using graph theory, which can be used to study changes in network structure (J.-P. Rodrigue, 2013).

The choice of a hub port always considers transshipment patterns as integrated parts as the key to the efficiency provided by container-based sea transportation (S. W. Lee, 2008). The primary reason for designating a port as a hub is to concentrate transported goods (in this case, containers) so that shipping companies can send larger ships and expect balanced inbound–outbound transportation to allow for reduced cost of shipping.

The benefits of making Bitung as the hub port for eastern Indonesian are twofold. First, it is nearer to other Indonesian hub ports (i.e., Surabaya, Tanjung Priok, and Belawan) than the other proposals (i.e., Sorong) (M. B. Zaman, 2015). Second, Bitung itself, from the data collected, can berth large container ships, making it ready for development as an eastern hub port. Thus, this recommendation is worth consideration by Indonesian maritime authorities.

4. Conclusions and Recommendations

The use of network analytics to determine hub ports, in this case, in Eastern Indonesia, assigns Bitung as the place of best hub port, as it obtains consistently high results for all three centrality indices. Other studies, using different approaches or adopting other algorithms, could present different results.

This article provides an alternative perspective concerning already published facts. In addition to that, since the eastern part of Indonesia still heavily relies on subsidized shipping lines, the so-called “*pelayaran perintis*”, we argue that determining Bitung as the hub port of the eastern part of Indonesia (which focuses on its relative distance from other ports), will help the government/ regulator to minimize the amount of subsidy for running “*pelayaran perintis*” in this region.

The determination of a port as a hub should not be determined based only on the results of mere algorithms. This study does show, however, the power of network analytics in the field of maritime logistics. Robust results can be obtained by taking other variables into account, such as (projected) trading volumes and investment cost.

Declarations

Author contribution

All authors contributed equally as the main contributor of this paper. All authors read and approved the final paper.

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Conflict of interest

The authors declare no conflict of interest.

Additional information

No additional information is available for this paper.

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