Transport model for implementing the national fish logistics system in Maluku

Risna Yusuf, Budi Wardono, Rismutia Hayu Deswati and Irwan Mulawan

Research Center for Marine and Fisheries Socio-Economics, Ministry of Marine Affairs and Fisheries, Jl. Pasir Putih, Ancol Timur Jakarta, Indonesia

E-mail: risnayusuf@gmail.com

Abstract. Maluku province, an archipelagic region with abundant fish resources, has been declared a National Fish Bank to ensure Indonesian national food security. To ensure the availability, affordability, and sustainability of fish supplies for national consumption and processing industries, it is therefore necessary to develop an effective and efficient National Fish Logistics System (known as SLIN) for the procurement, storage, transport, and distribution of fish products. This study aimed to develop an efficient fish transport model. Primary and secondary data were analysed by linear programming using the Transport model approach. The results show that the most efficient distribution costs for tuna and small pelagic fishes are IDR 612,922,192/distribution and IDR 467,668,438/distribution, respectively. Tuna landed in Ambon would be most efficiently distributed to Makassar, Surabaya, and Jakarta in volumes of 10,306 tonnes, 1,684 tonnes and 22,236 tonnes, respectively; whereas tuna landed in Tual would be most efficiently distributed to Makassar and Surabaya in volumes of 5,885 tonnes and 1,962 tonnes, respectively. All small pelagic fishes landed in Ambon would be most efficiently distributed to Jakarta in lots of 53,533 tonnes; all those landed in Dobo should be distributed Makassar in lots of 15,275 tonnes, and all those landed in Tual to Surabaya in lots of 14,572 tonnes. To increase distribution cost efficiency, the MLIN program transport model scenario suggests tuna and small pelagic fishes landed in Tual and Dobo should be distributed to Ambon before distribution to Jakarta, Surabaya, and Makassar. Collaboration between government and private sector actors is needed to support the MLIN program by optimizing the economic scale of fish processing plants in Maluku, providing fish carrier vessels in fishing zones and building proper cold storage and ice factories.

1. Introduction
Maluku Province as one of the provinces with archipelagic characteristics which historically, geographically, ally, has natural resource potential, and has abundant potential for fish resources needs to be designated as a National Fish Barn. The concept of MLIN itself is a sustainable fish production area, in developing superior commodities according to regional potential and becoming a center for providing services for goods and services as well as improving the quality and quality of the environment which is intended for the people's welfare as a dynamic form of food security policy and is the center of national fisheries economic growth [1,2]. One of the goals of establishing Maluku as the National Fish Barn is to ensure national food security. In realizing national food security, it is necessary to guarantee to meet the needs of both fish consumption in the community and the fish processing industry. Fulfillment of these needs can be obtained through the national fish logistics system, known as SLIN. In addition, SLIN is not only limited to how to provide physical facilities such as cold storage but is
related to all aspects from production to distribution such as determining supplies, selecting storage locations to aspects of transportation / distribution planning (Ministry of Marine Affairs and Fisheries [3]).

Fulfilment of fish consumption and fish processing industries requires guarantees for the procurement, storage, transportation and distribution of fish and fishery products, as well as materials and production tools through the National Fish Logistics System [4].

The National Fish Logistics System (SLIN) is a system for implementing production to distribution aspects that is integrated in planning, implementing, and monitoring the efficiency and effectiveness of fish flow and storage, finance, and documents (information) to meet user needs. SLIN as an integral part of the consequences of implementing Government Regulation no. 26 of 2012 concerning the Blueprint for the Development of the National Logistics System, where one of the main roles of the National Logistics System Blueprint is: (1) Providing direction and guidelines for the government and the business world to build an effective and efficient National Logistics System [5].

Related to efforts to build efficient and effective SLINs, transportation problems are very important in the distribution of products which are influenced by several factors including quality, consumer tastes and expansion of market access by opening alternative distribution channels and pay attention to how many allocations of product distribution to each market destination [6,7]. In addition, this transportation is an important supply chain driver, so it requires responsive transportation to centralize supplies and operate with limited facilities [8]. Transportation must be carried out in an integrated manner by ensuring the smooth running of commodities in an effective and efficient manner which is reflected in low, timely logistics costs and improving facilities and infrastructure[9,10], so that supply balance fish from the source of supply to the destination area is achieved and the price of fish can be well controlled [11].

Therefore, this research was conducted to analyse an efficient transportation model to support the Maluku program as a National Fish Barn (MLIN). It is hoped that the results of this study can provide input to the government to encourage an increase in efficient transportation distribution from supply areas to destination areas that become industrial centres.

2. Method

2.1. Location of research
The research was conducted in Maluku, which is the location of the national fish barn program. The supply areas in this study are districts / cities in Maluku Province and the destination areas in this study are the main destinations for the domestic market. Selected commodities are pelagic fish species, including tuna and small pelagic.

2.2. Type and sources of data
This research uses primary data and secondary data. Secondary data collected are data related to the amount of tuna and small pelagic production, and supply needs, while the primary data includes data on the distribution costs of tuna and small pelagic which are issued in the port of origin to the port of destination.

2.3. Data analysis method
The data analysis method used is linear programming analysis with a transportation method approach. In general, transportation methods relate to the distribution of a product to several destinations at minimum transportation costs, because only one item, a destination by fulfilling its demand from one or more sources [12]. Constraints in transportation problems, namely the number of goods available at each location of limited supply and these goods are needed at each location of demand [13]. The general objective in this method is to minimize the cost of sending goods from several locations of origin to several destination locations [14]. This transportation method is used to regulate the distribution of
goods from the supply area to the demand area optimally at the lowest cost. This method can be described in the form of a Linear Program problem model [15].

The linear programming method in this transportation method is a technique used to calculate the most optimal cost. Because of the typical form of transportation problems, it can be placed in a special tabular form called the transportation table [16]. The transportation model where this model is a form of a mathematical model that can help us to think quickly and systematically about the case with the basic assumption that the cost of transport on a certain route is proportional to the number of units sent [17]. In this study, the analytical tool used in this transportation method is a solution program that contains commands that function to analyze the optimization problem [18].

3. Result and discussion

3.1. Exiting condition of tuna fish distribution
The existing condition of tuna can be explained both in terms of the volume of tuna from the port of origin as a source of supply as well as the distribution cost incurred and then the tuna distributed to the port of destination which is used as industrial raw material (Table 1).

| Port of Origin | Port of Destination | Cost IDR/Kg | Other Port of Destination |
|----------------|---------------------|-------------|--------------------------|
|                | Makassar | Surabaya   | Jakarta     | Other Port of Destination |
| Ambon          | 0.00     | 1714.89    | 2,142.26   | 30,369                   |
| Tual           | 32.32    | 1385.58    | 1043.11    | 5,386                    |
| Other Port of Origin | 71042.68 | 55429.53   | 73934.63   | 0.00                     |

Source: Data from various sources is processed, 2021

The data above showed the existing condition of the distribution of tuna from ports of origin (Ambon, Tual) to the port of destination for tuna distribution (Makassar, Surabaya, Jakarta). In Table 2, overall, the largest production of tuna comes from Ambon with a total supply in lots of 34,226 tonnes compared to Tual as the ports of origin. In detail, tuna fish from Ambon distributed to Surabaya (1714.89 tonnes), and Jakarta (2,142.26 tonnes). Tuna fish from Tual distributed to Makassar in lots of 32.32 tonnes, Surabaya in lots of 1385.58 tonnes and Jakarta in lots of 1043.11 tonnes.

3.2. Existing conditions of tuna fish distribution costs in Maluku Province

| Port of Origin | Cost IDR/Kg | Other port of destination |
|----------------|-------------|--------------------------|
|                | Makassar    | Surabaya    | Jakarta    | Other port of destination |
| Ambon          | 2,769       | 1,923       | 2,769      | 2,487                    |
| Tual           | 2,779       | 1,933       | 2,779      | 2,497                    |
| Other port of Origin | 2,774   | 1,928       | 2,774      | 2,492                    |

Source: interview result, 2021

Based on Table 2, the distribution costs of tuna from ports of origins (Ambon and Tual) to the ports of destination (Makassar, Surabaya, and Jakarta) with details, namely the distribution cost from Ambon to Makassar, Surabaya and Jakarta, which are respectively IDR 2,769, IDR 1,923 and IDR
2,769. Distribution cost from Tual to Makassar, Surabaya, and Jakarta are IDR 2,779, 1,933, and 2,779. In addition, the existing condition of distribution cost of tuna showed that the distribution costs of tuna from Ambon to Makassar and Jakarta are higher than the distribution costs of tuna to Surabaya. Furthermore, the distribution costs for tuna from Tual to Makassar and Jakarta are higher than the distribution costs to Surabaya.

**Table 3.** Calculated distribution cost according to port of origin to destination port using program solver minimum total cost IDR 612,922,192

| Port of Origin | Port of Destination | Supply (tonnes) |
|----------------|---------------------|----------------|
|                | Makassar            | Surabaya       | Jakarta | Other Port of Destination |
| Ambon          | 10,306              | 1,684          | 22,236  | 0                      | 34,226 |
| Tual           | 5,885               | 1,962          | 0       | 0                      | 7,847  |
| Other Port of Origin | 54,884          | 54,884         | 54,884  | 35,755                 | 200,407|
| Demand         | 71,075              | 58,530         | 77,120  | 35,755                 | 242,480|

Source: Processed Data, 2021

Based on the results of calculations using the solver program (Table 3), it is found that the total of distribution cost of tuna from Ambon and Tual as ports of origin to the ports of destination (Makassar, Surabaya, and Jakarta) are IDR 612,922,192, with details of the distribution cost of tuna from Ambon distributed to Makassar in lots of 10,306 tonnes, to Surabaya in lots of 1,684 tonnes and Jakarta in lots of 22,236 tonnes, Tual distributed to Makassar in lots of 5,885 tonnes, to Surabaya in lots of 1,962 tonnes.

3.3. Efficiency of tuna logistic pathways

The efficiency of the tuna logistics is explained in terms of volume and distribution costs of Tuna from port of origin as a source of supply, as explained below.

![Figure 1. Efficiency of tuna logistic pathways in Maluku Province](image-url)
3.4. Existing conditions distribution of small pelagic in Maluku Province

The existing condition of small pelagic can be explained not only the volume of small pelagic from port of origin as a source of supply but also the distribution costs incurred and then small pelagic distributed to port of destination which are used as industrial raw materials (Table 4).

| Port of Origin | Port of Destination |
|----------------|---------------------|
|                | Makassar | Surabaya | Jakarta | Other Port of Destination |
| Ambon          |          | 0        | 1,404   | 4,571   | 47,558 |
| Dobo           | 0        | 11,217   | 11,007  | 29,223  |
| Tual           | 3        | 524      | 3,993   | 10,053  |
| Other Port of Origin | 15,272 | 42,475  | 38,649  | 0       |

Source: Data from various sources is processed, 2021

The data showed that distribution of small pelagic from ports of origin (Ambon, DoBo, Tual) to the ports of destination (Makassar, Surabaya Jakarta). In Table 4, overall, the largest production of small pelagic is from Ambon with a total supply of 53,533 tonnes compared to the other ports of origin (Dobo, Tual) namely from Dobo in lots of 51,447 tonnes, Tual in lots of 14,572 tonnes. In detail, small pelagic from Ambon distributed to Surabaya (1,404 tonnes) and Jakarta (4,571 tonnes). Small pelagic from Dobo distributed to Surabaya in lots of 11,217 tonnes, Jakarta in lots of 11,007 tonnes. Small pelagic from Tual distributed to Makassar in lots of 3 tonnes, Surabaya in lots of 525 tonnes, and Jakarta in lots of 3,993 tonnes.

| Port of Origin | Port of Destination |
|----------------|---------------------|
|                | Makassar | Surabaya | Jakarta | Other Port of Destination |
| Ambon          |          |          | 2,250   | 2,250   | 2,021 |
| Dobo           | 2,283    | 2,423    | 3,000   | 2,569   |
| Tual           | 2,260    | 1,438    | 2,469   | 2,055   |
| Other Port of Origin | 2,264 | 1,808   | 2,573   | 2,215   |

Based on Table 5, the distribution costs of small pelagic from 3 (three) regions as ports of origin namely Ambon, DoBo, Tual to destination areas, namely Makassar, Surabaya and Jakarta with details, namely distribution costs from Ambon to Makassar, Surabaya and Jakarta, namely -Each of IDR 2,250/kg, IDR 1,563/kg, IDR 2,250/kg. It showed that the distribution costs of small pelagic from Ambon to Surabaya are cheaper than to Makassar and Jakarta. The distribution costs for small pelagic from DoBo to Makassar are cheaper (IDR 2,283/kg) compared to the ports of destination (Surabaya and Jakarta), which are IDR 2,423/kg and IDR 3,000/kg, respectively. Distribution cost of small pelagic from Tual to Makassar are IDR 2,260/kg, Surabaya IDR 1,438/kg and to Jakarta IDR 2,469/kg.
### Table 6. Calculated distribution cost of small pelagic from port of origin to destination port using program solver minimum total cost 467,668,438, -

| Port of Origin | Port of Destination | Supply (tonnes) |
|----------------|---------------------|-----------------|
|                | Makassar            | Surabaya        | Jakarta | Other Port of Destination |
| Ambon          | 0                   | 0               | 53,533  | 0                        | 53,533          |
| Dobo           | 15,275              | 0               | 0       | 36,172                   | 51,447          |
| Tual           | 0                   | 14,572          | 0       | 0                        | 14,572          |
| Other Port of Origin | 15,275              | 55,620          | 58,220  | 50,661                   | 96,396          |
| Demand         | 15,275              | 55,620          | 58,220  | 86,833                   | 215,948         |

Source: Processed Data, 2021

Based on the results of calculation using the solver program (Table 6), it is found that the total of distribution cost of small pelagic from Ambon, Dobo and Tual as a port of origin to the ports destination (Makassar, Surabaya and Jakarta) are IDR. 467,668,438,— with the distribution details are small pelagic from Ambon distributed to Jakarta in lots of 53,533 tonnes, Dobo to Makassar in lots of 15,275 tonnes, and Tual to Surabaya in lots of 14,572 tonnes.

#### 3.5. Efficiency of small pelagic logistic pathways

The efficiency of the small pelagic logistics is explained in terms of volume and distribution costs from port of origin, as explained below.

![Diagram](image-url)

**Figure 2.** Efficiency of small pelagic fish logistics in Maluku Province
3.6. Scenario of transportation model in implementation of MLIN program

The scenario of transportation model to support the Maluku program as a National Fish Barn (MLIN). The scenario of it is that all types of fish, such as tuna and small pelagic from ports of origin (Dobo and Tual) must distribute to Ambon.

The implementation of Maluku program as a National Fish Barn (MLIN) needs an efficient fish transportation scenario for both tuna and small pelagic to support the program, where both tuna and small pelagic from ports of origin must distribute to Ambon to support the MLIN program as described in the figure below.

The figure below is a scenario for the tuna transportation model in supporting the MLIN program.

3.7. Tuna

![Figure 3. Scenario of tuna transportation model to support the MLIN Program](image)

The figure above is a model scenario for tuna transportation to support the MLIN program. So, tuna fish from Dobo as a port of origin distributed to Ambon in lots 51,447 tonnes with a distribution cost of IDR 3,874 thousand /tonnes, while tuna fish from Tual distributed to Ambon in lots of 7,847 tonnes with a distribution cost are IDR 2,906 thousand / tonnes.

3.8. Small pelagic

![Figure 4. Scenario of small pelagic transportation model to support the MLIN program](image)

The figure above is a model scenario of small pelagic transportation to support the MLIN program. So, the small pelagic from Tual as a port of origin distributed to Ambon in lots of 14,572 tonnes / IDR 2,156 thousand / tonnes.
4. Conclusion
Based on the research results, it showed that transportation has an important role in the national fish logistics system. So that it can support the Maluku program as a national fish barn. With the existence of a fish transportation model scenario (tuna and small pelagic) to support the MLIN program, the transportation of both tuna and small pelagic will be more efficient distributed to Ambon as the destination. Although distribution cost of Tuna and Small Pelagic is more efficient to Ambon compared to the other port destinations (Makassar, Surabaya, and Jakarta), but distribution cost to Ambon is still relatively higher than other port of destinations. Therefore, to support the MLIN program, it is necessary to support the government to get transportation cost is more efficient such as optimizing the capacity of UPIs in Maluku Province (especially Ambon), providing fishing vessels in fishing areas in districts / cities so that distribution costs are more efficient, and also providing supporting infrastructure at fishing locations in regencies / cities such as cold storage so that the quality of the fish is maintained.

References
[1] Suryawati S H and Tajerin T 2015 Penilaian Kesiapan Maluku Sebagai Lumbung Ikan Nasional J. Sos. Ekon. Kelaut. dan Perikan. 10 1–19
[2] Hikmayani Y and Suryawati S H 2016 Evaluasi kesiapan Kota Ambon dalam mendukung Maluku sebagai lumbung ikan nasional J. Kebijak. Sos. Ekon. Kelaut. dan Perikan. 6 97–110
[3] Kementerian Kelautan dan Perikanan 2013 Sistem Logistik Ikan Nasional Mulai di Garap Kementeri. Kelaut. dan Perikan.
[4] Peraturan Menteri Kelautan dan Perikanan (PERMEN-KP) 2014 Peraturan Menteri Kelautan dan Perikanan Republik Indonesia Nomor 5/ Permen-KP/2014 tentang Sistem Logistik Ikan Nasional (Indonesia)
[5] Nurshiidiq R S E, Anwar A and Benning B 2014 Tata Perdagangan Perikanan Indonesia Melalui Introduksi Standar Internasional Seafood Ecolabeling Pekan Ilmiah Mahasiswa Nasional Program Kreativitas Mahasiswa-Gagasen Tertulis 2014 (Indonesian Ministry of Research, Technology and Higher Education)
[6] Luhur E S and Yusuf R 2017 Analisis rantai nilai ikan cakalang di Kota Ambon, Maluku J. Sos. Ekon. Kelaut. dan Perikan. 12 93–105
[7] Riniwati H, Wati L A, Waluyo E, Wardani M P and Sofiati D 2020 Optimization Model Of Marketing Distribution Fish Processed Products By Transportation Method Model Optimasi Distribusi Pemasaran Produk Olahan Ikan Lele Dengan Metode Transportasi J. Econ. Soc. Fish. Mar. 8 68–81
[8] Chopra S, Meindl P and Kafr D V 2013 Supply chain management: Strategy, planning, and operation vol 232 (USA: Pearson Boston, MA)
[9] Yusuf R, Rosyidah L, Zamroni A and Apriliani T 2020 Rantai Pasok Dan Sistem Logistik Udang Vaname Di Kabupaten Pinrang, Provinsi Sulawesi Selatan Bul. Ilm. Mar. Sos. Ekon. Kelaut. dan Perikan. 6 25–35
[10] Rosyidah L, Yusuf R and Deswati R H 2020 Sistem Distribusi Udang Vaname Di Kabupaten Banyuwangi, Provinsi Jawa Timur Bul. Ilm. Mar. Sos. Ekon. Kelaut. dan Perikan. 6 51–60
[11] Yusuf R and Hikmayani Y 2017 Minimalisasi Biaya Distribusi Industri Pengolahan Produk Perikanan: Aplikasi Transportasi Program Solver J. Sos. Ekon. Kelaut. dan Perikan. 12 151–62
[12] Mulyono S 2002 Riset Operasi (Jakarta: Lembaga Penerbit Fakultas Ekonomi Universitas Indonesia)
[13] Suryaningtyas W 2009 Riset Operasi (Surabaya: Fakultas Keguruan dan Ilmu Pendidikan Universitas Muhammadiyah)
[14] Aribowo A S 2015 Visualisasi Teori Optimalisasi Biaya Transportasi Untuk Pembelajaran Riset Operasi Seminar Nasional Informatika (SEMNASIF) vol 1
[15] Asri M, Subagyo P and Handoko H 2000 Dasar-Dasar Operations Research (Yogyakarta: BPFE)
[16] Rosta J and Tannady H 2012 Pendistribusian produk yang optimal dengan metode transportasi J.
[17] Subardi A 1992 Metode Modified Distribution Dalam Operations Research *J. dan Pros. Manaj. dan Usahaw.* 21 2–7

[18] Dwijanto 2008 *Program Linear Berbantuan Komputer: Lindo, Lingo dan Solver* (Semarang: Universitas Negeri Semarang Press)