Distribution of Soap X in East Java Region with Bhumal Method and Traveling Salesman Problem

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ABSTRAK

Proses pendistribusian produk merupakan suatu upaya produsen untuk menyalurkan produknya kepada konsumen dengan sistem yang telah terdaftar dan terprogram. Pendistribusian produk kepada konsumen harus dilakukan secara cermat dan hati-hati. Sebab hal tersebut dapat menjadi salah satu kendala bagi perusahaan dalam memenangkan persaingan dengan perusahaan lain apabila kecepatan pendistribusiannya tidak tinggi. Cepat atau lambatnya pendistribusian produk kepada konsumen salah satunya bergantung pada kedekatan antara gudang penyalur dengan pasar (konsumen). Tujuan dari penyajian dan analisis data ini adalah untuk lebih memahami bagaimana cara membuat data, menganalisis, dan membuat simpulan yang dapat menentukan suatu keputusan terhadap suatu proses logistik secara umum dan produk sabun batangan dengan optimasi biaya transportasi menggunakan metode bhumal dan Traveling Salesman Problem.

Kata kunci: Logistik; Metode Bhumal; Penjadwalan

ABSTRACT

The product distribution process is an effort by producers to deliver their products to consumers with a registered and programmed system. Product distribution to consumers must be handled carefully and carefully. Because this can be one of the obstacles for companies in winning competition with other companies if the distribution speed is not high. The speed or slowness of product distribution to consumers, one of which depends on the proximity between the dealer's warehouse and the market (consumers). The purpose of this data presentation and analysis is to better understand how to make data, analyse, and make conclusions that can determine a decision on a logistics process in general and bar soap products with transportation cost optimisation using the bhumal method and Traveling Salesman Problem.

Keywords: *Logistics; Method Bhumal; Scheduling*

INTRODUCTION

Distribution of soap, a seemingly mundane process, encompasses a sophisticated and multifaceted network involving manufacturing, logistics, marketing, and sales. This process begins at the manufacturing facilities where raw materials are transformed into finished soap products through a series of chemical reactions and mechanical processes. Once production is complete, the soaps are packaged and prepared for distribution. The journey from the factory to the consumer's hands is a complex orchestration of activities requiring precision and efficiency to ensure that the product maintains its quality and integrity [1].

Logistics play a critical role in the distribution of soap. This involves the coordination of transportation, warehousing, and inventory management. Efficient logistics ensure that the soap is delivered from the manufacturer to various distribution centers, retailers, and ultimately to consumers [2]. Advanced logistics systems utilize sophisticated software and technology to track shipments, manage inventory levels, and optimize routes for delivery trucks. This not only reduces costs but also minimizes the environmental impact by reducing fuel consumption and emissions.

Marketing strategies are also crucial in the distribution of soap. Companies invest heavily in advertising and promotional activities to create brand awareness and drive consumer demand [3]. This includes traditional marketing channels such as television and print advertisements, as well as digital marketing strategies like social media campaigns and influencer partnerships [4]. Effective marketing ensures that consumers are aware of the soap brands available in the market and are persuaded to purchase them. Additionally, packaging design and product placement in stores are key elements that influence consumer purchasing decisions [5].

Sales channels for soap distribution can vary widely, including supermarkets, convenience stores, online platforms, and specialty shops. Each of these channels has unique characteristics and requires different approaches for effective distribution [6]. For instance, supermarkets may demand large volumes of product with specific shelf placement requirements, while online platforms require efficient order fulfillment and delivery systems. Understanding the nuances of each sales channel is essential for companies to successfully distribute their soap products and meet consumer demand [7].

Finally, the distribution of soap is influenced by regulatory and environmental considerations. Manufacturers and distributors must adhere to regulations governing product safety, labeling, and environmental impact. This includes compliance with local and international standards for ingredients, packaging, and waste disposal. Sustainable practices are increasingly important as consumers become more environmentally conscious. Companies are adopting eco-friendly packaging, reducing plastic use, and implementing recycling programs to minimize their environmental footprint. Balancing these regulatory and environmental factors with the need for efficient and cost-effective distribution is a complex but necessary aspect of the soap distribution process [8].

To determine efficient and effective distribution methods in the distribution process, it is essential to conduct a comprehensive analysis of various logistical factors [9]. This begins with assessing the current distribution network, including transportation routes, warehousing locations, and inventory management practices. By employing advanced analytical tools such as Geographic Information Systems (GIS) and supply chain modeling software, businesses can identify bottlenecks, optimize delivery routes, and strategically position warehouses to minimize transit times and costs. Additionally, leveraging data analytics to predict demand patterns allows for more accurate inventory forecasting, reducing the risk of overstocking or stockouts, thereby enhancing overall efficiency [10], [11].

Equally crucial is the integration of modern technology and automation in distribution processes. Implementing technologies such as Radio Frequency Identification (RFID) for real-time tracking, automated storage and retrieval systems (AS/RS), and advanced robotics for order fulfillment can significantly streamline operations. [12], [13] These technologies not only improve accuracy and speed but also reduce labor costs and minimize human error. Furthermore, adopting a multi-channel distribution strategy that encompasses both traditional retail and e-commerce platforms ensures a broader market reach and meets diverse consumer preferences. Regular performance monitoring through key performance indicators (KPIs) such as delivery lead times, order accuracy rates, and customer satisfaction levels is imperative for continuous improvement and maintaining an effective distribution network.

METHOD

Bhumal Method

The Bhumal Method, as depicted in the image, appears to be a specialized approach or framework used within a specific context, likely within the fields of logistics, distribution, or a related area. While the exact details of the method are not discernible from the image alone, such methods typically encompass a structured set of principles or steps designed to optimize certain processes. For instance, in logistics and distribution, a method like this might focus on streamlining supply chain operations, enhancing efficiency, and reducing costs through systematic analysis and strategic planning[8].

To fully understand and implement the Bhumal Method, one would need to delve into its specific components and steps, which could involve various analytical techniques, optimization models, and best practices tailored to the particular industry or application it addresses. These might include aspects such as demand forecasting, inventory management, transportation logistics, and performance metrics. By adhering to the structured guidelines of the Bhumal Method, organizations can achieve more efficient and effective distribution strategies, ultimately leading to improved operational performance and competitive advantage in their respective markets.

The Traveling Salesman Problem (TSP)

The Traveling Salesman Problem (TSP) is a classic optimization problem in the field of combinatorial optimization and operations research. It involves finding the shortest possible route for a salesman to visit a given set of cities exactly once and return to the starting city. Despite its seemingly straightforward premise, TSP is notoriously complex because the number of possible routes increases factorially with the number of cities, making it computationally challenging to solve as the problem size grows. The TSP is classified as an NP-hard problem, meaning that no efficient solution algorithm is known that can solve all instances of the problem optimally in polynomial time.

Solutions to the TSP have significant practical implications in various domains such as logistics, manufacturing, and transportation planning. Heuristic and approximation algorithms, such as the nearest neighbor, genetic algorithms, and simulated annealing, are often employed to find near-optimal solutions within a reasonable timeframe. Exact methods like branch and bound, dynamic programming, and integer linear programming can provide optimal solutions for smaller instances. Advances in computational techniques and increased computational power continue to push the boundaries of what can be solved in practical scenarios, but the TSP remains a benchmark problem for testing new optimization algorithms and methodologies in applied mathematics and computer science.

RESULT AND DISCUSSION

Retail location

Table 1. Retail locations

No	Retail locations	Demand Retail
1	Blitar City	274.889
2	Blitar Regency	26.102
3	Kediri Regency	333.490
4	Kediri City	37.809
5	Malang Regency	756.889
6	Malang City	127.077
7	Lumajang Regency	217.980
8	Probolinggo City	256.049
9	Probolinggo Regency	9.807
10	Pasuruan City	325.206
11	Pasuruan Regency	12.807
12	Sidoarjo Regency	718.960
13	Mojokerto City	182.643
14	Mojokerto Regency	5.417
15	Jombang Regency	255.718
16	Nganjuk Regency	191.122
17	Madiun City	61.211
18	Madiun Regency	6.044
19	Ngawi Regency	79.325
20	Lamongan Regency	416.082
21	Gresik Regency	242.037
22	Surabaya City	839.172

Warehouse locations

Table 2. Warehouse locations

No	Warehouse locations	Address
1	Probolinggo City	Anggrek No.11, Pilang, Kec. Kademangan, Kota Probolinggo, Jawa Timur 67221
2	Sidoarjo Regency	Lingkar Timur No.4, Prasungtani, Prasung, Kec. Buduran, Kabupaten Sidoarjo, Jawa Timur 61252
3	Kediri City	Kertosono-Kediri No.134, Putih, Gampengrejo, Kediri Regency, East Java 64182
4	Madiun City	Basuki Rahmad No.91, Tawangrejo, Kec. Kartoharjo, Kota Madiun, Jawa Timur 63123

Shipping Cost

For delivery to Retail, Colt Diesel Double (CDD) is a small capacity truck with six tyres. Four rear tyres and two front tyres with a maximum capacity of four tonnes. CDD trucks are a type of delivery truck that is divided into several types, namely: CDD box standard is up to four metres long with a width and height of up to two metres. The carrying capacity of the CDD Box Standard truck itself is up to 4 tonnes. This CDD Box Standard truck also has a protective box made of aluminium with a volume of 16 cbm. The rental price is IDR 3,000,000 for a distance of 359 km or IDR 8,400/km.

Table 3. Distance warehouse to retail

Retail	1	2	3	4	5	6	7	8	9	10	11
Total Requirement (1=96 pcs)	2863	272	3474	394	7884	1324	2271	2667	102	3388	133
Shipping Cost	Rp8.400	Rp8.400	Rp8.400	Rp8.400	Rp8.400	Rp8.400	Rp8.400	Rp8.400	Rp8.400	Rp8.400	Rp8.400
Distance WH1	168,0	156,0	159,0	179,0	101,0	92,0	51,0	3,2	5,0	35,0	38,0
Distance WH2	145,0	144,0	120,0	114	93,0	79,0	130,0	83,0	82,0	84,0	45,0
Distance WH3	51,0	45,0	29,0	7,6	105,0	106,0	214,0	167,0	166,0	168,0	129,0
Distance WH4	125,0	111,0	103,0	81	178,0	171,0	261,0	215,0	213,0	216,0	176,0

Retail	12	13	14	15	16	17	18	19	20	21	22
Total Requirement (1=96 pcs)	7489	1903	56	2664	1991	638	63	826	4334	2521	8741
Shipping Cost	Rp8.400	Rp8.400	Rp8.400	Rp8.400	Rp8.400	Rp8.400	Rp8.400	Rp8.400	Rp8.400	Rp8.400	Rp8.400
Distance WH1	79,0	100,0	100,0	125,0	169,0	218,0	216,0	231,0	139,0	113,0	92,0
Distance WH2	5,0	39	45,0	71,0	113,0	163,0	160,0	175,0	63,0	37,0	16,0
Distance WH3	109,0	69	66,0	42,0	35,0	82,0	80,0	95,0	106,0	125,0	115,0
Distance WH4	156,0	120	113,0	89,0	45,0	6,0	4,1	32,0	150,0	169,0	162,0

Factory Transport Costs to Retail

Delivery of products to the Warehouse is planned using a Wingbox Truck. Dimensions of the box: Length: 950cm, Width: 235cm, Height: 235cm and Carrying capacity: 50 cubic meters. SMB Trans provides rental price starting from IDR 2,500,000 for Surabaya-Malang (24,000/km).

Table 4. Factory Transport Costs to Retail

Warehouse	1	2	3	4
Distance	90 km	15 km	113 km	161 km
Factory	Rp 108	Rp 18	Rp 135	Rp 193

Warehouse to Retail Transportation Cost

Table 5. Warehouse to Retail Transportation Cost

	1	2	3	4	5	6	7	8	9	10	11
WH 1	492,8	4819,5	384,5	3817,8	107,6	583,8	188,7	10,1	411,1	86,8	2392,7
WH 2	425,4	4448,8	290,2	2431,4	99,1	501,3	480,9	261,4	6742,6	208,3	2833,5
WH 3	149,6	1390,2	70,1	162,1	111,9	672,6	791,7	525,9	13649,7	416,6	8122,6
WH 4	366,7	3429,3	249,1	1727,6	189,6	1085,1	965,6	677,1	17514,4	535,6	11081,9

	12	13	14	15	16	17	18	19	20	21	22
WH 1	88,6	441,5	14887,7	394,2	713,1	2872,0	28820,0	2348,3	269,4	376,5	88,4
WH 2	5,6	172,2	6699,5	223,9	476,8	2147,4	21348,2	1779,0	122,1	123,3	15,4
WH 3	122,3	304,6	9825,9	132,4	147,7	1080,3	10674,1	965,7	205,4	416,5	110,5
WH 4	175,0	529,8	16823,1	280,7	189,9	79,0	547,0	325,3	290,7	563,1	155,7

Distribution Cost Optimisation Analysis Using the Traveling Salesman Problem Method

From the results of the bhumal method allocation, the number of warehouses that must be served by the factory and the number of retailers that each warehouse must serve by saving using the Traveling Salesman Problem method.

1. **Fuso Box**

   Delivery of products to the Warehouse is planned using a Wingbox Truck.
   Dimensions of the box:
   Length: 660 cm
   Width: 235 cm
   Height: 235 cm Carrying capacity: 12 tonnes
   Cardboard dimensions:
   Length: 34 cm --- 600 : 34 = 17,6
   Width: 17 cm --- 235 : 17 = 13,8
   Height: 15 cm --- 235 : 15 = 15,67
   1 Cardboard: 10.56 kg

Number of boxes that can be transported 3,315 boxes
Total transport capacity 3,315 x 10.56 = 35,005 kg (35 tonnes)
Because the capacity exceeds the carrying capacity, the number of boxes transported is 1136 boxes with a load of (11,996 kg / 12 tonnes).

2. Truck CDD Long
Delivery of products to the Warehouse is planned using a Wingbox Truck.
Dimensions of the box:
Length: 50 cm
Width: 200 cm
Height: 210 cm Carrying capacity: 5.2 tonnes
Cardboard dimensions:
Length: 34 cm --- 530 : 34 = 15,5
Width: 17 cm --- 200 : 17 = 11,7
Height: 15 cm --- 210 : 15 = 14
1 Cardboard: 10.56 kg
Number of boxes that can be transported 2310 boxes
Total transport capacity 2310 x 10.56 = 24,303.2 kg (23 tonnes)
Because the capacity exceeds the transport capacity, the number of boxes transported is 492 boxes with a load of (5,200 kg / 5.2 tonnes).

3. CDE Box
Delivery of products to the Warehouse is planned using a Wingbox Truck.
Dimensions of the box: Length: 320cm
Width: 170cm
Height: 170cm Carrying capacity: 2500
Pallet Dimensions:
Length: 34 cm --- 320 : 34 = 9,4
Width: 17 cm --- 170 : 17 = 10
Height: 15 cm --- 170 : 15 = 11,3
1 Cardboard: 10.56 kg
Total transport capacity 1,062 x 10.56 = 11,216 kg (12 tonnes)
Because the capacity exceeds the carrying capacity, the number of boxes transported is 236 boxes with a load of (2,492 kg / 2.4 tonnes).

CONCLUSION

In soap distribution, the Bhumal Method offers a structured framework to optimize supply chain efficiency by leveraging strategic planning and advanced analytical techniques for inventory management, demand forecasting, and transportation logistics. When integrated with the Traveling Salesman Problem (TSP), it further refines distribution by determining the most efficient delivery routes to minimize travel distance and time. The TSP, renowned for its complexity, addresses the challenge of visiting multiple locations in the shortest possible path, ensuring cost-effective and timely deliveries. Together, these methodologies enhance operational performance, reduce costs, and promote sustainability, thereby ensuring optimal product availability and superior customer satisfaction in the competitive soap market.

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