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OPTIMIZING SHIPPING COSTS AT DL CAKE AND BAKERY USING TRANSPORTATION METHODS

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Abstract

Distribution and transportation costs are key components of operational expenses that significantly affect business efficiency and competitiveness, particularly for small and medium enterprises (SMEs) in the food sector. This study aims to analyze and optimize distribution costs at DL Cake and Bakery using a transportation model. The methods employed include the North West Corner (NWC), Least Cost (LC), and Vogel's Approximation Method (VAM) as initial solutions, as well as the Stepping Stone method for optimality testing. Research data were obtained through interviews and direct observations related to shipping costs, inventory capacity, and demand at distribution branches. The results indicate that the distribution problem at DL Cake and Bakery is a balanced transportation problem, with total supply and demand each amounting to 600 units. The NWC and VAM methods produce a total distribution cost of IDR 18,800,000, while the LC method results in a higher cost of IDR 19,650,000. Optimality testing using the Stepping Stone method shows that all opportunity cost values are positive, indicating that the obtained solution is optimal. Therefore, the minimum distribution cost for DL Cake and Bakery is IDR 18,800,000. The findings of this study are expected to serve as a reference for SMEs in implementing transportation methods to improve distribution cost efficiency.

Keywords: *North West corner (NWC) Method; Least Cost (LC); Vogel Approximation Method (VAM); Stepping Stone Method; Optimization; DL Cake end Bakery*

Abstrak

Biaya distribusi dan transportasi merupakan komponen kunci dari pengeluaran operasional yang secara signifikan memengaruhi efisiensi dan daya saing bisnis, khususnya untuk usaha kecil dan menengah (UKM) di sektor pangan. Studi ini bertujuan untuk menganalisis dan mengoptimalkan biaya distribusi di DL Cake and Bakery menggunakan model transportasi. Metode yang digunakan meliputi North West Corner (NWC), Least Cost (LC), dan Vogel's Approximation Method (VAM) sebagai solusi awal, serta metode Stepping Stone untuk pengujian optimalitas. Data penelitian diperoleh melalui wawancara dan observasi langsung terkait biaya pengiriman, kapasitas persediaan, dan permintaan di cabang distribusi. Hasil penelitian menunjukkan bahwa masalah distribusi di DL Cake and Bakery merupakan masalah transportasi seimbang, dengan total pasokan dan permintaan masing-masing sebesar 600 unit. Metode NWC dan VAM menghasilkan total biaya distribusi sebesar Rp 18.800.000, sedangkan metode LC menghasilkan biaya yang lebih tinggi yaitu Rp 19.650.000. Pengujian optimalitas menggunakan metode Stepping Stone menunjukkan bahwa semua nilai biaya peluang bernilai positif, yang mengindikasikan bahwa solusi yang diperoleh adalah optimal. Oleh karena itu, biaya distribusi minimum untuk DL Cake and Bakery adalah Rp 18.800.000.

Temuan penelitian ini diharapkan dapat menjadi referensi bagi UKM dalam menerapkan metode transportasi untuk meningkatkan efisiensi biaya distribusi.
Kata kunci: Metode Sudut Barat Laut (NWC); Biaya Terendah (LC); Metode Aproksimasi Vogel (VAM); Metode Stepping Stone; Optimasi; DL Cake and Bakery

I. INTRODUCTION

The increasingly dynamic and competitive global economy is driving companies across various sectors to improve operational efficiency to maintain business continuity. Globalization of trade, advances in logistics technology, and changes in consumer behavior require companies to optimally manage costs, particularly distribution and transportation costs. High logistics costs can reduce a company's competitiveness, particularly in sectors that rely on direct product distribution to consumers.

Nationally, the growth of small and medium enterprises (SMEs) in Indonesia has shown significant growth, including in the food and beverage industry. Nevertheless, many SMEs still face challenges in managing operational costs, particularly product delivery costs. Unsystematically planned transportation costs can reduce operational efficiency and business profitability. Therefore, a managerial approach supported by quantitative methods is needed to help companies optimize distribution costs effectively and measurably.

DL Cake and Bakery is a business engaged in the production and distribution of cakes and bread, delivering to several branches and customers in the Tangerang area. The perishable nature of bakery products and the demands for tight delivery times make transportation costs a significant component of operational costs. In practice, the company uses its own transportation fleet, but has not implemented a structured distribution method to determine shipping patterns with minimum costs. This situation creates the potential for wasteful shipping costs, which can impact the company's financial performance.

Operational costs are costs incurred by a company routinely to support daily operational activities, including distribution and transportation costs (Ramadhan and Narimawati, 2018).

In operations research, the transportation problem is an optimization model that aims to determine the distribution pattern of goods from several sources to several destinations at minimum cost. The application of transportation methods is one quantitative solution widely used in distribution decision-making.

It states that the application of transportation methods can provide optimal solutions for distributing goods by considering supply and demand capacity. (Saragih et al., 2022)

The results of this study indicate that the use of transportation methods can significantly reduce distribution costs. Consistently, it was found that transportation models are more efficient than conventional methods in determining distribution patterns. (Irwana Arofah 2021)

The combination of Vogel's Approximation Method (VAM) as an initial solution and the Stepping Stone method as an optimality test tool resulted in the lowest distribution costs compared to the North West Corner and Least Cost methods. (Dimasuharto, Subagyo, and Fitriani 2021)

Transportation cost problems commonly occur in companies with multiple distribution destinations, so selecting the right transportation method plays a crucial role in minimizing shipping costs (Shindy Widya Astuti 2024)

Transportation problems are typically related to the distribution of goods and services from various production centers to multiple sales locations or consumers. The sample is data on rice shipping costs from Rice Distributor X in Karawang Regency. The sample was then processed using the North West Corner (NWC) transportation method and Lingo software to determine how to minimize costs for each shipment. Goods distribution is closely related to adequate transportation activities. One solution to linear programming in goods distribution is to use transportation methods to ensure effective distribution with minimal cost allocation (Safari, Ceffi, and Suprapto 2020).

Several empirical studies on SMEs and manufacturing companies have shown that implementing transportation methods has a positive impact on distribution cost efficiency. Research on the Rajawali Glass and Aluminum SME showed that the use of VAM and Stepping Stone resulted in the lowest distribution costs compared to other methods (Dimasaharto, Subagyo, and Fitriani 2021).

Similar findings were also obtained in research on the distribution of drinking water and other consumer goods, which experienced cost reductions after implementing transportation models (Wahyuni and Astuti 2025).

Although extensive research on transportation methods has been conducted, most studies focus on large-scale manufacturing companies or specific industrial sectors. Research

specifically addressing shipping cost optimization in bakeries or small- and medium-sized food industries is relatively limited. Furthermore, few studies have comprehensively compared the North West Corner, Least Cost, and Vogel's Approximation Methods as initial solutions, along with the Stepping Stone method as an optimal solution within a single research area. Therefore, this study aims to fill this research gap.

Based on this description, this study aims to analyze shipping costs at DL Cake and Bakery, applying the North West Corner, Least Cost, and Vogel's Approximation Methods as initial distribution solutions, and using the Stepping Stone method to obtain the most optimal distribution solution. This research is expected to provide theoretical contributions to the development of operations research and logistics management literature, particularly in the SME food sector, as well as provide practical contributions as considerations for DL Cake and Bakery's management in making more efficient distribution decisions.

The problem formulation in this study includes the current shipping cost conditions applied by DL Cake and Bakery, the application of transportation methods in determining the initial solution for shipping costs, the use of the Stepping Stone method as an optimality test tool, and the determination of transportation methods that produce the most efficient shipping costs.

II. THEORITICAL STUDIES

Transportation Method Theory

The transportation method is a method used to optimally manage distribution from sources that provide the same product to locations where it is needed (Fahrudin 2023).

The transportation method is a way to solve distribution problems using linear programming. The goal is to determine the best delivery system from multiple sources to multiple destinations so that transportation costs can be minimized (Iswanto and Akbar 2021).

North West Corner (NWC) Method Theory

The North West Corner (NWC) method is one of the initial methods in transportation models used to obtain an initial feasible solution. The North West Corner method is a simple technique that determines distribution allocation starting from the upper left corner (northwest) of the transportation table without considering shipping costs, but only considering the balance between supply and demand. (Handy A Taha 2017)

Least Cost (LC) Theory

The Least Cost (LC) method is one of the initial solution methods in transportation problems that emphasizes selecting the route with the lowest shipping costs. The Least Cost Method works by allocating as many units of goods as possible to cells with the lowest transportation costs, while still considering the limitations of supply and demand capacity. This approach is designed to produce a more economical initial solution than methods that do not consider cost factors. (Hillier & Liebermen 2021)

Vogel's Approximation Method (VAM) Theory

The Vogel's Approximation Method (VAM) is an initial solution method for transportation problems developed to produce distribution costs that are close to optimal from the initial calculation stage. VAM works by calculating a penalty value for each row and column, obtained from the difference between the two lowest transportation costs. This penalty value is used as the basis for allocation decisions, allowing this method to direct distribution to routes that have the greatest impact on total costs. (Hamdy A Taha 2022)

Stepping Stone Theory

The Stepping Stone Method provides a quantitative overview of the opportunity cost for each alternative distribution route. If the opportunity cost is negative, then the route is worthy of inclusion in the solution because it can reduce total transportation costs. (Roberta S. Russell 2019)

III. RESEARCH METHODS

Research Stages

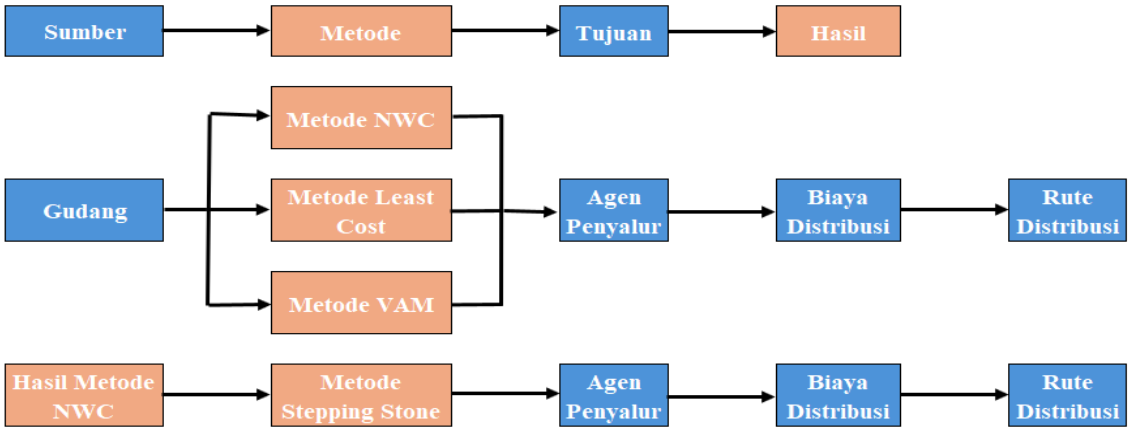

Figure 1: Research Stages

Explanation of Research Stages

A. Sources

The research involved several steps, including data sources, methodology, objectives, and results, as presented in Figure 1. The transportation cost variables analyzed included travel costs from the warehouse to the main agent and transportation costs incurred during the shipping process. The application of the transportation model aims to optimize distribution costs, thereby increasing company profitability by minimizing costs.

Data collection in this study was conducted using two methods:

1. Interviews, a face-to-face method, directly asking questions to the owner of DL Cake and Bakery, directly related to the data needed for the coconut shipping cost study, including shipping costs, warehouse supply, and demand from each market to which DL Cake and Bakery will ship.
2. Observation, a data collection method using direct observation and collecting field data necessary for the DL Cake and Bakery shipping cost study, including the location of DL Cake and Bakery's storage warehouse and the location of the markets to which DL Cake and Bakery will ship.

B. Methods

These include the North West Corner Method (NWC), the Least Cost Method (LC), and the Vogel's Approximation Method (VAM). The final solution method is derived from the NWC results.

North West Corner Method (NWC)

The North West Corner Method is used as the initial step in developing distribution solutions due to its ease of application and calculation. However, this method does not guarantee minimum distribution costs because it does not consider the cost structure of each shipping route. (Heizer, Jay Render, and Munson, Ummah 2020)

While the NWC method does not always produce the lowest distribution costs, it remains relevant as an initial comparison against other methods such as the Least Cost Method and Vogel's Approximation Method. Using the NWC makes it easier for researchers to understand the distribution structure and initial allocation of goods. (Irvana Arofah 2021)

Based on the opinions of these experts, it can be concluded that the North West Corner method is a simple and systematic method for determining initial solutions to transportation

problems. However, because it does not consider cost factors, this method needs to be combined with advanced optimization methods to obtain minimum distribution costs.

Least Cost (LC) Method

The Least Cost method provides a more realistic initial solution in business practice because it reflects managerial policy, which naturally chooses the lowest-cost distribution channel. This method is particularly suitable for companies with significant variations in transportation costs between distribution routes. (Render, B., Stair, R. M., Hanna, M. E., & Hale 2018)

The Least Cost method can significantly reduce total distribution costs compared to the company's initial distribution pattern. However, the results obtained are still an initial solution, so further methods are needed to ensure that the solution is optimal overall. Another opinion was expressed by (Dewi Puspaningtyas Faeni, Ananda Salaisha Ali, Firda Nasywa Putri, Gabriela Chintya Suratmono, Salwa Nabilah Kusumawardani 2025)

Based on these various opinions, it can be concluded that the Least Cost method is an initial solution that considers shipping costs as the basis for distribution allocation, resulting in more efficient costs than the simple method. However, this method still requires further optimality testing to ensure the distribution solution is truly optimal.

Vogel's Approximation Method (VAM)

The application of the Vogel's Approximation Method in a company's distribution system can significantly reduce logistics costs because it prioritizes allocation based on cost and capacity simultaneously. VAM is also considered more systematic and accurate than conventional methods that do not consider cost penalties. (Prayogi and Panjaitan 2022)

The VAM method's advantage lies in its ability to produce an initial solution with a lower total cost than the Least Cost method. However, this method still has limitations due to its heuristic nature, so the final result still needs to be tested for optimality using further methods to obtain a truly minimum distribution solution. (Anitasari et al. 2024)

The VAM method is a highly effective heuristic approach for solving medium- to large-scale transportation problems. This method often produces an initial solution that is optimal or very close to optimal, thereby reducing the number of iterations in subsequent optimality testing stages, such as the Stepping Stone or MODI methods. (Mokhtar S Bazaraa, John J Jarvis 2022)

Based on the various expert opinions, it can be concluded that Vogel's Approximation Method is a superior initial solution method for transportation problems because it considers cost penalties as the basis for distribution allocation. This method is very effective for companies with multiple distribution sources and destinations, but still requires further optimality testing to ensure overall cost efficiency.

Stepping Stone Method

The Stepping Stone Method is an optimality testing method for transportation problems used to evaluate and refine initial solutions to achieve minimum total distribution costs. Stepping Stone serves as a decision-making tool in operations management, helping companies identify inefficient distribution routes. Using a closed-path approach, this method allows for improved distribution allocation without disrupting the balance between supply and demand capacity. (Krajewski, L. j., & Ritzman 2021)

The Stepping Stone method is highly useful in logistics practice because it can convert initial heuristic solutions into truly optimal ones. This method helps companies sustainably minimize transportation costs, especially in complex distribution systems with multiple origins and destinations. (Winston 2023)

The Stepping Stone method serves not only as an optimality testing tool but also as a means of evaluating a company's distribution policies. With this method, management can understand the impact of changes in shipping routes on total costs, thus supporting more efficient and controlled logistics planning. (Siregar, H., & Lubis 2024)

Based on the opinions of these experts, it can be concluded that the Stepping Stone method is a distribution evaluation and improvement method that plays a strategic role in achieving minimum transportation costs. This method complements the initial solutions obtained from the NWC, Least Cost, and VAM methods, resulting in optimal distribution decisions oriented towards cost efficiency.

IV. RESEARCH RESULTS

DL Cake and Bakery is a F&B company that provides white bread and sweet bread in various flavors. With branches in Cipadu, Ciputat, Ceger, and Bintaro, DL Cake & Bakery ensures efficient distribution. The Ciputat branch serves as the main warehouse for storing and shipping products to other branches. The following table shows the inventory levels for each branch:

Table 1. Distribution of Goods Deliveries

Gudang	Cabang			Qs
	Ceger	Cipadu	Bintaro sektor 2	
Ciputat (Armada 1)	28.000	35.000	20.000	250
Ciputat (Armada 2)	35.000	40.000	24.000	200
Ciputat (Armada 3)	38.000	45.000	26.000	150
QD	150	250	200	600

The table shows the distribution of:

1. Shipments of goods from the Ciputat Warehouse, which has three fleets, to three destination branches: Ceger, Cipadu, and Bintaro Sector.
2. Each row represents the fleet used, while each column indicates the destination branch. The figures in the table indicate the shipping cost per unit of goods from each fleet to a specific branch. For example, the shipping cost from Fleet 1 to Ceger is 28,000, to Cipadu it is 35,000, and to Bintaro Sector 2 it is 20,000. The Qs column on the right shows the quantity of inventory that can be shipped by each fleet: 250 units for Fleet 1, 200 units for Fleet 2, and 150 units for Fleet
3. Meanwhile, the QD row at the bottom shows the quantity demanded by each branch: 150 units for Ceger, 250 units for Cipadu, and 200 units for Bintaro Sector 2. The total inventory and total demand are both 600 units, so this situation is a balanced transportation problem that can be analyzed to determine the distribution pattern with the most efficient shipping costs.

Northwest Corner Method (NWC)

Table 2. Processing using NWC

Gudang	Cabang			Qs
	Ceger	Cipadu	Bintaro sektor 2	
Ciputat (Armada 1)	28.000 150	35.000 100	20.000 X	~~250~~ ~~100~~
Ciputat (Armada 2)	35.000 X	40.000 150	24.000 50	~~200~~ ~~50~~
Ciputat (Armada 3)	38.000 X	45.000 x	26.000 150	~~150~~
Qd	~~150~~	~~250~~ ~~150~~	~~200~~ ~~150~~	600

Total = (Supply Ciputat (fleet 1) to Ceger x Cost) + (Supply Ciputat (fleet 1) to Cipadu x Cost) + (Ciputat (fleet 2) to Cipadu x Cost) + (Supply Ciputat (fleet 2) to Bintaro sector 2 x Cost) + (Supply Ciputat (fleet 3) to Bintaro sector 2 x Cost) = (28,000 x 150) + (35,000 x 100) + (40,000 x 150) + (24,000 x 50) + (26,000 x 150) = 4,200,000 + 3,500,000 + 6,000,000 +1,200,000 + 3,900,000 = 18,800,000

The calculation results show that the initial solution for DL Cake & Bakery's distribution transportation costs using the North West Corner (NWC) model is Rp 18,800,000.

Least Cost (LC) Method

Table 3: Least Cost (LC) Method

Gudang	Cabang			Qs
	Ceger	Cipadu	Bintaro sektor 2	
Ciputat (Armada 1)	28.000 50	35.000 x	20.000 200	~~250~~ 50
Ciputat (Armada 2)	35.000 100	40.000 100	24.000 x	~~200~~ ~~100~~
Ciputat (Armada 3)	38.000 x	45.000 150	26.000 x	~~150~~
QD	~~150~~ ~~100~~	~~250~~ ~~150~~	~~200~~	600

Total = (Supply Ciputat (fleet 1) to Ceger x Cost) + (Supply Ciputat (fleet 1) to Bintaro Sector 2 x Cost) + (Ciputat (fleet 2) to Ceger x Cost) + (Supply Ciputat (fleet 2) to Cipadu x Cost) + (Supply Ciputat (fleet 3) to Cipadu x Cost) = (28,000 x 50) + (20,000 x 200) + (35,000 x 100) + (40,000 x 100) + (45,000 x 150) = 1,400,000 + 4,000,000 + 3,500,000 + 4,000,000 + 6,750,000 = 19,650,000

Results The calculation reveals that the initial solution for DL Cake & Bakery's distribution transportation costs using the Least Cost (LC) method is IDR 19,650,000.

Vogel's Approximation Method (VAM)

Table 4: Vogel's Approximation Method (VAM)

Gudang	Cabang			Qs
	Ceger	Cipadu	Bintaro sektor 2	
Ciputat (Armada 1)	28.000 150	35.000 100	20.000 x	250
Ciputat (Armada 2)	35.000 x	40.000 150	24.000 50	200

Ciputat (Armada 3)	38.000 x	45.000	26.000 150	150
QD	150	250	200	600

Total = (Supply Ciputat (fleet 1) to Ceger x Cost) + (Supply Ciputat (fleet 1) to Cipadu x Cost) + (Ciputat (fleet 2) to Cipadu x Cost) + (Supply Ciputat (fleet 2) to Bintaro Sector 2 x Cost) + (Supply Ciputat (fleet 3) to Bintari Sector 2 x Cost) = (28,000 x 150) + (35,000 x 100) + (40,000 x 150) + (24,000 x 50) + (26,000 x 150) = 4,200,000 + 3,500,000 + 6,000,000 + 1,200,000 + 3,900,000 = 18,800,000

The calculation results show that the initial solution for DL Cake & Bakery's distribution transportation costs using the Vogel's Approximation Method (VAM) is IDR 18,800,000.

Stepping Stone Method

Table 5 Stepping Stone Method

Gudang	Cabang			Qs
	Ceger	Cipadu	Bintaro sektor 2	
Ciputat (Armada 1)	28.000 150	35.000 100	20.000 x	250
Ciputat (Armada 2)	35.000 x	40.000 150	24.000 50	200
Ciputat (Armada 3)	38.000 x	45.000 x	26.000 150	150
QD	150	250	200	600

The previous calculation used the results from the NWC method, followed by processing the empty cells tested using the Stepping Stone method based on the initial solution: Fleet 1 to Bintaro, Fleet 2 to Ceger, Fleet 3 to Ceger, and Fleet 3 to Cipadu. These cells were analyzed to determine potential reductions in total distribution costs. From the processing table using the Stepping Stone method, the following is obtained:

1. Ciputat (Fleet 1) to Bintaro, Sector 2 = 20,000 – 24,000 + 40,000 – 35,000 = 1,000
2. Ciputat (Fleet 2) to Ceger = 35,000 – 40,000 + 35,000 – 28,000 = 2,000
3. Ciputat (Fleet 3) to Ceger = 38,000 – 28,000 + 35,000 – 40,000 + 24,000 – 26,000 = 3,000
4. Ciputat (Fleet 3) to Cipadu = 45,000 – 26,000 + 24,000 – 40,000 = 3,000

Because the stepping stone calculations yielded positive results, we proceeded to create a calculation table using the Stepping Stone Final Solution Method data. Total = (Supply

Ciputat (fleet 1) to Ceger x Cost) + (Supply Ciputat (fleet 1) to Cipadu x Cost) + (Ciputat (fleet 2) to Cipadu x Cost) + (Supply Ciputat (fleet 2) to Bintaro sector 2 x Cost) + (Supply Ciputat (fleet 3) to Bintaro sector 2 x Cost) = (28,000 x 150) + (35,000 x 100) + (40,000 x 150) + (24,000 x 50) + (26,000 x 150) = 4,200,000 + 3,500,000 + 6,000,000 +1,200,000 + 3,900,000 = 18,800,000

The calculation results show that the initial solution for DL Cake and Bakery's distribution transportation costs using the Stepping Stone model is IDR 18,800,000.

V. CONCLUSION

Based on the results of processing DL Cake & Bakery's distribution data using the transportation method, it can be concluded that the problem being analyzed is a balanced transportation problem, because the total inventory from the Ciputat Warehouse, 600 units, equals the total demand from all branches, 600 units. This condition allows for the direct application of the North West Corner (NWC), Least Cost (LC), Vogel's Approximation Method (VAM), and Stepping Stone methods without additional adjustments.

The initial solution calculations show that the North West Corner (NWC) method results in a total distribution cost of Rp18,800,000. The Least Cost (LC) method results in a higher total distribution cost of Rp19,650,000. Meanwhile, the Vogel's Approximation Method (VAM) again results in a total distribution cost of Rp18,800,000. This indicates that not all initial solution methods produce the same distribution costs, even when using identical supply and demand data.

To determine whether the initial solution was optimal, testing was conducted using the Stepping Stone method with the initial solution from the NWC method. The evaluation of all empty cells showed that all improvement indices were positive. This condition indicates that there are no alternative distribution allocations that can reduce total shipping costs.

Therefore, it can be concluded that the distribution solution obtained using the North West Corner method and Vogel's Approximation Method has reached optimality. The minimum total distribution cost for DL Cake & Bakery is IDR 18,800,000. The results of this study can be used as a basis for decision-making in determining efficient distribution patterns and as a reference for applying transportation methods to similar distribution problems.

REFERENCES

Anitasari, Zindy, Wasono Wasono, Fidia Deny, and Tisna Amijaya. 2024. "Optimalisasi Biaya Transportasi Pendistribusian Produk Frozen Food Menggunakan Metode Vogel's Approximation Dan Metode Stepping Stone (Studi Kasus: PT. Ciomas Adisatwa Balikpapan)." *Jurnal Ilmiah Matematika* 3(1): 61–71. doi:https://doi.org/10.30872/basis.v3i1.1193.

Dewi Puspaningtyas Faeni, Ananda Salaisha Ali, Firda Nasywa Putri, Gabriela Chintya Suratmono, Salwa Nabilah Kusumawardani, Qaila Nesia Ramadhani. 2025. "PENERAPAN METODE TRANSPORTASI UNTUK OPTIMALISASI BIAYA DISTRIBUSI KENDARAAN(STUDI KASUS PADA PT ASTRA)." *Jurnal Riset Ilmiah* 2(5): 2318–24. doi:https://doi.org/10.62335.

Dimasuharto, Nugroho, Ade Momon Subagyo, and Risma Fitriani. 2021. "Menggunakan Model Transportasi Dan Metode Stepping Stone." *Intech* 7(2): 81–88.

Fahrudin. 2023. *Manajemen Operasional Teori Dan Praktik*. 1st ed. ed. Wahyu Kurniawadi. Banyumas: Wawasan Ilmu.

Heizer, Jay Render, Barry, and Chuck Munson, Ummah. 2020. "Operations Management: Sustainability and Supply Chain Management (13th Ed.)." *Sustainability (Switzerland)* 11(1): 913. http://scioteca.caf.com/bitstream/handle/123456789/1091/RED2017-Eng-8ene.pdf?

Herlawati. 2016. "Optimasi Pendistribusian Barang Menggunakan Metode Stepping Stone Dan Metode Modified Distribution (Modi)." *INFORMATION SYSTEM FOR EDUCATORS AND PROFESSIONALS* 1(1): 103–13. https://jurnal.ulb.ac.id/index.php/sigma/article/view/3317/2704.

Hillier & Liebermen. 2021. *INTRODUCTION TO Eleventh Edition*. New York: McGraw-hill Education.

Irvana Arofah, Nianty Nandasari Gesthantiara. 2021. "Optimasi Biaya Distribusi Barang Dengan Menggunakan Model Transportasi." *JMT (Jurnal Matematika dan Yerapan)* 3(1): 1–9.

Iswanto, and Ali Akbar. 2021. Umsida Press *Buku Ajar Manajemen Operasi*. M. Tanzil. Sidoarjo: Umsida Perss. https://press.umsida.ac.id/index.php/umsidapress/article/view/1285.

Krajewski, L. j., & Ritzman, L.P. 2021. Pearson *Operations Management : Processes and Supply Chains*. New Jersey: Pearson. https://thuvienso.hoasen.edu.vn/handle/123456789/13052%0Ahttps://thuvienso.hoasen.edu.vn/bitstream/handle/123456789/13052/Contents.pdf?sequence=1.

Mokhtar S Bazaraa, John J Jarvis, Hanif D Sherali. 2022. *Linear Programming And Network Flows (4th Ed)*. New Jersey: Wiley.

Prayogi, Satria Yuda, and Muhammad Iqbal Panjaitan. 2022. "Penerapan Metode Vogel's Approximation Method (VAM) Dalam Optimalisasi Biaya Transportasi Pengiriman Barang Berbasis Sistem Informasi (Studi Kasus: PT. Coca-Cola Amatil Indonesia (CCAI) Medan)." *Journal of Information Technology and Accounting* 5(1): 69–75.

Render, B., Stair, R. M., Hanna, M. E., & Hale, T. S. 2018. "Quantitative Analysis for Management (13th Ed)." *Quantitative Analysis for Management*. doi:10.56055/kvrbc.2023.11.10.1.

Roberta S. Russell, Bernard W. Taylor. 2019. "Operations and Supply Chain Management (10th Ed)." : 832.

Safari, Lusi Mustika, Muhamad Syafii Ceffi, and Muliadi Suprapto. 2020. "Optimasi Biaya Pengiriman Beras Menggunakan Model Transportasi Metode North West Corner (Nwc) Dan Software Lingo." *Jurnal Ilmiah Teknologi Infomasi Terapan* 6(3): 184–89. doi:10.33197/jitter.vol6.iss3.2020.402.

Shindy Widya Astuti, Media. 2024. "OPTIMALISASI BIAYA PENGIRIMAN AIR KEMASAN PADA PT. AGRIMITRA UTAMA PERSADA MENGGUNAKAN METODE RUSSELL APPROXIMATION, LEAST COST." *Jurnal Ilmiah Matematika* 12(02): 244–54. doi:https://doi.org/10.26740/mathunesa.v12n2.p329-336.

Siregar, H., & Lubis, R. 2024. "Analisis Optimalisasi Biaya Distribusi Menggunakan Metode Stepping Stone." *Jurnal Manajemen Operasi dan Logistik* 9(1): 22–31.

Taha, Hamdy A. 2022. Pearson *Operations Research: An Introduction 11th Edition*. 11th ed. New York: Pearson. doi:10.2307/3008276.

Taha, Handy A. 2017. *Operations Research An Introduction*. 10th ed. ed. Julian Partridge. London: Pearson.

Wahyuni, Sri, and Rifelly Dewi Astuti. 2025. "The Impact of Innovation Factors on Repurchase Intention : Enhancing the Competitiveness of Indonesian Handicrafts." *Journal of Marketing Innovation* (1): 42–65. doi:https://doi.org/10.35313/jmi.v5i1.222.

Winston, Wayne L. 2023. "Operations Research: Applications and Algorithms (5 Th Ed)." *Technometrics* 30(3): 1440. doi:10.2307/1270107.