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Comparison of Djikstra, Hybrid-PSO algorithms for optimizing the distribution route of papaya seeds and honey products (Case Study: PT. Agro Apiari Mandiri)

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KEYWORDS
djikstra algorithm; Hybrid-PSO; distribution route; papaya seeds; honey

ABSTRACT
Dynamic global competencies in the industrial sector drive fierce competition in capturing markets and increasing customer satisfaction, which requires efficiency in various aspects of business including distribution. PT. Agro Apiari Mandiri faces challenges in optimizing delivery routes to avoid delays. This study aims to compare the Dijkstra and Hybrid-PSO algorithms to determine the optimal distribution route in the Bogor, West Java, and Lebak, Banten regions, in order to reduce the distance and delivery time. The research methods include literature study, data collection, and route optimization model creation. The results show that PSO is more efficient in optimizing delivery routes than other methods, with variations in PSO parameters affecting total travel time, number of vehicles, and computing time. Implementation uses hardware and software such as MSI Laptops and Matlab. In conclusion, the use of PSO in distribution route optimization makes a significant contribution to the company's cost and distribution efficiency and can be a reference for further research in distribution route optimization.

Introduction

Global competence in the industrial sector continues to increase dynamically, encouraging industry players to compete fiercely in capturing the market and increase customer satisfaction to maintain their position. This effort requires efficiency in various aspects of the business, including the ability to produce good quality performance at optimal cost (Cantona et al., 2020). The distribution process is an important aspect of business, which affects consumer satisfaction through on-time delivery. Distribution planning and optimization of vehicle routes are key to avoiding delays that can harm consumers. PT. Agro Apiari Mandiri, which is engaged in the field of papaya seed seeds and honey products, requires good route optimization management (Darnita et al., 2017). The use of Djikstra and Hybrid-PSO algorithms in route optimization is urgently needed to ensure distribution efficiency. Particle Swarm Optimization (PSO) is an effective and often used optimization method to solve Vehicle Routing Problems (VRP), which aims to find the optimal route with a minimum distance. A variation of VRP, namely Vehicle Routing Problem with Time Windows (VRPTW), pays attention to specific time intervals for delivery services to customers (Khairina & Harahap, 2019).

Companies need a framework to decide what to do in route optimization management. This framework was formed using the PDCA concept to ensure that the company makes continuous improvements and uses the mapping results of the ISO 27001 standardization to ensure that the threats and risks that may occur will not affect the company's core business (Fatma et al., 2019). There are various kinds of route optimization that are currently in effect. The most widely applied is the Djikstra Algorithm implemented to find the shortest route for shipping goods. Furthermore, the coordinates or addresses of the recipient goods to be sent are needed to be used as a reference point in calculating and knowing the shortest route of all predetermined goods addresses (Marlina et al., 2017).

The Djikstra algorithm is used in calculating and finding the shortest route for shipping goods. Data on the goods to be sent is obtained from the storage area or warehouse. Before the goods are shipped, the goods are recorded first (Munir et al., 2020).

The admin determines the goods that will be sent by the courier based on the location or region. Couriers have areas that are their duty in delivering goods. After the admin determines the goods to be sent, the courier can follow which path must be passed to send the goods (Rofiq & Uzzy, 2014).

In managing the route optimization system owned by PT. Agro Apiari Mandiri is considered to still not have good IT governance capabilities in accordance with the expected competencies and there is still a lack of attention to supervision and assessment of route optimization, so there is a need for IT governance to ensure route optimization (Rudiyanto et al., 2020). Therefore, in ensuring route optimization, it is necessary to carry out an IT governance audit to ensure route optimization in order to be able to plan and recommend improvements to the weaknesses encountered, related to route optimization is necessary because it has a framework with a fairly good examination and is the most complete guide of route optimization best practices (Sastrakarmanjata et al., 2021). Therefore, it is necessary to design a route optimization model in managing route optimization that can provide guidance in the form of improvement strategies and reduce the weaknesses of the route optimization system that must be followed up in improving the quality of route optimization and policy recommendations. The recommendations given are expected to be a basis for directing route optimization improvements (Setiawan et al., 2019).

Route optimization is a standard to optimize the process of shipping and distributing goods produced by PT. Agro Apiari Mandiri in the form of papaya and honey seed products, with the research on route optimization carried out by the author, it is hoped that the reference on route optimization can be carried out optimally (Wang, 2018).

This research focuses on optimizing the distribution route of honey and papaya seed products in PT. Agro Apiari Mandiri often faces problems such as unplanned distribution, delivery delays, difficulty finding customer addresses, and untimely delivery reports, as well as management difficulties in decision-making. This study is limited to the use of comparative Djikstra and Hybrid-PSO algorithms to determine the optimal distribution route. The goal is to reduce mileage and minimize delivery time so as to achieve cost and distribution efficiency. The scope of the research covers the areas of Bogor, West Java and Lebak, Banten with a focus on delivery from the production house to the customer. The methodology used includes problem identification, literature study, data collection, and route optimization model creation. The results of the research are expected to make a significant contribution to the company in realizing the vision of route optimization as well as for researchers and readers as a reference for distribution route optimization.

The novelty of this research lies in the comparison of the Dijkstra algorithm and Hybrid Particle Swarm Optimization (Hybrid-PSO) for optimizing the distribution routes of papaya seeds and honey products at PT. Agro Apiari Mandiri. While Dijkstra is widely recognized for finding the shortest paths, integrating Hybrid-PSO brings a unique approach by combining global and local search strategies, which allows for better handling of complex, real-world distribution challenges, such as time windows and vehicle capacity constraints. The study's focus on using both algorithms for a case study specific to the distribution of agricultural products in Indonesia adds to the body of knowledge on algorithm performance in supply chain optimization in developing markets, where logistical challenges are compounded by infrastructure and operational issues.

The main objective of this research is to evaluate and compare the effectiveness of the Dijkstra algorithm and Hybrid-PSO in optimizing the distribution routes for PT. Agro Apiari Mandiri's products, with a focus on reducing delivery time and distance, while minimizing operational costs. The study aims to identify the most efficient route optimization method to improve supply chain management and customer satisfaction.

The benefits of this research are significant for both academic and practical applications. For businesses like PT. Agro Apiari Mandiri, the findings provide actionable insights on choosing the best algorithm for route optimization, leading to cost savings, reduced fuel consumption, and better delivery times. This will enhance customer satisfaction and operational efficiency. For academia, the comparison of these algorithms contributes to the literature on logistics optimization, providing a valuable reference for future studies in similar industries or regions, and encouraging the use of advanced hybrid methods in solving distribution problems.

Research Methods

This research method aims to obtain relevant data through various stages such as literature study, observation, analysis, and enterprise architecture (EA) design. The research process includes data preparation consisting of data collection and pre-processing, method implementation, verification and validation, as well as trials and analysis. Data was collected from PT. Apiari Mandiri related to customer information, vehicles, and requests. Data preprocessing involves cleaning the data to ensure its quality. The implementation of the method uses Djikstra and Hybrid-PSO algorithms for distribution route optimization. Validation is carried out by comparing the results of the algorithm with manual calculations using the same dataset. The analysis of the results aims to evaluate whether the algorithm used has met the research objectives. The research is scheduled to take place from June to August 2024 and uses a descriptive method through a case study at PT. Agro Apiari Mandiri, focuses on calculating the distance and travel time of distribution by paying attention to congestion parameters. The final results of the study are expected to provide an optimal distribution route.

Results and Discussions

Road Data

For road section data in this study, data from previous research was used, where road data coding was carried out on arterial roads and collector roads related to consumer data, and can be seen on the attachment page.

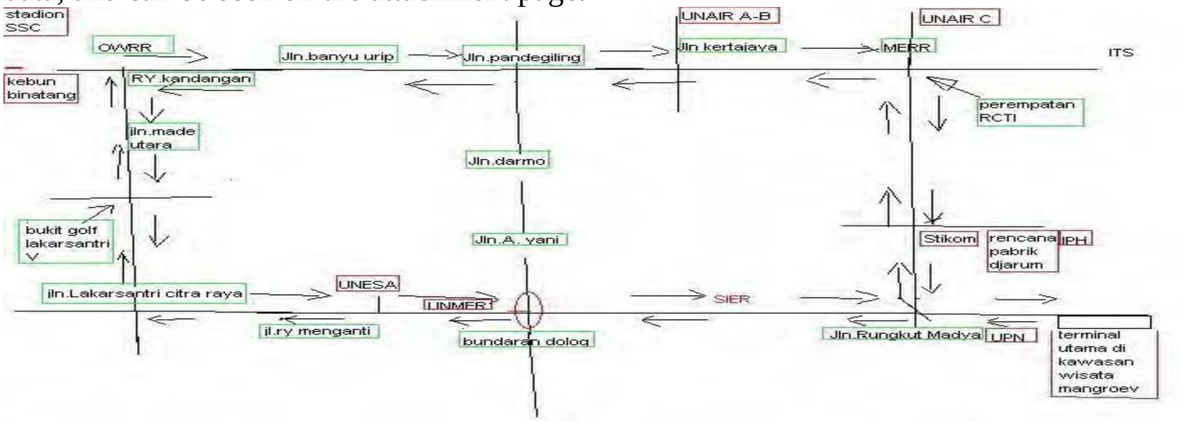
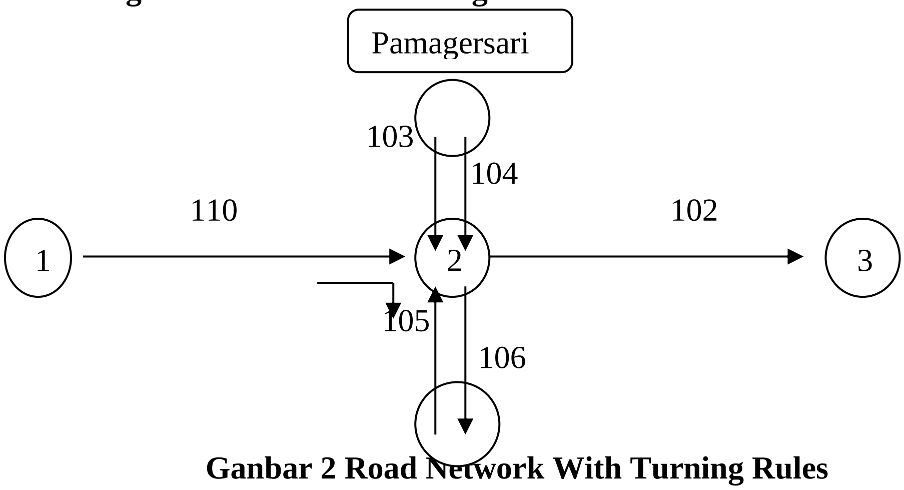


Figure 1 Model of the Jasinga – Lebak Banten Road Network



Ganbar 2 Road Network With Turning Rules

Table 1 Road Section

Code - Segment	Node - Origin	Node – Purpose	Tavel Time
101	1	2	4
102	2	3	5
103	2	4	6
104	4	2	6
105	5	2	3
106	2	5	3

Table 2. Road Rules

Code – Road Section	Node – Road Section
101	102
102	103
103	102
104	106
105	102
105	103

In the road section table, there is a kode_ruas column that shows the road section code, the node_asal column, the node_tujuan column, and the travel_time column, which states the distance from the road section in units of time.

In the road section table, there are kode_ruas columns, and next_ruas that state that the road that is biased is passed by complying with the existing turn rules.

From the network above, the deep modeling can be formed graphs as follows

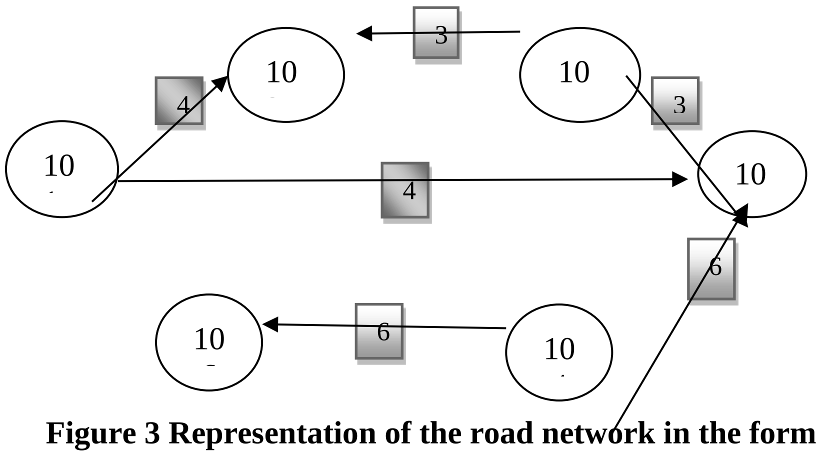


Figure 3 Representation of the road network in the form of a graph

Road Rules Data

Road rule data is needed to find out which road sections can be passed from a road section. From the rule data, it can be seen whether the road is one-way or two-way. Road rule data was obtained through field surveys (Koop et al., 2024).

Data on the Location of Consumers and Production Houses (PT. Agro Apiari Mandiri)

In this study, the data on the location of the production house uses data from the company PT. Agro Apiari Mandiri which is located in the city of Jasinga with the address Jl.Raya Jasinga Desa.Pamagersari Kec.Jasinga Regency.Bogor. As for consumer locations, the data is intuitive and entered randomly. The node number attribute is an assumption, so the address of the consumer's node with the production house is determined by adjusting the number so that the position is not much different from the original location.

Customer Service Route Data

To get the customer service route, the consumer data that was previously entered at random will be calculated using the Ant Colony System optimization.

Data Processing

Road Data Processing

As explained in the sub-chapter on road network modeling, road network data in districts. Bogor and Lebak Banten start by determining the nodenodes on the map. These nodes are representations of intersection points, turning points and meeting points of two roads. After obtaining the node data, the next step is to code the road section. In the road segment table, there are columns of origin and destination nodes related to the node table. Next is to determine the road rules stored in the next_ruas table and the preparation of the road table which provides information about the street name of each encoded section (Zhao & Sharma, 2023).

Processing of Customer Order Data

Order data by customers is displayed through the matlab command window which is presented in the form of a matrix.

Production House and Consumer Data

In this test, order data is used that is assumed to have been made one day before the delivery day. Data on production houses and consumers are presented in the following table:

Table 3 Testing Production House Data

Name	Node	Supplies	Time Begin	Time End
Papaya Seeds	66	10.000	7.00	15.00
Honey	66	10.000	7.00	15.00

Table 4 Testing consumer data

Name	Node	Papaya/Honey Seed Permits	Time Begin	Time End
Consumer 1	1	25	7.00	8.00
Consumer 2	7	30	7.00	8.00
Consumer 3	12	20	7.00	78.00
Consumer 4	21	35	9.00	9.00
Consumer 5	46	30	8.00	10.00
Consumer 6	60	45	7.00	10.00
Consumer 7	95	50	7.00	8.00
Consumer 8	135	35	7.00	8.00
Consumer 9	177	50	8.00	11.00
Consumer 10	189	40	7.00	11.00
Consumer 11	210	55	8.00	10.00
Consumer 12	244	15	9.00	11.00
Consumer 13	256	25	7.00	9.00
Consumer 14	289	35	8.00	9.00
Consumer 15	315	50	7.00	8.00
Consumer 16	333	55	8.00	12.00
Consumer 17	376	20	8.00	10.00
Consumer 18	402	25	7.00	10.00
Consumer 19	355	45	7.00	7.00
Consumer 20	400	35	7.00	8.00
Consumer 21	235	20	8.00	9.00
Consumer 22	104	50	9.00	11.00
Consumer 23	144	30	11.00	12.00
Consumer 24	140	20	9.00	11.00
Consumers 25	101	30	12.00	13.00
Consumer 26	254	45	14.00	15.00
Consumer 27	141	35	10.00	12.00
Consumer 28	121	15	13.00	14.00
Consumer 29	174	10	9.00	10.00
Consumers 30	264	15	10.00	11.00

Consumer 31	248	20	7.00	9.00
Consumer 32	298	20	7.00	9.00
Consumer 33	386	20	7.00	9.00
Consumer 34	39	20	7.00	9.00
Consumer 35	81	20	7.00	9.00
Consumer 36	44	20	8.00	10.00
Consumer 37	62	20	8.00	10.00
Consumer 38	28	20	8.00	10.00
Consumer 39	4	20	10.00	10.00
Consumer 40	113	20	8.00	10.00
Consumer 41	196	20	9.00	12.00
Consumer 42	181	20	9.00	12.00
Consumer43	175	20	9.00	12.00
Consumer 44	205	20	9.00	12.00
Consumer 45	161	20	9.00	12.00
Consumer 46	292	20	10.00	12.00
Consumer 47	242	20	10.00	12.00
Consumer 48	399	20	10.00	12.00
Consumer 49	408	20	10.00	12.00
Consumer 50	296	20	10.00	12.00

Particle Swarm Optimization Parameter Selection

The test was carried out using 50 consumer nodes, and the maximum number of iterations was 20, while the values of c1,c2,swarm varied. The purpose of the test was to determine the effect on the optimal route with variations in the parameters of Particle Swarm Optimization. The values compared from this test are; total travel time, final number of vehicles, and computing time (Daouda & Atila, 2024).

The test was carried out by determining the value of c2 = 2, the number of swarms = 20, the maximum iteration = 20, with a c1 value that varied starting from 1, 2, 3 to find the best c1 value.

The test is further carried out in the same way according to the test parameters performed where the test parameters are varied and the other parameters are constant.

From each parameter tested, 1 parameter will be searched that produces the optimal route (minimum travel time). Then from the best parameters, it was finally used to find the results of the optimization of the delivery route of papaya seed and honey products from the production house to the consumer.

In Hybrid PSO, there are several parameters that are determined from the beginning. These parameters will later be changed repeatedly and the results will be seen. The results of the parameter parameters will later be compared and seen for their properties.

V = Velocity of the particle
c1.c2 = Coefficients acceleration
Xj = Update particle position
Xj(i) = Particle Position I
Swarm = The number of bird agents used in optimization
Max Iteration = a value that indicates after which iteration the program will Stopped.

Table 5 PSO Parameter Selection Data

C1 (c1 = x, c2 = 2, Swarm = 20)						
	1		2		3	
Production House	47:38	8	52:01	7	48:1	7
C2 (c1 = 2,c2 = x, Swarm = 20)						
	1		2		3	
Production House	52.9	7	57.19	7	44.49	7
C1 (c1 = x, c2 = 2, Swarm = 20)						
	20		35		50	
Production House	3.27	7	3.18	7	3.12	7

PSO Parameter Selection Results

The best parameters obtained from the Delivery of Papaya Seeds and Honey

Name	C1	C2	Swarm
Papaya Seed Production House	1	3	35

Final Testing

After obtaining the best parameters, then these parameters will be used to carry out the final test. The results of his last test are as follows.

Results of Optimization of Papaya and Honey Seed Production House

a). Node position = '' Jl.raya jasinga desa.pamagersari kec.jasinga bogor regency' 'Girilaya' 'Jarak' 'Simogunung' 'Darmo Permai I' 'Kupang Indah' 'Tanjung Sari' 'Raya Dukuh Kupang' 'Kupang Indah X' 'Raya Sukomanunggal' 'Putat Gede' 'Sasatellite Selatan' 'Gunung Sari' 'Jajar' 'Darmo Indah Selatan' 'Satelit Selatan' 'Satelit Selatan' 'Hayam Wuruk' 'Darmo Harapan' 'Raya Darmo Indah' 'Achmad yani' 'Kebon Sari Tengah' 'Tandes' 'Kebon Sari'

b). Travel Time = 47 Minutes

c). Number of Vehicles = 5

- Vehicle Route 1 = 66 254 66
- Complete Route 66 - 77 - 85 - 381 - 121 - 129 - 157 - 380 ◊ 234 - 254 - 234 ◊380 - 157 - 77 - 66

Jasinga Desa.Pamgersari -'Major General Sungkono' - 'Major General Sungkono' -'Major General Sungkono' - 'Major General Sungkono' - 'Major General Sungkono' - 'Major General Sungkono' - 'Major General Sungkono' - 'Major General Sungkono' - 'Adityawarman' - 'Major General Sungkono' - 'Major General Sungkono' - 'Major General Sungkono' - 'Major General Sungkono' - 'Major General Sungkono' - 'Major General Sungkono' -, 'Major General Sungkono' - 'Major General Sungkono' - 'Major General Sungkono' - 'Jl.raya jasinga desa.pamagersari'

Figure 4 Vehicle route 1

- Vehicle Route 2 = 66 141 144 66
- Complete Route

66 - 77 - 85 - 381 - 121 - 123 - 132 – 141 - 132 - 123 - 129 - 157 - 380 - 209 - 194 - 208 195- 177- 170 - 169 - 154 - 156 - 144 - 156 -154 - 169 - 91 - 90 - 101 - 107 - 117 - 110 1- 18 - 121 - 381 - 77 - 66

'Jl. Raya Jasinga Desa.pamagersari' -'Major General Sungkono' - 'Major General Sungkono' -'Major General Sungkono' - 'Raya Dukuh Kupang' - 'Raya Dukuh Kupang' - 'Raya Dukuh Kupang' -'Raya Dukuh Kupang' - 'Raya Dukuh Kupang' - 'Raya Dukuh Kupang' - 'Major General Sungkono' - 'Major General Sungkono' - 'Major General Sungkono' - 'Adityawarman' - 'Hayam Wuruk' - 'Hayam Wuruk' - 'Hayam Wuruk' - 'Hayam Wuruk' - 'Gunung Sari' - 'Gunung Sari' - 'Gunung Sari' - 'Kebon Agung' - 'Kebon Agung' - 'Kebon Agung' - 'Agung' - 'Agung' - 'Agung' - 'Agung' - 'Kebon Agung' - 'Kebon Agung' - 'Kebon Agung' - 'Gunung Sari' -'Golf' - 'Golf' - 'Jajar' - 'Jajar' - 'Jajar' - 'Jajar' - 'Dukuh ' - 'Dukuh' - 'Dukuh' - 'Majjen Sungkono' - 'Maj.raya Jasinga Desa.pamagersari

Figure 5. Vehicle Route 2

- Vehicle Route 3 = 66 81 113 189 44 62 21 140 174 66
- Complete Route

66 - 62 - 75 - 81 - 86-◊ 87 - 99 - 113 - 134 - 173 - 198 - 189 - 198 - 80 - 68 - 57 -55 - 44 - 50 - 51 - 404 - 38 - 46 - 52 - 62 - 52 - 50 - 44 - 41 - 32 - 28 - 22 - 21 - 22 - 28 - 32 - 41 - 44 - 50 - 52 - 62 - 66 - 77 - 85 - 381 - 121 - 118 - 110 - 117 - 107 - 101 - 90 - 91 - 94 -

96 - 140 - 170 - 177 - 195 - 208 - 194 - 209 - 228 - 400 - 254 - 234 - 239 - 233 - 238 - 174 - 164 - 152 - 141 - 132 - 123 - 129 -121 - 381 - 77 -
66 '
"Jl.raya jasinga desa.pamagersari' - 'Kupang Indah XVII' - 'Kupang Indah X' - 'Raya Kupang Jaya' - 'Raya Kupang Jaya' - 'Raya Kupang Jaya' - 'Simogunung' -'Banyu Urip' - 'Banyu Urip' - 'Banyu Urip' -' - 'Girilaya' - 'Banyu Urip' - 'Banyu Urip' - 'Banyu Urip' - 'Banyu Urip' - 'Tandes' - 'Sukomanunggal' - 'Sukomanunggal' - 'Sukomanunggal' - 'Raya Sukomanunggal' -◊ ' ◊ Raya Sukomanunggal' - 'Raya Sukomanunggal' - 'RayaSukomanunggal' -◊ ◊ 'Darmo Baru Barat' -◊ 'Darmo Baru Barat' -◊ 'Kupang Indah' ◊ - 'Darmo ◊ Baru Barat' -◊ 'Darmo Baru Barat' -◊ 'Raya Sukomanunggal' ◊- 'Raya Sukomanunggal◊' - 'Raya Sukomanunggal' - 'Raya Sukomanunggal'◊ -◊ 'Sasatellite Selatan'◊ - 'Sasatellite Selatan' - 'Satelit Selatan◊' - 'Satelit Selatan' -◊ 'Satelit Selatan◊' - 'Satelit ◊ Selatan' - 'Satelit Selatan' -◊ 'Southern Satellite' - ◊ 'Southern Satellite' -◊ 'Southern Satellite' -◊'Southern Satellite' -◊ 'Raya Sukomanunggal'◊ - '◊Raya Sukomanunggal' -◊ 'Raya Sukomanunggal' - 'Raya Sukomanunggal' -◊ 'Darmo Baru Barat'◊ - 'Darmo Baru Barat' -◊ 'Kupang Indah' - ◊ 'Kupang Indah' -◊ 'Major General HR Muhammad' -◊ 'Major General Sungkono' - 'Major General Sungkono◊' - '◊Major General Sungkono'- ◊ 'Dukuh' -◊ 'Dukuh' - 'Dukuh' -◊ 'Jajar' -◊ 'Jajar' ◊ -◊ 'Jajar' - 'Jajar' -◊ '◊ ◊ Golf' -◊ 'Golf' -◊ 'Gunung Sari' -◊ 'Gunung Sari' - 'Gunung Sari' -◊ 'Hayam Wuruk' - 'Hayam Wuruk'◊ - 'Hayam Wuruk' - '◊Hayam Wuruk' - 'Hayam Wuruk' -◊ ◊ ◊ 'Adityawarman' -◊ 'Patmo Susanto' -◊ 'Patmo Susanto' -◊ 'Patmo Susanto' - 'Kembang Kuning' -◊ 'Kembang◊ Kuning' - '◊Banyu Urip Wetan V' -◊ 'Banyu Urip Wetan -V' ◊ 'Jarak' -◊ 'Jarak' ◊- 'Putat Jaya' -◊ 'Raya Dukuh Kupang' -◊ 'Raya Dukuh Kupang' ◊ - 'Raya Dukuh Kupang' -◊ 'Major General Sungkono' -◊ 'Major General Sungkono' - 'Major◊ General Sungkono' - 'Major General Sungkono' -◊ 'Jl.raya Jasinga Desa.Pmagersari

Figure 6 Vehicle route 3

From the results of the data test above, the Particle Swarm Optimization algorithm is able to provide an overview of the travel route of each vehicle dynamically in serving consumer nodes without having to violate the capacity constraints and time window constraints that have been determined by each consumer node.

Parameter Sensitivity Analysis

Sensitivity analysis is an analysis carried out to find out the consequences of changes in system parameters to changes in system performance in producing optimization results.

Sensitivity analysis was carried out by looking at the travel time value of the PSO parameter variation. The data analyzed for sensitivity on 1 papaya and honey seed production house only, namely PT. Apiari Agro Mandiri which is located at Jl.raya Jasinga Desa.Pamagersari, Bogor Regency.

In this study, there are 2 parameters of the Particle Swarm Optimization algorithm that I changed the value of. The first parameter is the acceleration coefficient (c1 and c2). C1 is useful for finding local best (pBest) and C2 is for finding global best (gBest). In general, the values for the acceleration coefficients c1 and c2 = 2. However, the value of the acceleration coefficient can be changed because each case has an ideal c1 and c2 in the value range between 0 and 4.

In this study, the smaller the value of c1, the smaller the travel time produced, but the larger the c2, the smaller the value of travel time.

The second is the size of the Swarm. The size of the swarm or population chosen depends on the problem at hand. The commonly used swarm size ranges from 20 to 50. In this study, I changed the parameters of the swarm at the number of 20, 35, and 50. And from the results of the study, it was found that swarms with a total of 35 had the minimum travel time.

The last one I tried to change the car's capacity load from 200, 300, and 400. With a car capacity of 200, the resulting travel time is 115 minutes. With a car capacity of 300, the resulting travel time is 78 minutes. With a car load of 400, the resulting travel time is 90 minutes (Islam et al., 2021).

Table 6 Testing by changing vehicle load

	200		300		400	
Papaya Seeds and Honey	47 Minutes	3	27 Minutes	3	174 Minutes	3
Total	47 Minutes	3	27 minutes	3	174 Minutes	3

From here, it can be seen that the travel time can be adjusted depending on the car's capacity and the time windows

Comparison with other methods

In testing using the Particle Swarm Optimization algorithm, the results are compared to other methods with the same data. The results of the comparison are as follows:

Table 7 Results of comparison with other methods

	Particle Swarm Optimization		Simulated Annealing		Ant Colony System	
Papaya Seeds and Honey	47 Minutes	3	148 Minutes	6	174 Minutes	7
Total	47 Minutes	3	148 minutes		174 Minutes	7

From the results of the comparison of the 3 methods above, it is concluded that the Particle Swarm Optimization algorithm produces the minimum travel time of 1 hour 46.44 minutes. And the Particle Swarm Optimization algorithm produces the maximum number of vehicles as many as 3 vehicles

Implementation Environment

Hardware Environment

The hardware environment used in the development of papaya and honey seed delivery route optimization using ***Hybrid PSO*** and ***Dijkstra algorithm*** is as follows:

Table 8 Hard Mixer Test Environment

Hardware	Specifications
Kind	**Laptop MSI Summit E14FlipEvo**
Processor	**Processor Intel Core i7 1360P**
RAM	**16 GB**
Hard Disk Drive	**1 TB SSD**

Software Environment

The hardware environment used in the development of papaya and honey seed delivery route optimization using ***Hybrid*** Particle Swarm ***Optimization*** with ***the dijkstra algorithm*** is as follows:

Table 9 Software Trial Environment

Software	Function
Windows 11 version 23H2	OS
Matlab R2024a	• Create a mathematical model • Optimize
Microsoft Excel 2020	• Processing data • Validate • Node graph creation

Implementation Limitations

The implementation limitations of the implementation of papaya and honey seed delivery route optimization using Hybrid Swarm Optimization with the Dijkstra Algorithm are as follows:

- The application only displays one route which is the best route generated by the calculation using Hybrid Swarm Optimization with the dijkstra algorithm.
- The use of maps of each city is carried out by making road intersections as nodes, where each street is depicted by drawing a line between one node to another according to the road data
- The map depicted is a map of each city as a whole, not a map of calculations.

1. Figure 7 Consumer Mileage Spread across Bogor and Rangkasbitung Regencies

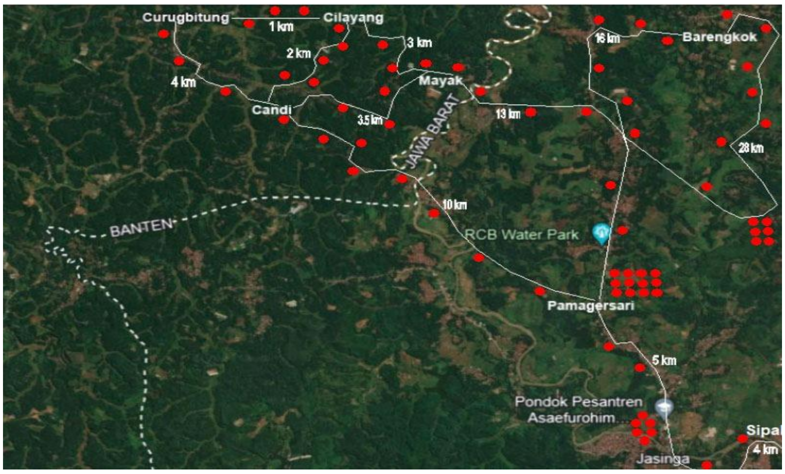


Figure 7. Distance Traveled by Each Node

2. Figure 8. Mileage Search for Each Node

Figure 8. Mileage Search for Each Node

Figures 7 and 8 are a display of the map of Bogor and Rangkas bitung regencies in which there is an image of an arrow showing the location point of Pamagersari Village as the initial location of the papaya and honey seed production house. K1 and K2, ... Kn, is the destination location. Road junctions on the map are called nodes where they are marked by red dots on the map display.

3. Enlarged Map View

Figure 9. Enlarged Map

Figure 9 is the map display in Figures 1 and 2. which has been enlarged so that the names of the nodes are clearly visible.

Table 10 Initialization of Node Naming

Native Node Name	Initialization
N28	a
N13	b
N3.5	c
N10	d
N2	e
N4	f
N16	g
N5	h

Table 10 is the initialization of the original node names into other names, namely sequential alphabetical letters, aiming to facilitate the depiction of the matrix process of finding the smallest weight of each node, each of which has a connection.

Table 11 Latitude and Longitude Location

Location	Road	Latitude	Longitude	Nearby Nodes
Papaya Seed Production House and Honey	Pamagersari Village Rt.01 Rw.03 Jasinga Village, Jasinga District, Bogor Regency	-6.301847	107.163662	a
K1	Jl.Raya Cigudeg Jasinga	-6.301295	107.163995	b
K2	Jl.Raya Curugbitung – Jasinga	-6.300991	107.164768	e

Table 11 is a description of latitude and longitude coordinates obtained from the system using Google geocoding. After the location coordinates are obtained, the system looks for the nearest node to be used as a reference point for the node's location.

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That the location of the papaya and honey seed production house (PT. Agro Apiari Mandiri) is adjacent to node a while K2 is adjacent to node e. The following is an explanation of the calculation of mileage using the Haversine Formula.

Table 12 Weight of Congestion

Road Condition	**Weight**
Usual	1
Lots Seamless	0.8
Bad	0.65
Severe traffic jam	0.4

Table 12 is an explanation of each congestion weight value. The weight of the road section is obtained from the assumption that the road section has a maximum capacity of vehicles consisting of four-wheeled vehicles with an average speed of 40 km/h.

So it is certain that on the road section there will be congestion, so one of the alternative lanes can be chosen by assuming the difference in weight of each road intersection that normal conditions are smooth roads so that they are given a weight of 1, which is 100% of the conditions of the average speed recorded. A weight of 0.8 is 80% of the road conditions are crowded and smooth. A weight of 0.65 is 65% of normal conditions which means that the road is jammed and 0.4 is a severe traffic jam.

Table 13 Distance and Relationship of Each Node

Node	Coordinates	Relationship		Distance Between Nodes (km)
		Node	Congestion Weight	
a	-6.301840782165527 107.16505432128906	b	0.4	0.03
		h	1	0.158
b	-6.301568984985452 107.16505432128906	c	0.4	0.031
		g	0.65	0.159
		a	0.65	0.03
c	-6.330718040466309 107.1871109008789	d	1	0.028
		f	0.4	0.159
		b	0.8	0.031
d	-6.301036357879639 107.1650390625	e	0.4	0.158
		f	1	0.028
e	-6.309691905975342 107.1411890930175781	d	0.4	0.158
		f	0.8	0.028
f	-6.311672687530518 107.14118194580078	e	0.65	0.028
		c	0.65	0.159
		g	0.65	0.031
g	-6301599502563477 107.16361236572266	b	1	0.159
		f	0.65	0.031
		h	0.8	0.03
h	-6.296785831451416 107.15249633789062	a	0.65	1.5
		g	1	0.03

Table 13 contains the relationship of each node and the predetermined congestion weight of the system. The distance is obtained from the calculations that have been previously exemplified. The following are the stages of finding the shortest route and travel time with the Dijkstra Algorithm using the weight of congestion.

a. Determine the average speed of the vehicle.
b. Calculating the Dijkstra matrix of the initial node set N6365 (location of papaya and honey seed production houses)
c. Calculation of travel time weight (hours)
d. Meng Convert travel time from hours to minutes

Furthermore, the value of the congestion weight between node a and node b is 0.4 and the distance obtained is 0.03 km. After the travel time between nodes is obtained, the shortest route is determined using the dijkstra matrix. The following is described in advance the results of the travel time that has been taken into account which can be seen in Table 5.

Table 14 Travel Time of All Nodes

Node Departure	Destination Node	Congestion Weight	Mileage	Travel Time
a	b	0.4	0.03	0.1125
	c	1	0.158	0.237
b	c	0.4	0.031	0.11625
	g	0.65	0.159	0.366923
	a	0.65	0.03	0.069231
c	d	1	0.028	0.042
	f	0.4	0.159	0.59625
	b	0.8	0.031	0.058125
d	e	0.4	0.158	0.5925
	c	1	0.028	0.042
e	d	0.4	0.158	0.5925
	f	0.8	0.028	0.0525
f	e	0.65	0.028	0.064615
	c	0.65	0.159	0.366923
	g	0.65	0.031	0.071538
g	b	1	0.159	0.2385
	f	0.65	0.031	0.071538
	h	0.8	0.03	0.05625
h	a	0.65	1.5	3.461538
	g	1	0.03	0.045

Table 14 is the result of the travel time of all nodes that have been obtained from the calculation of the travel weight. Where the parameters are departure nodes to each destination point. The destination point is the connected node. The travel time obtained is a material processed on the dijkstra matrix.

	Filing	Coordinates of Papaya and Honey Seeds		Factory Coordinates			Distance Traveled (km)	Travel Time (minutes)	Results of the order to -
		Latitude	**Longitude**	**Consumer Name**	**Latitude**	**Longitude**			
1	**Papaya Seed and Honey Production House**	-6.3019297	107.16500840000003	Mrs. Mardiyanah	-6.3098703,107	107.16020159999994	1.58	3.25	2
		-6.3019297	107.16020159999994	Mrs. Dayat	-6.3072119	107.16299679999997	1.64	3.17	1
		-6.30192997	107.16020159999994	Mr. Sriyono	-6.3097986	107.15524069999992	1.91	3.75	4
		-6.3019297	107.16020159999994	Mr. Dudi	-6.31251399999	107.15442610000002	1.74	3.60	3
		-6.3019297	107.16020159999994	Mrs. Tati	-6.3161217	107.17980080000007	3.17	6.70	5

There are 5 Consumer locations that are included in the list of delivery destinations for Papaya Seed Products and Honey at the same time. So that the order of consumers is found first to last based on the Optimm route to deliver papaya seed products and honey according to the order.

The first test results were obtained in the first order, namely Mr. Dayat's house, the second place was Mrs. Mardiyanah's house, the third place was Mr. Dudi's house, Mr. Sriyono's house and the last delivery was Mrs. Tati's house.

The sequence is obtained based on distance traveled and travel time where the first order is time and distance of small value.

Conclusion

Based on the results of the trial using Hybrid Swarm Optimization (PSO) parameters and the Dijkstra Algorithm on optimizing the delivery route of papaya and honey seeds, several conclusions can be drawn. Hybrid Swarm Optimization and Dijkstra's algorithm successfully provided an alternative delivery queue to some consumers, but faced problems when two locations were very close together, resulting in unrealistic mileage. Clustering using the Simplified Parallel Assignment method has been proven to be effective for Vehicle Routing Problems in PT. Agro Apiari Mandiri. The use of the right parameters in Particle Swarm Optimization results in minimal travel time, and the combination of Hybrid Swarm Optimization and the Dijkstra Algorithm provides optimal results. More efficient routing reduces distribution costs for shippers. The selection of population number and crossover probability values is important in the optimization of the Dijkstra Algorithm. For further development, it is recommended to use alternative methods, GIS applications, road segmentation updates, expansion of origin and destination areas, as well as consideration of route conditions and additional variables such as time constraints and available fleets. Implementation of other algorithms such as Differential Evolution, Ant Colony, and Simulated Annealing is also needed for the comparator in solving the Vehicle Routing Problem with Delivery and Pick-Up.

References

Cantona, A., Fauziah, F., & Winarsih, W. (2020). Implementasi algoritma dijkstra pada pencarian rute terpendek ke museum di Jakarta. *Jurnal Teknologi dan Manajemen Informatika*, *6*(1), 27–34.

Daouda, A. S. M., & Atila, Ü. (2024). A Hybrid Particle Swarm Optimization with Tabu Search for Optimizing Aid Distribution Route. *Artificial Intelligence Studies*, *7*(1), 10–27.

Darnita, Y., Toyib, R., & Rinaldi, R. (2017). Implementasi Algoritma Floyd Warshall Untuk Menentukan Letak Dan Lokasi Perusahaan Travel/Rental Mobil Di Kota Bengkulu. *Pseudocode*, *4*(2), 144–155.

Fatma, N. F., Ponda, H., & Roy, M. (2019). *Peningkatan Waktu Reaksi Pada Proses Produksi Produk Acrydic 5000x Dengan Konsep PDCA*. Heuristic.

Islam, M. A., Gajpal, Y., & ElMekkawy, T. Y. (2021). Hybrid particle swarm optimization algorithm for solving the clustered vehicle routing problem. *Applied Soft Computing*, *110*, 107655.

Khairina, N., & Harahap, M. K. (2019). RSA Cryptographic Algorithm using Cubic Congruential Generator. *Journal of Physics: Conference Series*, *1424*(1), 12010.

Koop, L., Ramos, N. M. do V., Bonilla-Petriciolet, A., Corazza, M. L., & Voll, F. A. P. (2024). A Review of Stochastic Optimization Algorithms Applied in Food Engineering. *International Journal of Chemical Engineering*, *2024*(1), 3636305.

Marlina, L., Suyitno, A., & Mashuri, M. (2017). Penerapan Algoritma Dijkstra dan Floyd-Warshall untuk Menentukan Rute Terpendek Tempat Wisata Di Batang. *Unnes Journal of Mathematics*, *6*(1), 36–47.

Munir, K., Ashraf, S., Munir, I., Khalid, H., Muneer, M. A., Mukhtar, N., Amin, S., Ashraf, S., Imran, M. A., & Chaudhry, U. (2020). Zoonotic and reverse zoonotic events of SARS-CoV-2 and their impact on global health. *Emerging microbes & infections*, *9*(1), 2222–2235.

Rofiq, M., & Uzzy, R. F. (2014). Penentuan Jalur Terpendek Menuju Cafe Di Kota Malang Menggunakan Metode Bellman-Ford Dengan Location Based Service Berbasis Android. *Jurnal Ilmiah Teknologi Informasi Asia*, *8*(2), 49–64.

Rudiyanto, A. D., Wahyuddin, M. I., & Andrianingsih, A. (2020). Perbandingan Algoritma Floyd-Warshall Dan Dijkstra Untuk Menentukan Rute Rumah Sakit Terdekat Jalur Evakuasi Kecelakaan Lalu Lintas Berbasis Web. *INTECOMS: Journal of Information Technology and Computer Science*, *3*(2), 336–345.

Sastrakarmanjata, I. B. R., Kusuma, P. D., & Setianingsih, C. (2021). Pemilihan Rute Terpendek Pasien Untuk Penanganan Covid–19 Di Jakarta Menggunakan Algoritma A. *eProceedings of Engineering*, *8*(5).

Setiawan, V., Kiftiah, M., & Partiwi, W. B. (2019). Analisis Algoritma Floyd Warshall Untuk Menentukan Lintasan Terpendek Pengangkutan Sampah (Studi Kasus: Pengangkutan Sampah di Kabupaten Kubu Raya). *Bimaster: Buletin Ilmiah Matematika, Statistika dan Terapannya*, *6*(03).

Wang, X. Z. (2018). The comparison of three algorithms in shortest path issue. *Journal of Physics: Conference Series*, *1087*(2), 22011.

Zhao, H., & Sharma, A. (2023). Logistics Distribution Route Optimization Based on Improved Particle Swarm Optimization. *Informatica*, *47*(2).