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Preface

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PROCEEDING NATIONAL CONFERENCE ON MATHEMATICS EDUCATION (NACOME) 2019

Theme : MODELING IN
MATHEMATICS
INSTRUCTION: THE
FIRST STEP TOWARDS
PROBLEM SOLVING

Palembang,
November 27 2019

Aula Pascasarjana Universitas
Sriwijaya

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<http://ejournal.fkip.unsri.ac.id/index.php/nacomeunsri>
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PREFACE

The honourable Rector of Universitas Sriwijaya

The honourable Dean of Faculty of Teacher Training and Education of Universitas Sriwijaya

The honourable invited guests, participants and speakers of National Conference on Mathematics Education (NaCoME) 2019.

On behalf of all National Conference on Mathematics Education (NaCoME) 2019 and Workshop on Mathematical Modeling Committees, I would like to express my deepest gratitude for your participation in this event. This year, NaCoME and Workshop on Mathematical Modeling 2019 is themed "Modeling in Mathematics Instruction: The First Step towards Problem Solving".

With the existence of industrial revolution 4.0, teachers are required to become more innovative in conducting instructions, either by utilizing technology, evaluating students' processes and learning outcomes, especially facilitating students to support their higher order thinking skills. With those frames in mind, students must be fostered to be able to compete globally, therefore, the purpose of holding this event is to increase student achievement and competitive spirit, while increasing the insight of educators, prospective educators, and education personnel to improve the quality of education.

As the chair of this event, I would like to report that we have invited participants from all of South Sumatra Province through collaboration with the Mathematics Education Alumni Association (IKADIKMAT) and Universitas Sriwijaya. The total participants in this event consisting of 131 speakers, 162 non-speaker participants, and 41 workshop participants, come from 11 provinces from all over Indonesia namely from DI Aceh, South Sumatra, Lampung, DKI Jakarta, Banten, West Sumatra, Bengkulu, Jambi, West Java, West Sulawesi, and Nusa Tenggara Timur. The Keynote speakers of this Event are Dr. Tan Liang Soon from the Academy of Singapore Teachers, Prof. Wono Setiabudhi, Professor of mathematics from the Bandung Institute of Technology, and Dr. Yusuf Hartono, Associate Professor of Mathematics Education from Universitas Sriwijaya.

Through blind review session, revision, and editors' considerations, we have selected 86 articles out of 131 submitted papers to be published in Scopus-indexed IOP Conference Proceeding (Journal of Physics: Conference Series). Hopefully, these papers will make a significant contribution to education in Indonesia and throughout the world.

Chair of NaCoME 2019

Dr. Darmawijoyo



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Peer review statement

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Mathematical modelling of traveling salesman problem (TSP) by implementing simulated annealing and genetic algorithms

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Mathematical modelling of traveling salesman problem (TSP) by implementing simulated annealing and genetic algorithms

F M Puspita^{1*}, A Meitriova², and S Yahdin¹

¹Mathematics Department, Faculty of Mathematics and Natural Sciences, Universitas Sriwijaya, Indralaya, South Sumatra, Indonesia

²Mathematics Education Program, Postgraduate Program, Universitas Sriwijaya, Palembang, South Sumatra, Indonesia

*Corresponding author's email: fitrimayapuspita@unsri.ac.id

Abstract. The Traveling Salesman Problem (TSP) is very well known as one of the optimization problems of circuit of Hamiltonian, which will seek for the shortest route that must be passed by a number of city salesmen exactly once and will return to the initial city. Genetic Algorithm (GA) and Simulated Annealing (SA) are one method that can be used in TSP case. Fertilizer distribution at PT. Sahabat Mewah dan Makmur (SMM) in Belitung which is one of the branches of PT. Austindo Nusantara Jaya Group does not yet have an optimal fertilizer distribution schedule, where when fertilizer will be distributed from the starting point of distribution to the location of storage warehouses, it is not determined which location points will receive delivery, shipments are made to warehouse locations that still have enough storage space or stacked in the nearest warehouse. PT.SMM distributes fertilizer from Port of Tanjung Pandan to warehouses in Jangkang, Balok, Ladang Jaya, Sari Bunga, and Aik Ruak. The results show that in the GA of 120 routes, there are 8 routes with a distance of 175 km; In SA, the shortest distance is equal to GA, which is 175 km.

1. Introduction

Optimization is the process of making something better than before or the process of finding the best solution (the optimal value) from the optimization problem [1,2]. One optimization problem is determining the shortest route. In general, determining the shortest route can use conventional methods [3, 4] and heuristic methods. Conventional methods are easier to understand than heuristic methods, because in the conventional method only comparing the distance and finding the shortest distance while in the heuristic method the results obtained are more varied, more accurate, the error rate is smaller, and the calculation time is more short [5].

Traveling Salesman Problem (TSP) is one form of optimization problem from the Hamiltonian circuit (the path that passes every point exactly once, except the origin and end points that are passed twice) [6], where the shortest route to be passed by a number of city salesmen exactly one time and returned to the city early (starting point of distribution) [7,8].

The heuristic method consists of various kinds of algorithms, one of which are genetic algorithm and simulated annealing [5-9]. Genetic Algorithm (GA) branch of the evolution algorithm which can be said as an adaptive method commonly used to solve value search problems in an optimization problem [7-10]. GA is based on genetic processes that exist in living things [7-11], in this study based on the distribution route and distance traveled. GA can be used to find solutions to problems in the real world whether simple or complex problems, if well designed it will produce an optimum solution [8, 9]. In this study, the GA stage includes determining a possible distribution route to be a solution, evaluating



distribution routes, calculating convergent percentages of distribution routes, checking stop conditions, selecting distribution routes, exchanging selected distribution routes, mutating selected distribution routes, checking again the distribution route chosen was the final solution [7].

Simulated Annealing (SA) is an algorithm that is applied with the aim of finding an approach to the global optimum solution of a combinatorial problem, where the existing search space for solutions is too broad, so there is no way to find exact solutions to these problems [12-16]. SA was developed based on the idea of the mechanism of cooling behavior and the process of crystallization (annealing) of hot material [12-17]. In this article, the SA stage is to bring up the initial state which is the distribution route, calculate the amount of distance traveled, update the distribution route, calculate the number of mileage distribution routes that have been updated, choose a random number (0,1], calculate the probability based on Boltzmann distribution, compare the value of Boltzmann probability calculation and random generated value [18].

Previously, research on GA and SA had been carried out by Widyadana and Pamungkas [12], which concluded that in terms of performance and processing time SA was superior to GA. In general, the advantages of GA include optimizing variables, can be used on extensive data searches, providing a list of optimal variables not only a single solution, can be used on flexible data [19,20]. In general, the advantages of SA are being able to avoid local minimum traps [21].

At present, the oil palm plantation industry has mushroomed in almost all regions in Indonesia. With the many companies and communities that have oil palm plantations, of course competition in the number of production, quality of production and human resources is increasingly stringent from day to day. Good and correct management of oil palm plants will produce good quality production, in managing oil palm plantations fertilizers are usually needed as a source of nutrients needed by plants that lack nutrients. Fertilizer distribution at PT. Sahabat Mewah dan Makmur (SMM) in Belitung which is one of the branches of PT. Austindo Nusantara Jaya Group does not yet have an optimal fertilizer distribution schedule, where when fertilizer will be distributed from the starting point of distribution to the location of storage warehouses it is not determined which location points will receive delivery, shipments are made to warehouse locations that still have enough storage space or stacked in the nearest warehouse. Optimal fertilizer distribution is expected to make it easier for employees to distribute fertilizer from the distribution starting point to the intended distribution points and reduce fertilizer delivery costs. That is why the research on designing the mathematical modelling of distribution routes of this company is crucial to be conducted.

2. Method

The methods used are Genetic Algorithm and Simulated Annealing. The data used in this study was obtained from one of the branches of the ANJ Group in Belitung, namely PT. Sahabat Mewah dan Makmur (SMM). The data used is secondary data (is from PT. SMM in 2016) about the starting point of the location and the location of the destination for the distribution of fertilizers along with the distance traveled. The research was conducted at the Mathematics Department, Faculty of Mathematics and Natural Sciences, Sriwijaya University.

Implementation of TSP with GA and SA on the problem of fertilizer distribution at PT. SMM, where with the starting point of distribution is Port of Tanjung Pandan, Belitung and distribution points for warehouse purposes in Jangkang, Balok, Ladang Jaya, Sari Bunga, and Aik Ruak.

3. Result and Discussion

3.1. Genetic Algorithm (GA)

Some terms that must be understood in GA are Genotype (Genes), Allele, Chromosome, Individual, Population and Fitness Value [22]. In this study, genes are sequences of vertex numbers (position) from the intended distribution and location of warehouses, alleles are numbers given at vertex, Chromosomes are fertilizer distribution routes of PT. SMM, Individuals are distances that may be a solution, Population is a set of distances travel that might be a solution, and fitness value is the number of mileage of the distribution route.

Table 1 states the distribution location where vertex 1 states Port of Tanjung Pandan as the starting point for distribution, vertex 2 is warehouse location in Jangkang, vertex 3 explains warehouse location in Balok, vertex 4 is warehouse location in Ladang Jaya, vertex 5 describes the warehouse location in Sari Bunga, and vertex 6 denotes the warehouse location in Aik Ruak.

Table 1. Distribution location.

Number of vertex	Distribution location
1	Port of Tanjung Pandan
2	Jangkang Estate
3	Balok Estate
4	Ladang Jaya Estate
5	Sari Bunga Estate
6	Aik Ruak Estate

Then, Table 2 states the distance between distribution locations where 1-2 states the distance from the Port of Tanjung Pandan to the warehouse location in Jangkang and 2-1 states the distance from the warehouse location in Jangkang to Tanjung Pandan Port with the same distance of 45 km, and so on until the route sequence number 5-6 and 6-5 has the same distribution distance of 22 km.

Table 2. Distance between distribution location.

Route Sequence Number		Distance Between Distribution Location (Km)
1 – 2	2 – 1	45
1 – 3	3 – 1	55
1 – 4	4 – 1	58
1 – 5	5 – 1	65
1 – 6	6 – 1	70
2 – 3	3 – 2	10
2 – 4	4 – 2	13
2 – 5	5 – 2	20
2 – 6	6 – 2	25
3 – 4	4 – 3	23
3 – 5	5 – 3	35
3 – 6	6 – 3	33
4 – 5	5 – 4	7
4 – 6	6 – 4	15
5 – 6	6 – 5	22

After describing the data, it is continued by determining the distribution route. In the TSP coding used is permutation encoding, the distribution route is permutation *vertex* 1, 2, 3, 4, 5, and 6. Where the distribution route consists of:

$$(n - 1)! = (6 - 1)! = 5! = 5 \times 4 \times 3 \times 2 \times 1 = 120 \text{ routes}$$

Distribution routes are formed randomly, expressed as vector v :

$$v_k = [g_1, g_2, \dots, g_n] \text{ with } 1 \leq k \leq \text{size of population}$$

With:

v_k : Distribution route to k

g_1, g_2, \dots, g_n : *vertex* to 1, 2, ..., n

From the 120 routes that might be the solution, 15 routes with different amounts of mileage, are randomly selected using Microsoft Excel (in Table 3) were obtained. Table 3 shows the distribution

routes and the number of distances, as number 1 (v_1) the distribution routes is 1 – 4 – 5 – 6 – 3 – 2 – 1 state the distribution route from Port of Tanjung Pandang – Ladang Jaya – Sari Bunga – Aik Ruak – Balok – Jangkang – Port of Tanjung Pandan with a total distance of 175 km, and so on until v_{15} (as described in the same way as v_I).

Table 3. Distribution routes with different amounts of mileage once randomly selected using Microsoft Excel from 120 routes that might be solutions.

Number	Distribution Routes (v_k)	Amount of Mileage $f(v_k)$ (km)
1 = v_1	1 – 4 – 5 – 6 – 3 – 2 – 1	$58 + 7 + 22 + 33 + 10 + 45 = 175$
2 = v_2	1 – 6 – 4 – 5 – 2 – 3 – 1	$70 + 15 + 7 + 20 + 10 + 55 = 177$
3 = v_3	1 – 4 – 6 – 5 – 2 – 3 – 1	$58 + 15 + 22 + 20 + 10 + 55 = 180$
4 = v_4	1 – 6 – 4 – 5 – 3 – 2 – 1	$70 + 15 + 7 + 35 + 10 + 45 = 182$
5 = v_5	1 – 4 – 6 – 5 – 3 – 2 – 1	$58 + 15 + 22 + 35 + 10 + 45 = 185$
6 = v_6	1 – 2 – 5 – 4 – 3 – 6 – 1	$45 + 20 + 7 + 23 + 33 + 70 = 198$
7 = v_7	1 – 5 – 4 – 3 – 2 – 6 – 1	$65 + 7 + 23 + 10 + 25 + 70 = 200$
8 = v_8	1 – 2 – 4 – 3 – 6 – 5 – 1	$45 + 13 + 23 + 33 + 22 + 65 = 201$
9 = v_9	1 – 3 – 4 – 2 – 6 – 5 – 1	$55 + 23 + 13 + 25 + 22 + 65 = 203$
10 = v_{10}	1 – 4 – 5 – 3 – 2 – 6 – 1	$58 + 7 + 35 + 10 + 25 + 70 = 205$
11 = v_{11}	1 – 2 – 5 – 3 – 6 – 4 – 1	$45 + 20 + 35 + 33 + 15 + 58 = 206$
12 = v_{12}	1 – 2 – 6 – 5 – 3 – 4 – 1	$45 + 25 + 22 + 35 + 23 + 58 = 208$
13 = v_{13}	1 – 4 – 3 – 6 – 2 – 5 – 1	$58 + 23 + 33 + 25 + 20 + 65 = 224$
14 = v_{14}	1 – 6 – 3 – 5 – 2 – 4 – 1	$70 + 33 + 35 + 20 + 13 + 58 = 229$
15 = v_{15}	1 – 5 – 3 – 4 – 2 – 6 – 1	$65 + 35 + 23 + 13 + 25 + 70 = 231$

After determining the distribution route, continue the GA stage by evaluating the distribution route selected in Table 3, so that the number of mileage $f(v_k)$ is obtained (in Table 3). Based on Table 3 and evaluation of the distribution route above, the distribution route v_1 is the best distribution route with the smallest mileage.

Then proceed with distribution route selection using the roulette wheel, with the roulette wheel stage (determine the minimum function of each distribution route mileage, determine the total evaluation of the distribution route mileage, determine the probability value for each distribution route, determine the cumulative probability value of each route distribution) based on the conditions at that stage, the distribution route v_1 obtained through selection is the same as the v_8 distribution route before being selected. New distribution route after going through the roulette wheel selection stages, is presented in Table 4.

Table 4. New distribution route after going through the roulette wheel selection stages.

Distribution Routes (v_k)	Distribution Routes on Table 4 are the same with Distribution Route on Table 3
1 - 2 - 4 - 3 - 6 - 5 - 1	$v_1 = v_8$
1 - 4 - 6 - 5 - 2 - 3 - 1	$v_2 = v_3$
1 - 2 - 6 - 5 - 3 - 4 - 1	$v_3 = v_{12}$
1 - 4 - 5 - 3 - 2 - 6 - 1	$v_4 = v_{10}$
1 - 6 - 4 - 5 - 3 - 2 - 1	$v_5 = v_4$
1 - 4 - 5 - 6 - 3 - 2 - 1	$v_6 = v_1$
1 - 5 - 4 - 3 - 2 - 6 - 1	$v_7 = v_7$
1 - 4 - 6 - 5 - 3 - 2 - 1	$v_8 = v_5$
1 - 6 - 4 - 5 - 2 - 3 - 1	$v_9 = v_2$
1 - 2 - 5 - 4 - 3 - 6 - 1	$v_{10} = v_6$
1 - 3 - 4 - 2 - 6 - 5 - 1	$v_{11} = v_9$
1 - 5 - 3 - 4 - 2 - 6 - 1	$v_{12} = v_{15}$
1 - 2 - 5 - 3 - 6 - 4 - 1	$v_{13} = v_{11}$
1 - 4 - 3 - 6 - 2 - 5 - 1	$v_{14} = v_{13}$
1 - 6 - 3 - 5 - 2 - 4 - 1	$v_{15} = v_{14}$

After the distribution route selection, the GA stage is continued with cross-breeding. In this study, the process of interbreeding uses the Single-Point Crossover (SPX) method. In the SPX stage, the crossover (pc) probability is assumed to be 0.25. After the SPX stage is complete the distribution route chosen is the distribution route v_{11} and v_{15} . Distribution routes after crossing using the SPX method are as follows.

Table 5. Distribution routes after crossing using the SPX method.

Distribution Routes (v_k)
1 - 2 - 4 - 3 - 6 - 5 - 1
1 - 4 - 6 - 5 - 2 - 3 - 1
1 - 2 - 6 - 5 - 3 - 4 - 1
1 - 4 - 5 - 3 - 2 - 6 - 1
1 - 6 - 4 - 5 - 3 - 2 - 1
1 - 4 - 5 - 6 - 3 - 2 - 1
1 - 5 - 4 - 3 - 2 - 6 - 1
1 - 4 - 6 - 5 - 3 - 2 - 1
1 - 6 - 4 - 5 - 2 - 3 - 1
1 - 2 - 5 - 4 - 3 - 6 - 1
1 - 3 - 3 - 5 - 2 - 4 - 1
1 - 5 - 3 - 4 - 2 - 6 - 1
1 - 2 - 5 - 3 - 6 - 4 - 1
1 - 4 - 3 - 6 - 2 - 5 - 1
1 - 6 - 4 - 2 - 6 - 5 - 1

After the crossing process is complete, the GA stage is followed by a mutation on the distribution route using Microsoft Excel randomized distribution points so that it is obtained:

Table 6. Result of randomization vertex.

Vertex	Result of randomization vertex
1	3
2	1
3	4
4	6
5	2
6	5

From table 6 after vertex is randomized, vertex 1 is replaced by vertex 3, vertex 2 is replaced by vertex 1, and so on. The number of distribution routes that have mutated in one generation is $n * pop_size = 6(15) = 90$ routes. If the specified mutation probability value (pm) is 0.01 then it is expected that $0.9 \approx 1$ mutation per route. Each distribution route has the same opportunity to experience mutations, therefore random numbers that have a range (0,1] will be selected using Microsoft Excel as many as 90. Distribution routes that have random numbers smaller than $pm = 0.01$ are chosen as mutations. The distribution routes selected are shown in Table 7.

Table 7. Distribution routes chosen to be moved.

Sequence Position of Random Numbers	Distribution route to -	Numbering Route to -	Random Numbers
13	12	3	0.001087

From Table 7, the position of a random number sequence that has a value of 0.001087 which is randomized using Microsoft Excel is number 13, with the distribution route that experiences mutations is the 12th distribution route in Table 3 and the randomized distribution point is the 3rd point, so that the distribution route is obtained after the mutation:

Table 8. Distribution routes after the mutation.

Distribution Routes (v_k)
1 - 2 - 4 - 3 - 6 - 5 - 1
1 - 4 - 6 - 5 - 2 - 3 - 1
1 - 2 - 6 - 5 - 3 - 4 - 1
1 - 4 - 5 - 3 - 2 - 6 - 1
1 - 6 - 4 - 5 - 3 - 2 - 1
1 - 4 - 5 - 6 - 3 - 2 - 1
1 - 5 - 4 - 3 - 2 - 6 - 1
1 - 4 - 6 - 5 - 3 - 2 - 1
1 - 6 - 4 - 5 - 2 - 3 - 1
1 - 2 - 5 - 4 - 3 - 6 - 1
1 - 3 - 3 - 5 - 2 - 4 - 1
1 - 5 - 4 - 3 - 2 - 6 - 1
1 - 2 - 5 - 3 - 6 - 4 - 1
1 - 4 - 3 - 6 - 2 - 5 - 1
1 - 6 - 4 - 2 - 6 - 5 - 1

The last stage of GA is decoding, where recalculation is carried out on the number of distribution routes that have gone through the stages of selection, crossing and mutation. The decoding result is v_{11}

and v_{15} which is not Hamiltonian (one vertex is passed twice and there is another vertex that is not skipped).

3.2. Simulated Annealing (SA)

The Simulated Annealing steps are as follows:

- 1) Select the initial *state* S_0 , for example is $1 - 2 - 3 - 6 - 4 - 5 - 1$
- 2) Calculate *energy* E_0 pada S_0 , is $1 - 2 - 3 - 6 - 4 - 5 - 1 = 45 + 10 + 33 + 15 + 7 + 65 = 175$ km.
- 3) State S updates with the update rules according to the problem being S_i , is:
 - a. Choose randomly r_1 dan r_2 with points (1,6], using Microsoft Excel.
 - b. For *state* values at position r_1 until position r_2 is exchanged. Obtained $r_1 = 2$ and $r_2 = 3$
State before being update $1 - 2 - 3 - 6 - 4 - 5 - 1$
State after being update $1 - 3 - 2 - 6 - 4 - 5 - 1$
 - c. Calculate *energy* E_i , $1 - 3 - 2 - 6 - 4 - 5 - 1 = 55 + 10 + 25 + 15 + 7 + 65 = 177$ km.
- 4) Select uniform distribution random number $p = (0.1]$; $p = 0.396478$ (using Microsoft Excel)
- 5) Ifa $p < e^{-\frac{\Delta E}{kT}}$, the *state* is accepted; if doesn't, the *state* is rejected. Calculate *Boltzmann* probability with $T = 0,2$; obtained:

$$p(E) = e^{-\frac{E_i - E_0}{kT}} = e^{-\frac{177 - 175}{(1,380658 \times 10^{-23})0,2}} = e^{-\frac{2}{2,761316 \times 10^{-24}}} = 1$$

because $p < e^{-\frac{\Delta E}{kT}}$, so the *state* is accepted.

- 6) Back to step 3, because the updated state distance is not the shortest route, repeat until the updated route is the shortest route, so the shortest route in SA is route $1 - 2 - 3 - 6 - 5 - 4 - 1$ with mileage of 175 km.

From the 120 possible routes can be solution, there are 15 different distances are 8 routes with mileage of 175 km, 12 routes with mileage of 177 km, 8 routes with mileage of 180 km, 4 routes with mileage of 182 km, 4 routes with mileage of 185 km, 12 routes with mileage of 198 km, 4 routes with mileage of 200 km, 12 routes with mileage of 201 km, 16 routes with mileage of 203 km, 4 routes with mileage of 205 km, 4 routes with mileage of 206 km, 20 routes with mileage of 208 km, 4 routes with mileage of 224 km, 4 routes with mileage of 229 km, and 4 routes with mileage of 231 km.

Based on Table 3, as for the shortest route obtained from GA with a distance of 175 km, namely:

- 1) Port of Tanjung Pandan - Jangkang - Balok - Aik Ruak - Sari Bunga - Ladang Jaya - Port of Tanjung Pandan;
- 2) Port of Tanjung Pandan - Jangkang - Balok - Aik Ruak - Ladang Jaya - Sari Bunga - Port of Tanjung Pandan;
- 3) Port of Tanjung Pandan - Jangkang - Ladang Jaya - Sari Bunga - Aik Ruak - Balok - Port of Tanjung Pandan;
- 4) Port of Tanjung Pandan - Jangkang - Sari Bunga - Ladang Jaya - Aik Ruak - Balok - Port of Tanjung Pandan;
- 5) Port of Tanjung Pandan - Balok - Aik Ruak - Ladang Jaya - Sari Bunga - Jangkang - Port of Tanjung Pandan;
- 6) Port of Tanjung Pandan - Balok - Aik Ruak - Sari Bunga - Ladang Jaya - Jangkang - Port of Tanjung Pandan;
- 7) Port of Tanjung Pandan - Ladang Jaya - Sari Bunga - Aik Ruak - Balok - Jangkang - Port of Tanjung Pandan;
- 8) Port of Tanjung Pandan Port - Sari Bunga - Ladang Jaya - Aik Ruak - Balok - Jangkang - Port of Tanjung Pandan;

4. Conclusion

From the calculations in SA, the shortest route for the distribution of fertilizer PT. SMM is the Port of Tanjung Pandan - Jangkang - Balok - Aik Ruak - Sari Bunga - Ladang Jaya - Port of Tanjung Pandan with a distance of 175 km.

The results of calculations in GA and SA are the same as the results, the shortest route of fertilizer distribution is obtained in PT. SMM with a distance of 175 km. From the length of time spent to calculate the shortest route with GA and SA, the calculation using SA is faster than GA.

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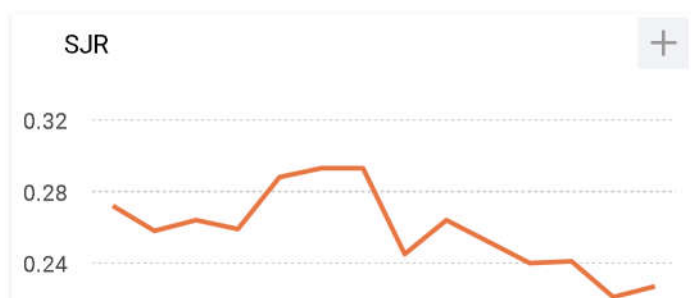
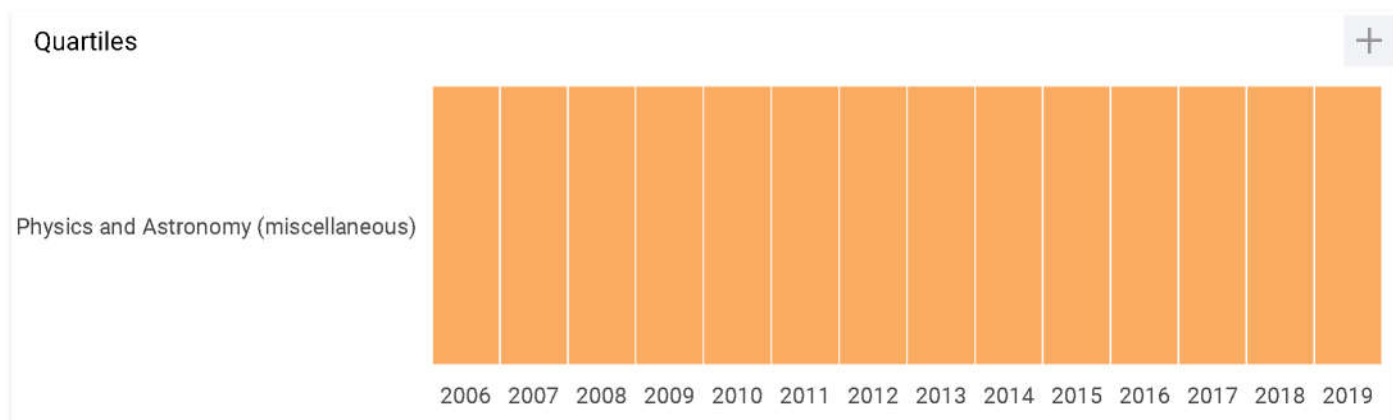
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Journal of Physics: Conference Series

Country	United Kingdom - SJR Ranking of United Kingdom	<h1 style="font-size: 48px; margin: 0;">70</h1> <p style="margin: 0;">H Index</p>
Subject Area and Category	Physics and Astronomy Physics and Astronomy (miscellaneous)	
Publisher	IOP Publishing Ltd.	
Publication type	Journals	
ISSN	17426588, 17426596	
Coverage	2005-2020	
Scope	The open access Journal of Physics: Conference Series (JPCS) provides a fast, versatile and cost-effective proceedings publication service.	
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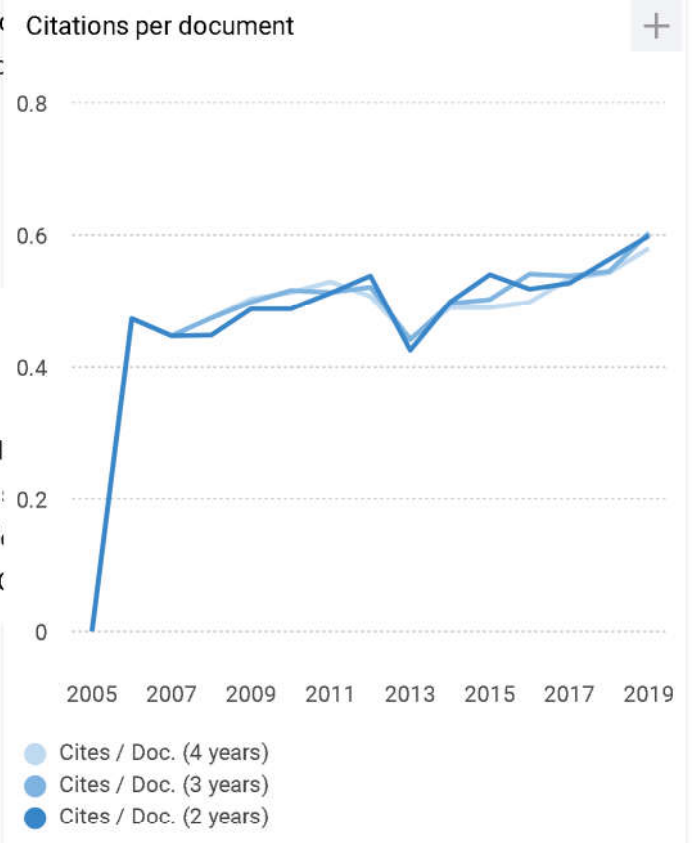
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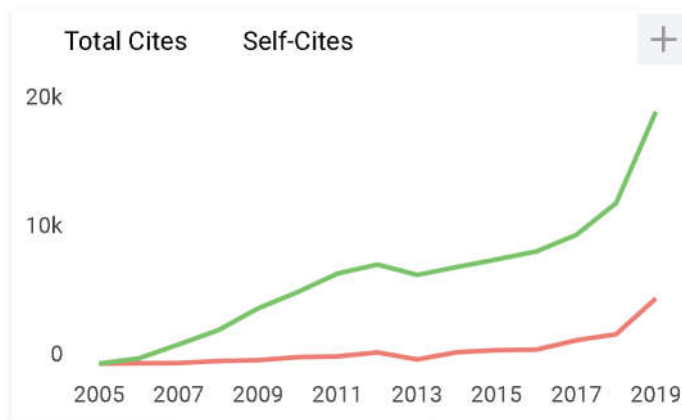
Melanie Ortiz 4 weeks ago

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Saiqa Khan 1 month ago

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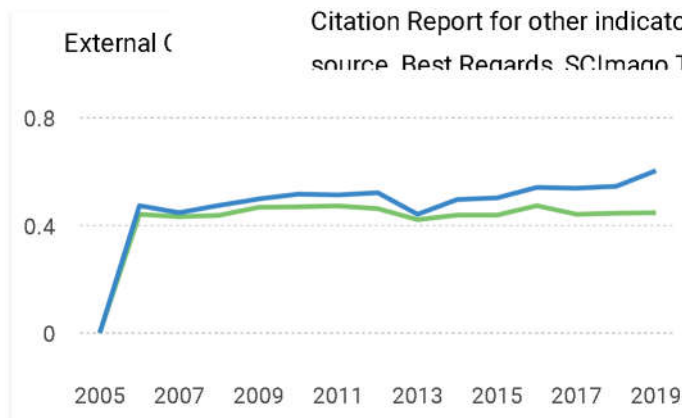


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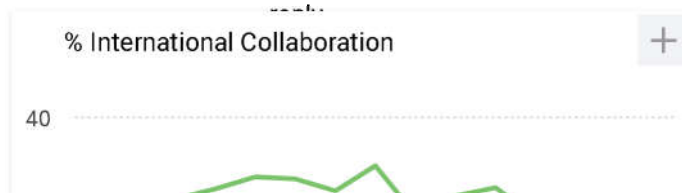
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Citation Report for other indicators (like Impact Factor) with a Web of Science data source. Best Regards, SCImago Team

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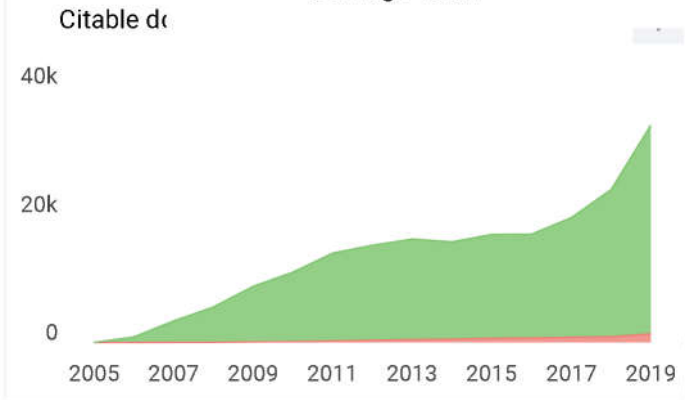
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Melanie Ortiz 1 month ago

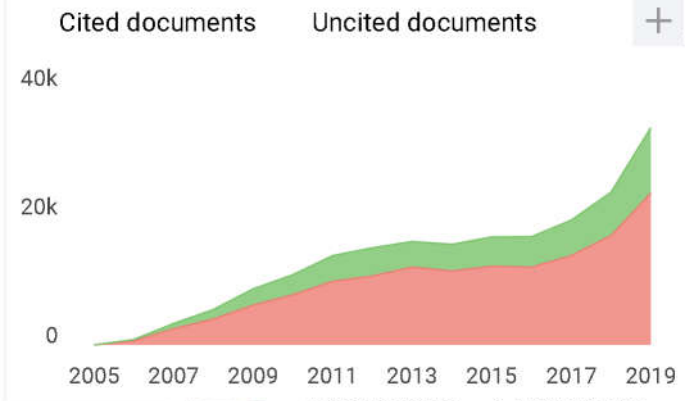
Dear Ahmad,

Thank you for contacting us. We calculate the SJR data for all the publication types, but the Quartile data are only calculated for Journal type's publications. Best regards,
SCImago Team



2 months ago

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performance and physiological status of stressed Japanese
Conf. Series: Journal of Physics: Conf. Series 1294 (2019)
ous Preview , although the journal is registered in Scopus



SCImago Team



Melanie Ortiz 2 months ago

Dear Sir,

thank you very much for your comment, unfortunately we cannot help you with your request. We suggest you to contact directly with Scopus support:

https://service.elsevier.com/app/answers/detail/a_id/14883/kw/scimago/supporthub/scopus/

Best Regards, SCImago Team

Journal of Physics: Conference Series
Q3
SJR 2019 0.23
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Rose 4 months ago

Dear SCImago Team,

It is stated in the JPCS homepage that the journal is a proceeding publication (<https://iopscience.iop.org/journal/1742-6596>). Is it valid and common for proceeding publication to have Q3 rank over years in scopus?

Looking forward for you explanation.

reply



Melanie Ortiz 4 months ago

SCImago Team

Dear Rose,

Thank you for contacting us.

As you probably already know, SJR is a portal with scientometric indicators of journals indexed in Scopus. All the data have been provided By Scopus /Elsevier. This fact implies that Scopus sends us an annual update of their publications and their metadata. If Journal of Physics: Conference Proceeding appears as a "Journal publication's type " it means that Scopus has categorized it like this. In addition, we have to say that the metadata belongs to Scopus, thus SCImago doesn't have the authority over this data which are exclusively property of Scopus/Elsevier. SCImago has a signed agreement that limits our performance to the generation of scientometric indicators derived from the metadata sent in the last update.

Referring the indicators, we inform you that we calculate the SJR data for all the publication types, but the Quartile data are only calculated for Journal type's publications.

Best regards, SCImago Team

D Dian Handayani 5 months ago

Dear editor,

We intend to a held conference in the medical and health science scope. Is that possible for us to send our full paper that has been presented (oral presentation) to be published in this journal as proceeding?

Many thanks, looking forward for your favorable feedback

Regards,

Dian

reply



Melanie Ortiz 5 months ago

SCImago Team

Dear Dian,

thank you for contacting us.

We are sorry to tell you that SCImago Journal & Country Rank is not a journal. SJR is a portal with scientometric indicators of journals indexed in Elsevier/Scopus.

Unfortunately, we cannot help you with your request, we suggest you to contact the journal's editorial staff , so they could inform you more deeply. Best Regards, SCImago Team



La Zakaria 5 months ago

I would like to ask you about Sjr for 2019.

reply



Melanie Ortiz 5 months ago

SCImago Team

Dear La Zakaria ,The indicators for 2019 will be available in June 2020 and before that we can't know what will happen whith with this journal . Best Regards, SCImago Team

J

Jorge Moreno 5 months ago

Dear Editorial Board,

I have a question: I am an author of this journal and I need the paper to be included in OpenAIRE, to then include it in my EC project. I have been looking for it but I couldn't find it. Could you help me with some instructions?

Thanks a lot for your help!

Jorge

reply



Melanie Ortiz 5 months ago

SCImago Team

Dear Jorge,

thank you for contacting us.

We are sorry to tell you that SCImago Journal & Country Rank is not a journal. SJR is a portal with scientometric indicators of journals indexed in Elsevier/Scopus.

Unfortunately, we cannot help you with your request, we suggest you to contact the journal's editorial staff , so they could inform you more deeply. Best Regards, SCImago Team

H

HÜSEYİN KALKAN 6 months ago

Hello Dear Authorized

Which indexes are your journal entitled "Journal of Physics: Conference Series". I need this information I'll be glad if you help with this. Yours truly. Dr. Hüseyin KALKAN

reply



Melanie Ortiz 6 months ago

SCImago Team

Dear HÜSEYİN,

thank you for contacting us.

Sorry to tell you that SCImago Journal & Country Rank is not a journal. SJR is a portal with scientometric indicators of journals indexed in Elsevier/Scopus.

Unfortunately, we cannot help you with your request, we suggest you to visit the journal's homepage or contact the journal's editorial staff , so they could inform you more deeply.

Best Regards, SCImago Team

S Sirwan 7 months ago

Dear this journal why is not in the Thomson Reuters?

reply



Melanie Ortiz 7 months ago

SCImago Team

Dear Sirwan, SCImago Journal and Country Rank uses Scopus data, our impact indicator is the SJR. Check our web to locate the journal. We suggest you to consult the Journal Citation Report for other indicators (like Impact Factor) with a Web of Science data source. Best Regards, SCImago Team

T ThangNguyen 7 months ago

Dear, Editorial Board!

Our paper was published in the Journal of Physics: Conference Series, 11/2019. But now, we cannot find it on site Scopus.com. Question to you: is this paper was included in the scopus database or not?

Thank you very much!

reply

SCImago Team

**Melanie Ortiz** 7 months ago

Dear Thang,
thank you for contacting us.
Sorry to tell you that SCImago Journal & Country Rank is not a journal. SJR is a portal with scientometric indicators of journals indexed in Elsevier/Scopus.
Unfortunately, we cannot help you with your request, we suggest you to contact the journal's editorial staff , so they could inform you more deeply. Best Regards, SCImago Team

T tamara 7 months ago

we participate in 2nd international conference and our paper was published in journal of physics: conference series ,2019
I ask : did this journal stay in rank Q3 in 2019 .

reply

SCImago Team

**Melanie Ortiz** 7 months ago

Dear Tamara, the publication of articles referring to 2019 is not over yet (we are in December), and much less it has been possible to cite unpublished articles. The 2019 indicators will not be available until June 2020. We cannot see what will happen in the future with this journal. Best Regards, SCImago Team

S Sri Wahyuningsih 7 months ago

Dear, The Editorial Board,

I have a publication in Journal of Physics: Conference Series. But I have a problem, because my name in the journal is wrong. Is it possible to fix it?

Thank you for your attention

Best regards

reply

SCImago Team

**Melanie Ortiz** 7 months ago

Dear Sri,

thank you for contacting us.

Sorry to tell you that SCImago Journal & Country Rank is not a journal. SJR is a portal with scientometric indicators of journals indexed in Elsevier/Scopus.

Unfortunately, we cannot help you with your request, we suggest you to contact the journal's editorial staff , so they could inform you more deeply. Best Regards, SCImago Team

J Jnana Ranjan Senapati 8 months ago

I have a publication in Journal of Physics: conference series. Whether it will be considered as a journal or conference proceeding ?

reply

A ahmed abed 8 months ago

dear Jnana Ranjan Senapati

as shown in in the Publication type (upper the page)

it is JOURNAL



Melanie Ortiz 8 months ago

SCImago Team

Dear Jnana,

thank you for contacting us.

Unfortunately, we cannot help you with your request, we suggest you to contact the journal's editorial staff , so they could inform you more deeply.

Best Regards, SCImago Team

A Archana Varsoliwala 8 months ago

Dear, Editorial Board.

This "Journal of Physics: Conference Series" is classified as 'Journal' or 'Conference Proceeding'? I am confused about this. So kindly reply and try to remove my confusion.

Thank you.

Regards,

reply

M MD SARFARAZ ALAM 5 months ago

Dear Archana Varsoliwala

I have checked on the SCOPUS website and got the result JPCS will consider as a Journal.
You can also check this information in this link: <https://www.scopus.com/sources.uri>

Regard

Md. Sarfaraz Alam
Research Scholar
IIT Guwahati (India)



Melanie Ortiz 8 months ago

SCImago Team

Dear Archana,

You can see the Publication type just above. Best Regards, SCImago Team

M Minetaka Sugiyama 2 years ago

Dear Ms. Elena Corera,

I am sorry to ask you such a basic question but only some papers in Journal of Physics conference series can be found in PubMed.

Is it possible to search and see other papers in PubMed?

Sincerely yours,
Minetaka Sugiyama

reply

I Igor V. Bogachkov 2 years ago

I see my papers (Journal of Physics: Conference Series, 2018, v. 1015) in "Web of Sc.", but cannot see ISI or Quartile in WoS! Q3 is only Scopus, or WoS too?

1. Bogachkov I. V. Detection of initial level of Brillouin frequency shift in optical fibres of different types // Journal of Physics: Conference Series, 2018, v. 1015 (2018). – pp. 1 – 6. DOI: 10.1088/1742-6596/1015/2/022004 WOS:000446952000004 (ISSN: 1742-6588)

2. Bogachkov I. V., Lutchenko S. S. Reliability assessment of fiber optic communication lines depending on external factors and diagnostic errors // Journal of Physics: Conference Series, 2018, v. 1015 (2018). – pp. 1 – 7. DOI: 10.1088/1742-6596/1015/2/022005 WOS:000446952000005 (ISSN: 1742-6588)

Wait your answer, best regards.



Elena Corera 2 years ago

SCImago Team

Dear Minetaka,

thank you very much for your comment. Unfortunately, we cannot help you with your request, we suggest you contact journal's editorial staff so they could inform you more deeply. You can find contact information in SJR website <https://www.scimagojr.com>

Anyway, if there is any user who has already published in the journal, maybe could help us with your request.

Best Regards,
SCImago Team

W Wahyu Widada 2 years ago

Dear The Editorial Board,
Please provide information, why is Volume 1088 incomplete uploaded?
Thank you.

reply



Elena Corera 2 years ago

SCImago Team

Dear Wahyu Widada,

thank you very much for your comment. Unfortunately, we cannot help you with your

request, we suggest you contact journal's editorial staff so they could inform you more deeply. You can find contact information in SJR website <https://www.scimagojr.com>

Best regards,
SCImago Team



Mohammad Faizal bin Hassan 2 years ago

Dear, Editorial Board.

This "Journal of Physics: Conference Series" is classified as 'Journal' or 'Conference Proceeding'? I am a little bit confused about this, as my university recognize this as a Conference Proceeding (not Journal), but SCImago (see 'Publication type' above) classified it as a Journals.

Your clarification is highly appreciated.

Thank you.

Regards,

Mohammad Faizal
Postgraduate Student (PhD)
Universiti Putra Malaysia (UPM)
Malaysia

reply

M MD SARFARAZ ALAM 5 months ago

Dear Mohammad Faizal bin Hassan

I have checked on the SCOPUS website and got the result JPCS will be considered as a Journal. You can also check this information SCOPUS website in this link:
<https://www.scopus.com/sources.uri>

Regard

Md. Sarfaraz Alam
Research Scholar
IIT Guwahati (India)



Melanie Ortiz 5 months ago

SCImago Team

Thanks for your participation! Best Regards, SCImago Team



Elena Corera 2 years ago

SCImago Team

Dear Mohammad, SJR is a portal with scientometric indicators of journals indexed in Scopus. SJR has no authority over the data of the journals; they are the ones that Scopus sends us. So we have informed Scopus of the changes you are proposing and we will wait for the response to update the data of your journal. Best Regards, SCImago Team

S

sunarti 2 years ago

hello

how about the price if i want to submit in this journal?

reply



Elena Corera 2 years ago

SCImago Team

Dear Sunarti,
thank you very much for your comment, unfortunately we cannot help you with your request. We suggest you look for author's instructions in the journal's website.
Best Regards,
SCImago Team

I

Ikhlasul Ardi Nugroho 2 years ago

Dear The Editorial Board,
My Director Assistance said that Journal of Physics: conference series is not a reputed journal but a proceeding. Is that correct?
Thank you for your explanation
Best regards

Ikhlasul ardi nugroho
Post graduate Yogyakarta State University

reply



Pavel D. Terekhov 1 year ago

Yes, JPCS is a journal for proceedings publications of different international conferences over the world.



Elena Corera 2 years ago

SCImago Team

Dear Ikhlasul,
thank you very much for your comment. You can use our data to analyze the journal. It has been in Q3 for years and the value of the SJR has been decreasing over the years.
Best Regards,
SCImago Team

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Mathematical modelling of traveling salesman problem (TSP) by implementing simulated annealing and genetic algorithms

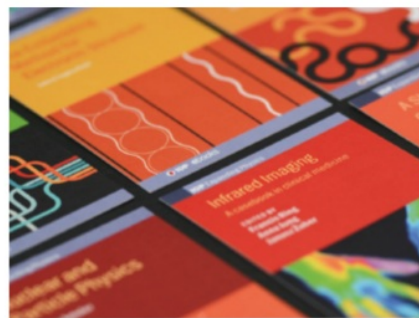
By Fitri maya Puspita

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Mathematical modelling of traveling salesman problem (TSP) by implementing simulated annealing and genetic algorithms

F M Puspita^{1*}, A Meitriova², and S Yahdin¹

¹Mathematics Department, Faculty of Mathematics and Natural Sciences, Universitas Sriwijaya, Indralaya, South Sumatra, Indonesia

²Mathematics Education Program, Postgraduate Program, Universitas Sriwijaya, Palembang, South Sumatra, Indonesia

*Corresponding author's email: fitrimayapuspita@unsri.ac.id

Abstract. The Traveling Salesman Problem (TSP) is very well known as one of the optimization problems of circuit of Hamiltonian, which will seek for the shortest route that must be passed by a number of city salesmen exactly once and will return to the initial city. Genetic Algorithm (GA) and Simulated Annealing (SA) are one method that can be used in TSP case. Fertilizer distribution at PT. Sahabat Mewah dan Makmur (SMM) in Belitung which is one of the branches of PT. Austindo Nusantara Jaya Group does not yet have an optimal fertilizer distribution schedule, where when fertilizer will be distributed from the starting point of distribution to the location of storage warehouses, it is not determined which location points will receive delivery, shipments are made to warehouse locations that still have enough storage space or stacked in the nearest warehouse. PT.SMM distributes fertilizer from Port of Tanjung Pandan to warehouses in Jangkang, Balok, Ladang Jaya, Sari Bunga, and Aik Ruak. The results show that in the GA of 120 routes, there are 8 routes with a distance of 175 km; In SA, the shortest distance is equal to GA, which is 175 km.

1. Introduction

Optimization is the process of making something better than before or the process of finding the best solution (the optimal value) from the optimization problem [1,2]. One optimization problem is determining the shortest route. In general, determining the shortest route can use conventional methods [3, 4] and heuristic methods. Conventional methods are easier to understand than heuristic methods, because in the conventional method only comparing the distance and finding the shortest distance while in the heuristic method the results obtained are more varied, more accurate, the error rate is smaller, and the calculation time is more short [5].

Traveling Salesman Problem (TSP) is one form of optimization problem from the Hamiltonian circuit (the path that passes every point exactly once, except the origin and end points that are passed twice) [6], where the shortest route to be passed by a number of city salesmen exactly one time and returned to the city early (starting point of distribution) [7,8].

The heuristic method consists of various kinds of algorithms, one of which are genetic algorithm and simulated annealing [5-9]. Genetic Algorithm (GA) branch of the evolution algorithm which can be said as an adaptive method commonly used to solve value search problems in an optimization problem [7-10]. GA is based on genetic processes that exist in living things [7-11], in this study based on the distribution route and distance traveled. GA can be used to find solutions to problems in the real world whether simple or complex problems, if well designed it will produce an optimum solution [8, 9]. In this study, the GA stage includes determining a possible distribution route to be a solution, evaluating



distribution routes, calculating convergent percentages of distribution routes, checking stop conditions, selecting distribution routes, exchanging selected distribution routes, mutating selected distribution routes, checking again the distribution route chosen was the final solution [7].

Simulated Annealing (SA) is an algorithm that is applied with the aim of finding an approach to the global optimum solution of a combinatorial problem, where the existing search space for solutions is too broad, so there is no way to find exact solutions to these problems [12-16]. SA was developed based on the idea of the mechanism of cooling behavior and the process of crystallization (annealing) of hot material [12-17]. In this article, the SA stage is to bring up the initial state which is the distribution route, calculate the amount of distance traveled, update the distribution route, calculate the number of mileage distribution routes that have been updated, choose a random number (0,1], calculate the probability based on Boltzmann distribution, compare the value of Boltzmann probability calculation and random generated value [18].

Previously, research on GA and SA had been carried out by Widyadana and Pamungkas [12], which concluded that in terms of performance and processing time SA was superior to GA. In general, the advantages of GA include optimizing variables, can be used on extensive data searches, providing a list of optimal variables not only a single solution, can be used on flexible data [19,20]. In general, the advantages of SA are being able to avoid local minimum traps [21].

At present, the oil palm plantation industry has mushroomed in almost all regions in Indonesia. With the many companies and communities that have oil palm plantations, of course competition in the number of production, quality of production and human resources is increasingly stringent from day to day. Good and correct management of oil palm plants will produce good quality production, in managing oil palm plantations fertilizers are usually needed as a source of nutrients needed by plants that lack nutrients. Fertilizer distribution at PT. Sahabat Mewah dan Makmur (SMM) in Belitung which is one of the branches of PT. Austindo Nusantara Jaya Group does not yet have an optimal fertilizer distribution schedule, where when fertilizer will be distributed from the starting point of distribution to the location of storage warehouses it is not determined which location points will receive delivery, shipments are made to warehouse locations that still have enough storage space or stacked in the nearest warehouse. Optimal fertilizer distribution is expected to make it easier for employees to distribute fertilizer from the distribution starting point to the intended distribution points and reduce fertilizer delivery costs. That is why the research on designing the mathematical modelling of distribution routes of this company is crucial to be conducted.

2. Method

The methods used are Genetic Algorithm and Simulated Annealing. The data used in this study was obtained from one of the branches of the ANJ Group in Belitung, namely PT. Sahabat Mewah dan Makmur (SMM). The data used is secondary data (is from PT. SMM in 2016) about the starting point of the location and the location of the destination for the distribution of fertilizers along with the distance traveled. The research was conducted at the Mathematics Department, Faculty of Mathematics and Natural Sciences, Sriwijaya University.

Implementation of TSP with GA and SA on the problem of fertilizer distribution at PT. SMM, where with the starting point of distribution is Port of Tanjung Pandan, Belitung and distribution points for warehouse purposes in Jangkang, Balok, Ladang Jaya, Sari Bunga, and Aik Ruak.

3. Result and Discussion

3.1. Genetic Algorithm (GA)

Some terms that must be understood in GA are Genotype (Genes), Allele, Chromosome, Individual, Population and Fitness Value [22]. In this study, genes are sequences of vertex numbers (position) from the intended distribution and location of warehouses, alleles are numbers given at vertex, Chromosomes are fertilizer distribution routes of PT. SMM, Individuals are distances that may be a solution, Population is a set of distances travel that might be a solution, and fitness value is the number of mileage of the distribution route.

Table 1 states the distribution location where vertex 1 states Port of Tanjung Pandan as the starting point for distribution, vertex 2 is warehouse location in Jangkang, vertex 3 explains warehouse location in Balok, vertex 4 is warehouse location in Ladang Jaya, vertex 5 describes the warehouse location in Sari Bunga, and vertex 6 denotes the warehouse location in Aik Ruak.

Table 1. Distribution location.

Number of vertex	Distribution location
1	Port of Tanjung Pandan
2	Jangkang Estate
3	Balok Estate
4	Ladang Jaya Estate
5	Sari Bunga Estate
6	Aik Ruak Estate

Then, Table 2 states the distance between distribution locations where 1-2 states the distance from the Port of Tanjung Pandan to the warehouse location in Jangkang and 2-1 states the distance from the warehouse location in Jangkang to Tanjung Pandan Port with the same distance of 45 km, and so on until the route sequence number 5-6 and 6-5 has the same distribution distance of 22 km.

Table 2. Distance between distribution location.

Route Sequence Number		Distance Between Distribution Location (Km)
1-2	2-1	45
1-3	3-1	55
1-4	4-1	58
1-5	5-1	65
1-6	6-1	70
2-3	3-2	10
2-4	4-2	13
2-5	5-2	20
2-6	6-2	25
3-4	4-3	23
3-5	5-3	35
3-6	6-3	33
4-5	5-4	7
4-6	6-4	15
5-6	6-5	22

After describing the data, it is continued by determining the distribution route. In the TSP coding used is permutation encoding, the distribution route is permutation *vertex* 1, 2, 3, 4, 5, and 6. Where the distribution route consists of:

$$(n - 1)! = (6 - 1)! = 5! = 5 \times 4 \times 3 \times 2 \times 1 = 120 \text{ routes}$$

Distribution routes are formed randomly, expressed as vector v :

$$v_k = [g_1, g_2, \dots, g_n] \text{ with } 1 \leq k \leq \text{size of population}$$

With:

v_k : Distribution route to $-k$

g_1, g_2, \dots, g_n : *vertex* to 1, 2, ..., n

From the 120 routes that might be the solution, 15 routes with different amounts of mileage, are randomly selected using Microsoft Excel (in Table 3) were obtained. Table 3 shows the distribution

routes and the number of distances, as number 1 (v_1) the distribution routes is 1 – 4 – 5 – 6 – 3 – 2 – 1 state the distribution route from Port of Tanjung Pandang – Ladang Jaya – Sari Bunga – Aik Ruak – Balok – Jangkang – Port of Tanjung Pandan with a total distance of 175 km, and so on until v_{15} (as described in the same way as v_j).

Table 3. Distribution routes with different amounts of mileage once randomly selected using Microsoft Excel from 120 routes that might be solutions.

Number	Distribution Routes (v_k)	Amount of Mileage $f(v_k)$ (km)
1 = v_1	1 – 4 – 5 – 6 – 3 – 2 – 1	$58 + 7 + 22 + 33 + 10 + 45 = 175$
2 = v_2	1 – 6 – 4 – 5 – 2 – 3 – 1	$70 + 15 + 7 + 20 + 10 + 55 = 177$
3 = v_3	1 – 4 – 6 – 5 – 2 – 3 – 1	$58 + 15 + 22 + 20 + 10 + 55 = 180$
4 = v_4	1 – 6 – 4 – 5 – 3 – 2 – 1	$70 + 15 + 7 + 35 + 10 + 45 = 182$
5 = v_5	1 – 4 – 6 – 5 – 3 – 2 – 1	$58 + 15 + 22 + 35 + 10 + 45 = 185$
6 = v_6	1 – 2 – 5 – 4 – 3 – 6 – 1	$45 + 20 + 7 + 23 + 33 + 70 = 198$
7 = v_7	1 – 5 – 4 – 3 – 2 – 6 – 1	$65 + 7 + 23 + 10 + 25 + 70 = 200$
8 = v_8	1 – 2 – 4 – 3 – 6 – 5 – 1	$45 + 13 + 23 + 33 + 22 + 65 = 201$
9 = v_9	1 – 3 – 4 – 2 – 6 – 5 – 1	$55 + 23 + 13 + 25 + 22 + 65 = 203$
10 = v_{10}	1 – 4 – 5 – 3 – 2 – 6 – 1	$58 + 7 + 35 + 10 + 25 + 70 = 205$
11 = v_{11}	1 – 2 – 5 – 3 – 6 – 4 – 1	$45 + 20 + 35 + 33 + 15 + 58 = 206$
12 = v_{12}	1 – 2 – 6 – 5 – 3 – 4 – 1	$45 + 25 + 22 + 35 + 23 + 58 = 208$
13 = v_{13}	1 – 4 – 3 – 6 – 2 – 5 – 1	$58 + 23 + 33 + 25 + 20 + 65 = 224$
14 = v_{14}	1 – 6 – 3 – 5 – 2 – 4 – 1	$70 + 33 + 35 + 20 + 13 + 58 = 229$
15 = v_{15}	1 – 5 – 3 – 4 – 2 – 6 – 1	$65 + 35 + 23 + 13 + 25 + 70 = 231$

After determining the distribution route, continue the GA stage by evaluating the distribution route selected in Table 3, so that the number of mileage $f(v_k)$ is obtained (in Table 3). Based on Table 3 and evaluation of the distribution route above, the distribution route v_1 is the best distribution route with the smallest mileage.

Then proceed with distribution route selection using the roulette wheel, with the roulette wheel stage (determine the minimum function of each distribution route mileage, determine the total evaluation of the distribution route mileage, determine the probability value for each distribution route, determine the cumulative probability value of each route distribution) based on the conditions at that stage, the distribution route v_1 obtained through selection is the same as the v_8 distribution route before being selected. New distribution route after going through the roulette wheel selection stages, is presented in Table 4.

Table 4. New distribution route after going through the roulette wheel selection stages.

Distribution Routes (v_k)	Distribution Routes on Table 4 are the same with Distribution Route on Table 3
1 - 2 - 4 - 3 - 6 - 5 - 1	$v_1 = v_8$
1 - 4 - 6 - 5 - 2 - 3 - 1	$v_2 = v_3$
1 - 2 - 6 - 5 - 3 - 4 - 1	$v_3 = v_{12}$
1 - 4 - 5 - 3 - 2 - 6 - 1	$v_4 = v_{10}$
1 - 6 - 4 - 5 - 3 - 2 - 1	$v_5 = v_4$
1 - 4 - 5 - 6 - 3 - 2 - 1	$v_6 = v_1$
1 - 5 - 4 - 3 - 2 - 6 - 1	$v_7 = v_7$
1 - 4 - 6 - 5 - 3 - 2 - 1	$v_8 = v_5$
1 - 6 - 4 - 5 - 2 - 3 - 1	$v_9 = v_2$
1 - 2 - 5 - 4 - 3 - 6 - 1	$v_{10} = v_6$
1 - 3 - 4 - 2 - 6 - 5 - 1	$v_{11} = v_9$
1 - 5 - 3 - 4 - 2 - 6 - 1	$v_{12} = v_{15}$
1 - 2 - 5 - 3 - 6 - 4 - 1	$v_{13} = v_{11}$
1 - 4 - 3 - 6 - 2 - 5 - 1	$v_{14} = v_{13}$
1 - 6 - 3 - 5 - 2 - 4 - 1	$v_{15} = v_{14}$

After the distribution route selection, the GA stage is continued with cross-breeding. In this study, the process of interbreeding uses the Single-Point Crossover (SPX) method. In the SPX stage, the crossover (pc) probability is assumed to be 0.25. After the SPX stage is complete the distribution route chosen is the distribution route v_{11} and v_{15} . Distribution routes after crossing using the SPX method are as follows.

Table 5. Distribution routes after crossing using the SPX method.

Distribution Routes (v_k)
1 - 2 - 4 - 3 - 6 - 5 - 1
1 - 4 - 6 - 5 - 2 - 3 - 1
1 - 2 - 6 - 5 - 3 - 4 - 1
1 - 4 - 5 - 3 - 2 - 6 - 1
1 - 6 - 4 - 5 - 3 - 2 - 1
1 - 4 - 5 - 6 - 3 - 2 - 1
1 - 5 - 4 - 3 - 2 - 6 - 1
1 - 4 - 6 - 5 - 3 - 2 - 1
1 - 6 - 4 - 5 - 2 - 3 - 1
1 - 2 - 5 - 4 - 3 - 6 - 1
1 - 3 - 3 - 5 - 2 - 4 - 1
1 - 5 - 3 - 4 - 2 - 6 - 1
1 - 2 - 5 - 3 - 6 - 4 - 1
1 - 4 - 3 - 6 - 2 - 5 - 1
1 - 6 - 4 - 2 - 6 - 5 - 1

After the crossing process is complete, the GA stage is followed by a mutation on the distribution route using Microsoft Excel randomized distribution points so that it is obtained:

Table 6. Result of randomization vertex.

Vertex	Result of randomization vertex
1	3
2	1
3	4
4	6
5	2
6	5

From table 6 after vertex is randomized, vertex 1 is replaced by vertex 3, vertex 2 is replaced by vertex 1, and so on. The number of distribution routes that have mutated in one generation is $n * pop_size = 6(15) = 90$ routes. If the specified mutation probability value (pm) is 0.01 then it is expected that $0.9 \approx 1$ mutation per route. Each distribution route has the same opportunity to experience mutations, therefore random numbers that have a range (0,1] will be selected using Microsoft Excel as many as 90. Distribution routes that have random numbers smaller than $pm = 0.01$ are chosen as mutations. The distribution routes selected are shown in Table 7.

Table 7. Distribution routes chosen to be moved.

Sequence Position of Random Numbers	Distribution route to -	Numbering Route to -	Random Numbers
13	12	3	0.001087

From Table 7, the position of a random number sequence that has a value of 0.001087 which is randomized using Microsoft Excel is number 13, with the distribution route that experiences mutations is the 12th distribution route in Table 3 and the randomized distribution point is the 3rd point, so that the distribution route is obtained after the mutation:

Table 8. Distribution routes after the mutation.

Distribution Routes (v_k)
1 - 2 - 4 - 3 - 6 - 5 - 1
1 - 4 - 6 - 5 - 2 - 3 - 1
1 - 2 - 6 - 5 - 3 - 4 - 1
1 - 4 - 5 - 3 - 2 - 6 - 1
1 - 6 - 4 - 5 - 3 - 2 - 1
1 - 4 - 5 - 6 - 3 - 2 - 1
1 - 5 - 4 - 3 - 2 - 6 - 1
1 - 4 - 6 - 5 - 3 - 2 - 1
1 - 6 - 4 - 5 - 2 - 3 - 1
1 - 2 - 5 - 4 - 3 - 6 - 1
1 - 3 - 3 - 5 - 2 - 4 - 1
1 - 5 - 4 - 3 - 2 - 6 - 1
1 - 2 - 5 - 3 - 6 - 4 - 1
1 - 4 - 3 - 6 - 2 - 5 - 1
1 - 6 - 4 - 2 - 6 - 5 - 1

The last stage of GA is decoding, where recalculation is carried out on the number of distribution routes that have gone through the stages of selection, crossing and mutation. The decoding result is v_{11}

and v_{15} which is not Hamiltonian (one vertex is passed twice and there is another vertex that is not skipped).

3.2. Simulated Annealing (SA)

The Simulated Annealing steps are as follows:

- 1) Select the initial state S_0 , for example is 1 – 2 – 3 – 6 – 4 – 5 – 1
- 2) Calculate energy E_0 pada S_0 , is 1 – 2 – 3 – 6 – 4 – 5 – 1 = 45 + 10 + 33 + 15 + 7 + 65 = 175 km.
- 3) State S updates with the update rules according to the problem being S_i , is:
 - a. Choose randomly r_1 dan r_2 with points (1,6], using Microsoft Excel.
 - b. For state values at position r_1 until position r_2 is exchanged. Obtained $r_1 = 2$ and $r_2 = 3$
 State before being update 1 – 2 – 3 – 6 – 4 – 5 – 1
 State after being update 1 – 3 – 2 – 6 – 4 – 5 – 1
 - c. Calculate energy E_i , 1 – 3 – 2 – 6 – 4 – 5 – 1 = 55 + 10 + 25 + 15 + 7 + 65 = 177 km.
- 4) Select uniform distribution random number $p = (0, 1]$; $p = 0.396478$ (using Microsoft Excel)
- 5) Ifa $p < e^{-\frac{\Delta E}{kT}}$, the state is accepted; if doesn't, the state is rejected. Calculate Boltzmann probability with T = 0,2; obtained:

$$p(E) = e^{-\frac{E_i - E_0}{kT}} = e^{-\frac{177 - 175}{(1,380658 \times 10^{-23})0,2}} = e^{-\frac{2}{2,761316 \times 10^{-24}}} = 1$$
 because $p < e^{-\frac{\Delta E}{kT}}$, so the state is accepted.
- 6) Back to step 3, because the updated state distance is not the shortest route, repeat until the updated route is the shortest route, so the shortest route in SA is route 1 – 2 – 3 – 6 – 5 – 4 – 1 with mileage of 175 km.

From the 120 possible routes can be solution, there are 15 different distances are 8 routes with mileage of 175 km, 12 routes with mileage of 177 km, 8 routes with mileage of 180 km, 4 routes with mileage of 182 km, 4 routes with mileage of 185 km, 12 routes with mileage of 198 km, 4 routes with mileage of 200 km, 12 routes with mileage of 201 km, 16 routes with mileage of 203 km, 4 routes with mileage of 205 km, 4 routes with mileage of 206 km, 20 routes with mileage of 208 km, 4 routes with mileage of 224 km, 4 routes with mileage of 229 km, and 4 routes with mileage of 231 km.

Based on Table 3, as for the shortest route obtained from GA with a distance of 175 km, namely:

- 1) Port of Tanjung Pandan - Jangkang - Balok - Aik Ruak - Sari Bunga - Ladang Jaya – Port of Tanjung Pandan;
- 2) Port of Tanjung Pandan - Jangkang - Balok - Aik Ruak - Ladang Jaya - Sari Bunga – Port of Tanjung Pandan;
- 3) Port of Tanjung Pandan - Jangkang - Ladang Jaya - Sari Bunga - Aik Ruak - Balok – Port of Tanjung Pandan;
- 4) Port of Tanjung Pandan - Jangkang - Sari Bunga - Ladang Jaya - Aik Ruak - Balok – Port of Tanjung Pandan;
- 5) Port of Tanjung Pandan - Balok - Aik Ruak - Ladang Jaya - Sari Bunga - Jangkang – Port of Tanjung Pandan;
- 6) Port of Tanjung Pandan - Balok - Aik Ruak - Sari Bunga - Ladang Jaya - Jangkang – Port of Tanjung Pandan;
- 7) Port of Tanjung Pandan - Ladang Jaya - Sari Bunga - Aik Ruak - Balok - Jangkang – Port of Tanjung Pandan;
- 8) Port of Tanjung Pandan Port - Sari Bunga - Ladang Jaya - Aik Ruak - Balok - Jangkang – Port of Tanjung Pandan;

4. Conclusion

From the calculations in SA, the shortest route for the distribution of fertilizer PT. SMM is the Port of Tanjung Pandan - Jangkang - Balok - Aik Ruak - Sari Bunga - Ladang Jaya - Port of Tanjung Pandan with a distance of 175 km.

The results of calculations in GA and SA are the same as the results, the shortest route of fertilizer distribution is obtained in PT. SMM with a distance of 175 km. From the length of time spent to calculate the shortest route with GA and SA, the calculation using SA is faster than GA.

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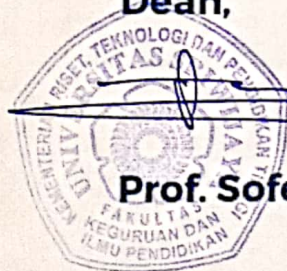
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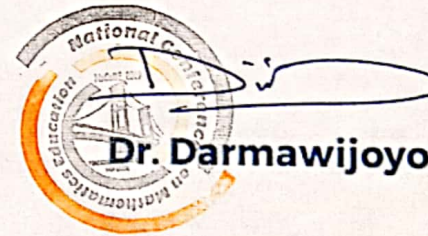
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