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Hayati Mukti Asih <hayati.asih@ie.uad.ac.id>

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iDecon 2020 submission 48

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iDecon 2020 <idecon2020@easychair.org> 30 July 2020 at 10:47
To: Hayati Mukti Asih <hayati.asih@ie.uad.ac.id>

Dear authors,

We received your submission to iDecon 2020 (9th International Conference on Design and Concurrent Engineering):

Authors : Hayati Mukti Asih, Raden Achmad Chairdino Leuveano and Annur Rahman
Title : TRAVELING SALESMAN PROBLEM WITH PRIORITIZATION FOR PERISHABLE PRODUCTS IN YOGYAKARTA, INDONESIA
Number : 48

The submission was uploaded by Hayati Mukti Asih <hayati.asih@ie.uad.ac.id>. You can access it via the iDecon 2020 EasyChair Web page

https://easychair.org/conferences/?conf=idecon2020

Thank you for submitting to iDecon 2020.

Best regards,
EasyChair for iDecon 2020.

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Hayati Mukti Asih <hayati.asih@ie.uad.ac.id>

[Revised Manuscript] Paper ID 48 - Hayati Mukti Asih et al.

Hayati Mukti Asih <hayati.asih@ie.uad.ac.id> 28 August 2020 at 13:24
To: International Conference on Design and Concurrent Engineering <idecon@utem.edu.my>

Good day, IDECON 2020 Team

Here the attached files are the revised manuscript and the list of changes file.
Thank you for your kindly support.

Best regards,
Hayati Mukti Asih, Ph.D.
Industrial Engineering Department
Universitas Ahmad Dahlan

On Wed, 19 Aug 2020 at 19:18, International Conference on Design and Concurrent Engineering <idecon@utem.edu.my> wrote:

> Dear Hayati Mukti Asih, Raden Achmad Chairdino Leuveano and Annur Rahman.
>
> CONGRATULATION.
>
> Your paper PID 48 has been accepted for IDECON 2020.
>
> TITLE: TRAVELING SALESMAN PROBLEM WITH PRIORITIZATION FOR PERISHABLE PRODUCTS IN YOGYAKARTA, INDONESIA.
>
> AUTHORS: Hayati Mukti Asih, Raden Achmad Chairdino Leuveano and Annur Rahman.
>
> Reviewers have now commented on your paper. You will see that they are advising you to revise your manuscript.
>
> For your guidance, reviewers' comments are appended below.
>
> ----------------------- REVIEW 1 ---------------------
>
> OVERALL EVALUATION: Accept
>
> REVIEWER'S CONFIDENCE: High
>
> ----------- Review -----------
>
> 1. There is no discussion sentence in the abstract.

2. In Sub-section 2.3, there is no mentioned about the gene in the chromosome. What is supposed the gene representing?

3. At Figure 8, it is for experiment 3?

4. Suggest to relate the research with the some publications such as:

a. Zakaria, M. Z., Jamaluddin, H., Ahmad, R. and Loghmanian, S. M. R. (2012). Comparison between Multi-Objective and Single-Objective Optimization for the Modeling of Dynamic Systems. Journal of Systems and Control Engineering, Part I. Proc. Instn. Mech. Engrs., 226 (7), 994-1005.

b. Zakaria, M. Z., Jamaluddin, H., Ahmad, R. and Muhaimin, A. H. (2011). Effects of Genetic Algorithm Parameters on Multiobjective Optimization Algorithm Applied to System Identification Problem. Modeling, Simulation and Applied Optimization (ICMSAO), 2011 4th International Conference on, 19-21 April 2011. Kuala Lumpur, 1-5 pp.

c. Zakaria, M. Z., Jamaluddin, H., Ahmad, R. and Loghmanian, S. M. R. (2010). Multiobjective Evolutionary Algorithm Approach in Modeling Discrete-Time Multivariable Dynamics Systems. Computational Intelligence, Modelling and Simulation (CIMSiM), 2010 Second International Conference on, 28-30 Sept. 2010. Bali, Indonesia, 65-70 pp.

----------------------- REVIEW 2 ---------------------

OVERALL EVALUATION: Accept

REVIEWER'S CONFIDENCE: Medium

----------- Review -----------

This research idea is very interesting and useful for reducing shipping distances for perishable products. This paper is quite well written. It would be perfect if some errors were corrected, such as

1. In some parts, there are some grammar writing errors.

2. You need to check the conformity between the notation written in the equation with its explanation, for example in equation 1.

3. There is a cropped image layout.

4. This paper will further contribute to the body of knowledge if researchers add a discussion on why the percentage reduction in travel distance for the weighted TSP model is smaller than the classical TSP model. What needs to be improved to increase its contribution?

5. In the paper, it is stated that the weighted TSP model is more applicable, but it has not been explained in detail why this is said.

----------------------- REVIEW 3 ---------------------

General Comments

a) Topic formatting: please follow format:

1.Introduction 2. Methodology 3. Result and Discussion 4. Conclusion

5. Acknowledgements and 6. References.

b) ABSTRACT

Should consist of Introduction, Problem Statement, QUANTITATIVE results and QUANTITATIVE Conclusion.

c) Make sure the keyword used “;” and at the end exclude “.” for example

Prolonged Standing; Muscle Activity; Stamping Process; Automotive Industry; Small and Medium Industries

d) Make sure the citation in text used only in numbering style. Please change if having a year.

e) Table’s content and Figure: Font Palatino Linotype, size 8 (Table’s content)

Figure must be legible with 300 dpi

f) Equation: Use only Equation Editor (don’t use insert eqn) with the setting

Main Body: Palatino Linotype, size 11

Superscript or subscript: Palatino Linotype, size 9

Equation must be located at the center and numbered.

g) Increase the number of references to >15.

h) References:

i. Journal must have the following elements and using this format (exactly the

same):

V. Balasubramanian, K. Adalarasu and R. Regulapati, "Comparing dynamic and stationary standing postures in an assembly task”, International Journal of Industrial Ergonomics, vol. 39, no. 5, pp. 649-654, 2009.

ii. Conference Proceeding (no italic and use only this format):

J.K. Author, “Title of paper,” in Unabbreviated Name of Conference, City of Conference, State (if given), year, pp. xxx-xxx.

iii. Books (italic only in the title and must have a location of publisher):

B. Klaus and P. Horn, Robot Vision. Cambridge, MA: MIT Press, 1986.

iv. Online References (italic only in the title and use this format):

R.J. Vidmar. (1994). On the use of atmospheric plasmas as electromagnetic reflectors [Online]. Available FTP: atmnext.usc.edu Directory: pub/etext/1994 File: atmosplasma.txt

i) Authors are required to check the similarity index through turnitin. The allowable index is up to 30%. Please also ensure that no respiratory is set when using turnitin.

j) Language needs to be proof-read carefully.

Please submit:

1. A list of changes or a rebuttal against each point which is being raised; and
2. Full **REVISED MANUSCRIPT** file in MS Word template to the editor at idecon@utem.edu.my.

There is no format requirement for the Point-to-Point responses.

Authors are requested to give full consideration in answering all the reviewer’s comments.

Paper should be no more than 12 pages in length inclusive of tables, figures and illustrations.

The deadline for revision submission is 16th September 2020.

We thank you for your interest and look forward to meeting you soon in the Virtual Conference. Please visit our official conference website at https://idecon2020.utem.edu.my/ for further details.

Yours sincerely,

Best Regards,

PROF. MADYA DR. MOHD RIZAL BIN SALLEH
Chief Editor IDECON 2020
Faculty of Manufacturing Engineering, UTeM

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3 attachments

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Hayati Mukti Asih <hayati.asih@ie.uad.ac.id>

JAMT – iDECON 2020 Special Issue PID 18

International Conference on Design and Concurrent Engineering <idecon@utem.edu.my> 15 April 2021 at 13:56
To: Hayati Mukti Asih <hayati.asih@ie.uad.ac.id>
Cc: PROFESOR DR MOHD RIZAL BIN SALLEH <rizal@utem.edu.my>, "PROFESOR MADYA TS. DR. EFFENDI BIN MOHAMAD" <effendi@utem.edu.my>, "DR. MOHD EDEEROZEY BIN ABD MANAF" <edee@utem.edu.my>, "DR. NADIAH BINTI AHMAD" <nadiaha@utem.edu.my>, "DR. TOIBAH BINTI ABD RAHIM" <toibah@utem.edu.my>, "IR. DR. MOHAMAD RIDZUAN BIN JAMLI" <ridzuanjamli@utem.edu.my>

Dear Author,

Greetings from iDECON 2020.

We hope this email find you well.

Thank you very much for your continuous supports to iDECON 2020.

The iDECON2020 technical committee is pleased to inform you that your manuscript will be extended to the Journal of Advanced Manufacturing Technology (JAMT) ISSN: 1985-3157; e-ISSN: 2289-8107, which is a Scopus index journal.

We had reviewed your article and there are a few important comments (included in the attachment) that need your respond for facilitating the publishing of this article soon.

Please note that all equations and inline symbols in text must use MathType editor (30 days trial version is available at https://store.wiris.com/en/products/mathtype/download).

We would like to advise the author to perform the correction of the article using the attached file since it has been formatted according to the JAMT template.

Also, we would like to seek your assistance to NOT to make any changes on the formatting of your article especially on the spacing of the paragraph. For details article formatting, your can refer to the attached document of JAMT paper template.

We would like to receive the respond from the author before 29th April 2021 (Thursday).

Thank you very much and Best regards.

On behalf of the Chairman

iDECON 2020

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2 attachments

18. PID 48 UAD.docx
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Hayati Mukti Asih <hayati.asih@ie.uad.ac.id>

Publication in Journal of Advanced Manufacturing Technology (JAMT)

PROFESOR MADYA TS. DR. MUHAMMAD HAFIDZ FAZLI BIN MD FAUADI <hafidz@utem.edu.my>
To: "hayati.asih@ie.uad.ac.id" <hayati.asih@ie.uad.ac.id>

13 January 2023 at 08:50

Dear Authors,

Kindly be informed that we have received your manuscript entitled "TRAVELING SALESMAN PROBLEM WITH PRIORITIZATION FOR PERISHABLE PRODUCTS IN YOGYAKARTA, INDONESIA" from iDECON 2020 secretariat to be considered for publication in JAMT.

We are pleased to inform you that the manuscript is publishable, but specific revisions are required. Please find the reviewed manuscript attached.

Additionally, please ensure that the content similarity is less than 30% similarity index. If the comment includes a proofreading requirement, kindly attach the receipt of proofreading.

We are expecting to receive the corrected version before 20 January 2023.

Feel free to contact me for any further clarification.

Thank you.

Yours sincerely,

Associate Professor Ts. Dr. Muhammad Hafidz Fazli Bin Md Fauadi
Chief Editor
Journal of Advanced Manufacturing Technology (JAMT)

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76100 Durian Tunggal,
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Review dari Reviewer JAMT

Journal of Advanced Manufacturing Technology (JAMT)

TRAVELING SALESMAN PROBLEM WITH PRIORITIZATION FOR PERISHABLE PRODUCTS IN YOGYAKARTA, INDONESIA

H.M. Asih[1], R.A.C. Leuveano[2], and A. Rahman[1]

[1]Faculty of Industrial Technology,
Universitas Ahmad Dahlan, Jalan Ringroad Selatan, Kragilan, Tamanan, Kec. Banguntapan, Bantul, Daerah Istimewa Yogyakarta 55191, Indonesia.

[2]Faculty of Engineering and Built Environment, Universiti Kebangsaan Malaysia, Bangi, 43600, Selangor, Malaysia.

Corresponding Author's Email: [1]hayati.asih@ie.uad.ac.id

Article History: Received xxxxx; Revised xxxx; Accepted xxxx

ABSTRACT: This paper considers Travelling Salesman Problem (TSP), which is related to find the shortest possible path that visits each node or depot of a cluster exactly once. TSP problem is difficult to solve, especially, in the presence of each node has different open time while the product is perishable. Therefore, this research proposes the TSP model to solve the transshipment problem based on a case study of a bakery distributor's small and medium-sized enterprise (SME) in Yogyakarta, Indonesia. In this study, the TSP model is proposed for solving two conditions, namely the classical and the weighted TSP model. A classical TSP model for solving unprioritized nodes. Meanwhile, the weighted TSP model is to solve the transshipment problem by considering the nodes that should be prioritized due to the high demand and the opened nodes or depots in the early morning or afternoon. Therefore, this model aims to minimize the total distance traveled by finding the optimum sequence delivery nodes on a tour. To achieve the objective, the genetic algorithm is employed. Based on the result of experimenting with the proposed model by using GA, then there are improvements on total distance saving for the classical TSP model and the weighted TSP model about 46.68% and 45.74%, respectively. The proposed model can be useful to help a driver truck in deciding the sequence delivery nodes of the product.

KEYWORDS: *Travelling Salesman Problem; Nodes; Route; Genetic Algorithm*

Commented [WU1]: General comment:
1. Explain the relevancy of the research scope for the paper to be published in JAMT. Explanation could be included in Title/ Abstract/ Introduction etc. Authors are advised to show the relevancy by citing relevance articles published in JAMT (2017 onwards).
2. Proofread is required. Kindly attach the evidence of proofread.
3. Please make sure the format complies to the JAMT template to expedite the publication process.

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1.0 INTRODUCTION

Travelling Salesman Problem (TSP) is a challenging problem in the field of Operational Research. Generally, assumptions in this problem are a finite number of nodes, each node is visited only once, and the distance or the cost to travel between each city is known. The main goal is to find the shortest route with given a list of specific destinations (nodes) to the distance traveled or the transportation cost can be minimized. In the real industry, some weights are required to be considered in TSP. The weight means the prioritization of particular nodes in a tour. These weights are based on the preferences of the company. The additional weights on the nodes will make the problem more complex compare to the classical TSP. Besides, the perishable products effect the distribution of those products at the right time and right place. Therefore, this problem is more challenging. By having a minimum total distance traveled on tour, the transportation cost is also reduced.

The weight or prioritization of TSP has been discussed in previous researches. Ginting et al. [1] proposed item delivery simulation using Dijkstra Algorithm to find the shortest route for salesman by considering some priorities. Bossek et al. [2] also examined weight the nodes during a tour by developing the approximation algorithm and randomized search heuristics. TSP is a fundamental problem in combinatorial optimization and a canonical NP-hard problem [3]. Previous researches have been investigated TSP by employing some methods. Xing et al. [4] compared monte carlo tree search and deep search neural networks in solving TSP. Then, Strak et al. [5] developed a self-adaptive discrete particle swarm optimization algorithm and ant colony optimization for TSP so that the minimum sum of distance could be achieved. Next, Miller et al. [6] developed an intelligent transportation system traveling salesman problem for transportation network in Anchorage, Alaska as a case study. The aim is to compute the route with minimum cost.

Rodriguez-Pereira et al. [7] developed integer linear programming and branch-and-cut algorithm to solve Steiner TSP. Next, Huang et al. [8] proposed multi-solutions TSP using a niching memetic algorithm. Besides, Karaboga and Gorkemli [9] developed a combinatorial artificial bee colony algorithm to solve TSP. Then, Hossain et al. [10] proposed a genetic algorithm (GA) with a modified crossover operator to find the best routes within 5 to 50 different cities.

Besides, Alzyadat et al. [11] minimized the route path by changing

Commented [WU4]: Introduction must mainly focus on TSP for perishable products in industrial and manufacturing engineering sector

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Commented [WU9]: Improper citation style.

Commented [WU10]: Kindly add the elements of critical review three factors, such as the number of cities, the number of generations, and population size using GA with comparing crossover operators. From those methods, GA is proved more efficient in solving optimization [12]. It is also supported by Vandana et al. [13] in their survey article that compares GA and dynamic programming, branch and bound, greedy algorithm, etc. to solve TSP. Not only TSP, but GA was also successfully implemented in various applications, such as inventory problems [14, 15], forecasting error [16], gas furnace system, etc.

The objective of this research is to minimize the total distance traveled by determining the optimal sequence delivery nodes in a route. The main contribution is developing GA by varying some operators. Those operators are population size, crossover probability, and mutation probability. It will explore the effect of changing those operators on finding the optimal solutions. Also, the proposed model is considering the weight or prioritization in TSP as a case study in real problem so that this model is also contributing in practice. Then, the model developed is using Microsoft Excel and add-ins GeneHunter. It is easier for the practitioner to implement this proposed model.The structure of this paper is as follows. Section 2.0 presents the proposed model of GA to solve TSP. Section 3.0 describes results and discussion. Finally, Section 4.0 elaborates conclusion and future research.

Commented [WU11]: Clarification - Is it objective of the research or objective of the optimization model?

Commented [WU12]: Authors have to highlight the novelty. Many papers have used GA to solve TSP problem. Clearly state the unique attributes of the GA or TSP in this research compared to others.
Also, discuss the significance of the study.

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2.0 PROPOSED MODEL

2.1 Problem description

This research develops the TSP model based on a real case study of a bakery distributor's small and medium-sized enterprise (SME) in Yogyakarta, Indonesia for the transshipment of perishable products. The main problem of this research is deciding optimal sequence delivery nodes or stores of the product in one route. In this problem, a truck driver often re-routes on the same nodes due to some nodes have uncertain time in opening the nodes. For instance, some nodes are possibly opened in the early morning or afternoon. As a result, unsynchronized delivery nodes make a truck driver do redundant tasks to deliver the product while the product is perishable. Furthermore, this problem can affect to the long-distance traveled and directly increase the transportation costs. To solve these problems, some nodes require the weight in a route. The weight in this case study refers to the nodes that should be prioritized based on the demand of the product and the opening time of nodes. Therefore, this paper

Commented [WU14]: Clarification needed – distributor/ factory? Is it related to food and beverages manufacturing facility?

develops the TSP model with priority nodes based on the weight given. The objective of this model is to minimize the distance traveled by determining the optimal sequence delivery nodes in one route. In short, the specification of the proposed model in which representing the case of being studied are defined as follows:

i. There is a single truck in which distributing a single product into 17 nodes.
ii. Each node is visited only once.
iii. The distance to travel between each city is known.

2.2 Mathematical model

The mathematical model of classical TSP problem could be formulated as follows:

$$Z(X) = \sum_{i-1}^{n-1} D\left(X_i, X_{i+1}\right) + D\left(X_n, X_1\right) \quad (1)$$

where, n is the total number of nodes, Xi is the node number in position i, $D(X_i, X_j)$ is the distance from Xi to Xi and $D(X_i, X_j) = D(X_j, X_i)$.The objective in (1) is minimizing the total distance of a complete tour by optimizing the sequence of delivery nodes. Based on Eq. (1), then the classical TSP model is modified by considering prioritized nodes, namely, weighted TSP model. In practice, these nodes are bakeries, schools, supermarkets, and small shops. Because of the products distributed is bread, which is mostly eaten in the morning (high demand and open early morning), so that certain nodes like schools are the most priority ones. Then, the supermarkets are the last node that is distributed, because they are open in the afternoon so that there is no need to re-route. In this case, X1 is set to be the node of school while Xn is considered as supermarkets.

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Figure 1 presents the scheme of the proposed TSP model for the bakery distributor's SME system. Based on Figure 1, there are input, process, and output. The inputs are the distance matrix and the number of nodes with the constraint given is the weight/ prioritize the nodes. The mathematical model either classical or weighted TSP problem is coded in Microsoft Excel software. This software is compatible because industrial practitioners commonly use this software whose general purpose that can easily solve distribution problems without learning new modeling or programming language, or buy expensive and specific tools, or hire a specialist to do so. In contrast, previous researches employed modeling language (i.e. MATLAB, GAMS, AMPL), or programming language (i.e. Delphi, Java, C), or commercial solvers such as CPLEX which makes the proposed solution difficult to be applied on the real industry. Moreover, to find the near or optimum solution of the TSP model, then the genetic algorithm based GeneHunter software is used. Therefore, both Microsoft Excel and GeneHunter are employed to conduct experiments to find the best routes with minimum distance for both the classical and weighted TSP model. A detailed discussion of the optimization process using a genetic algorithm is presented in the next sub-section.

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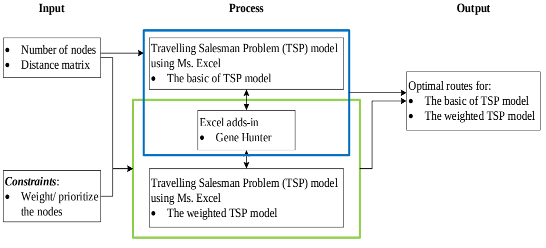

Figure 1: The scheme of the proposed TSP model for the bakery distributor's SME system.

2.3 Genetic Algorithm (GA) method

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As mentioned earlier, the GA method is employed to solve the problem of classical and weighted TSP. The main objective is to minimize the total distance traveled and thereby reduce transportation costs. To start the GA method, the following initial information is required:

i. Population size (N): Sets of the chromosome are kept in each generation.
ii. Crossover rate (Pc): The probability of crossover in the GA method.
iii. Mutation rate (Pm): The probability of mutation in the GA method.

Generally, the steps in the GA method are as follows:

i. Initialization
An initial value of population (N) is generated randomly. In this case, the population consists of several chromosomes that refer to the sequence delivery nodes of a tour (which is gen in GA) as

shown in Table 1. Meanwhile, the population size (N) is determined based on the modeler for each experiment.

Table 1: Example of chromosome

X_1	X_2	X_3	…	…	X_{n-1}	X_n

ii. Evaluating fitness function
Since GA is categorized as an optimization problem, then a fitness function that is referred to as the objective function needs to be calculated to evaluate the chromosome or solutions in the population. Therefore, the expression of a fitness function is equal to that of TSP model.

iii. Selecting the chromosome
This stage is the selection phase which how the genetic algorithm chooses the parents for the next generation. It chooses N chromosomes among the parents and the offspring with the best fitness value. There is some selection method, such as roulette wheel, tournament, ranking, and elitist. In this study, the elitist method is used to select the best chromosome.

iv. Performing crossover
This phase is an important part of GA in which two parent chromosomes are paired to create offspring. This research is conducted by selecting randomly a pair of chromosomes from the generation with probability Pc. In this research, the probability of crossover is set into several values to experiment such as 0.95, 0.9, 0.85, 0.8, 0.75, and 0.7. The crossover process has some different types of crossover operators are one-point, two-point, multiple-points, and uniform. This study employs a one-point crossover to generate new offspring. Figure 2 presents a graphical representation of the crossover operations based on the TSP problem. First, a random crossover point is chosen, then split the parents at that point(s), finally, the offsprings are created by exchanging the tails.

v. Performing mutation
The mutation process is required to do as it maintains genetic diversity from one generation of a population so that it ensures a border search space to be searched by GA. The probability of mutation in the experiment uses 0.01, 0.02, 0.025, 0.3, 0.4, and 0.5. Figure 4 illustrates the mutation process.

vi. Termination of the GA process
The last step of GA is to stop the searching process after a solution that is near or optimum has met the user's expectation.

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This research decides to stop the process of GA after 300 generations. Moreover, the best chromosome with minimum fitness is selected as the near or optimum solution for each experiment.

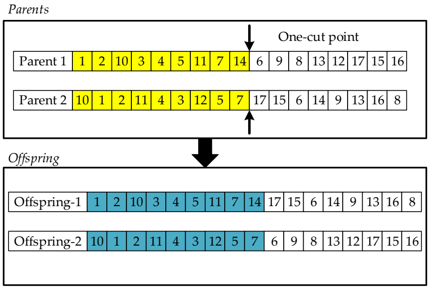

Figure 3: The one-cut point crossover

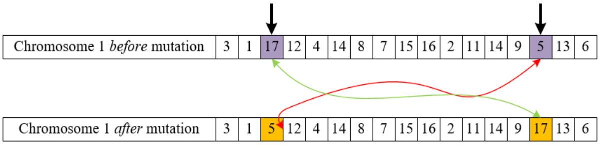

Figure 4: The mutation process

3.0 RESULTS AND DISCUSSION

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2.Highlight the significance of the findings.

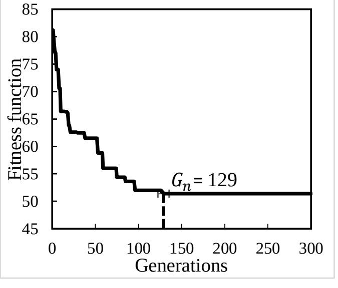
This section elaborates on the experimental results of the proposed model by evaluating its performances. The data, such as the distance matrix among nodes collected from a real case study, was collected. After that, those data and Eq. (1) are employed to develop the classical and weighted TSP model through GA.

Table 3 presents the experimental results of the classical TSP model and the weighted TSP model. It shows three different experiments (i.e. experiment 1, 2, and 3 for the classical TSP model has the same fitness value even though there are differences in crossover probability, mutation probability, and population size. The different values of GA parameters have experimented with the effect of the performance. In this table, "CPUt" denotes the CPU time of solving the problem in seconds and "Fitness" denotes the fitness value in kilometers.

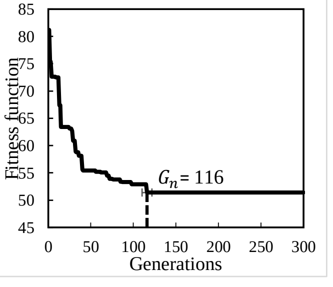
For the classical TSP model, the best fitness value is 51.4. It means the total distance traveled in a tour is 51.4 kilometers. Figures 5 shows the trend of fitness value optimization in the classical TSP of the parameter-tuned GA for different crossover probability, mutation probability, and population size. On the other hand, the fitness value optimization for the weighted TSP model is presented in Figure 6.

Table 3: Experimental results: the classical TSP and the weighted TSP

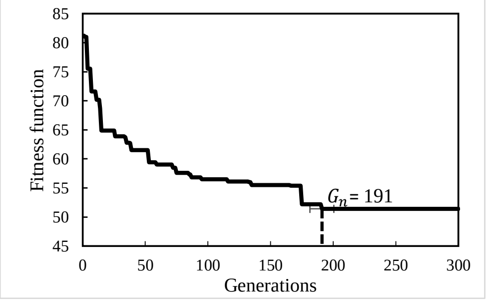
	No. of Experiment	Crossover	Mutation	Pop	Fitness	CPUt
The classical TSP model	1	0.95	0.04	80	51.4	20
	2	0.9	0.01	100	51.4	25
	3	0.85	0.03	120	51.4	29
	4	0.8	0.05	140	54.6	32
	5	0.75	0.025	160	53.9	38
	6	0.7	0.02	180	52.2	43
The weighted TSP model	1	0.95	0.04	80	58.8	22
	2	0.9	0.01	100	55.9	28
	3	0.85	0.03	120	52.3	32
	4	0.8	0.05	140	55.5	35
	5	0.75	0.025	160	57.7	40
	6	0.7	0.02	180	59.6	45



(a)



(b)



(c)

Figure 5. The trend of fitness value optimization: The classical TSP model for (a) experiment 1, (b) experiment 2, and (c) experiment 3

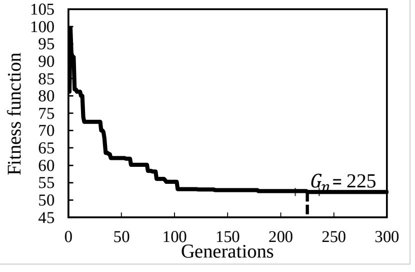


Figure 6. The trend of fitness value optimization: The weighted TSP model for experiment 3

To examine the percentage of fitness value reduction (total distance traveled in a tour) obtained by the implementation of the parameter-tuned GA above as follows.

$$\% = \frac{TD_{initial} - TD_{tuned}}{TD_{initial}} \times 100\% \quad (2)$$

TD initial denotes the total distance of the current system without optimization. TD tuned denotes near-optimal total distance traveled of the parameter-tuned GA. Then, based on the results of Table 2, for the classical TSP model and the weighted TSP model are as follow:

Total distance saving (the classical TSP model)

$$\frac{96.4-51.4}{96.4}\times 100\% = 46.68\% \tag{3}$$

Total distance saving (the weighted TSP model)

$$\frac{96.4-52.3}{96.4}\times 100\% = 45.74\% \tag{4}$$

According to the obtained results, there are improvements in total distance saving for the classical TSP model and the weighted TSP model, i.e. 46.68% and 45.74%, respectively. The weighted TSP model has smaller improvement than the classical one as it considers some contraints to minimize the travel distance while considering some prioritizations due to the high demand and the opened nodes or depots in the early morning or afternoon.

Even though the weighted TSP model has smaller improvement and has higher CPU time (see Table 2) than the classical one, the weighted TSP model is more applicable for bakery distributor's SME in Yogyakarta, Indonesia as this model considers the prioritization of particular nodes to find the optimal sequence of delivery nodes in a tour.

4.0 CONCLUSION

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In this paper, the TSP model was developed for transshipment perishable product under the case study of several nodes or depots in Yogyakarta. The proposed TSP model consists of the classical and weighted TSP model. Specifically, the weighted TSP model is developed by considering the nodes that should be prioritized due to the high demand and the opened nodes or depots in the early morning or afternoon. Hence, the objective of both models is to minimize the distance traveled by finding optimum sequence delivery nodes on a tour. To find near or optimum solution, then GA is employed. Based on the result of experimenting with the proposed model by using GA, then there are improvements on total distance saving for the classical TSP model and the weighted TSP model about 46.68% and 45.74, respectively. It shows that the proposed model can be useful to help a driver truck in deciding the sequence delivery nodes of the product under two conditions, namely un-prioritized and prioritized nodes based on the demand and the opened nodes in a certain time. For future research, this model can be extended into several considerations include, the model can be developed by considering uncertainty in the time of delivery, and the other solution approaches can be applied to solve the model problem, therefore, a comparison among algorithm become interesting topics in term of model performance.

ACKNOWLEDGEMENT

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2.Reference 4 – arXiv is an archive. Authors have to include the actual publication details.
3. There are many formatting errors/ incomplete information. For example (not limited to): Reference 1, 4 11, 14 (missing).
4.Please refer to the JAMT template and make sure each reference is formatted according to the JAMT style.

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TRAVELING SALESMAN PROBLEM WITH PRIORITIZATION FOR PERISHABLE PRODUCTS IN YOGYAKARTA, INDONESIA

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A. Rahman

M. Faishal

ABSTRACT

The Traveling Salesman Problem (TSP) is challenging, especially when multiple nodes have varied opening hours and the product is perishable. Due to some nodes' inconsistent store opening times, truck drivers frequently reroute on those same networks. This study proposes the TSP model to resolve the distribution problem based on a case study of a bakery distributor's small and medium enterprises (SMEs) in Yogyakarta, Indonesia. This study proposed the TSP model to solve two conditions: the classical and the weighted TSP model. A classical TSP model was for unprioritized nodes, and the weighted TSP model was for the distribution problem, considering the prioritized nodes due to the opening hours of nodes or depots starting in the early morning or afternoon. Therefore, this model aims to minimize the distance travelled by finding the optimum sequence delivery nodes on tour for classical and weighted TSP. To achieve the objective, some experiments using genetic algorithms were employed. Based on the result of experimenting with the proposed model using GA, the total distance-saving improvements for the classical and weighted TSP

models were about 46.68% and 45.74%, respectively. The proposed model can help a driver truck decide the product's sequence delivery nodes.

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TRAVELING SALESMAN PROBLEM WITH PRIORITIZATION FOR PERISHABLE PRODUCTS IN YOGYAKARTA, INDONESIA

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ABSTRACT: The Traveling Salesman Problem (TSP) is challenging, especially when multiple nodes have varied opening hours and the product is perishable. Due to some nodes' inconsistent store opening times, truck drivers frequently reroute on those same networks. This study proposes the TSP model to resolve the distribution problem based on a case study of a bakery distributor's small and medium enterprises (SMEs) in Yogyakarta, Indonesia. This study proposed the TSP model to solve two conditions: the classical and the weighted TSP model. A classical TSP model was for unprioritized nodes, and the weighted TSP model was for the distribution problem, considering the prioritized nodes due to the opening hours of nodes or depots starting in the early morning or afternoon. Therefore, this model aims to minimize the distance travelled by finding the optimum sequence delivery nodes on tour for classical and weighted TSP. To achieve the objective, some experiments using genetic algorithms were employed. Based on the result of experimenting with the proposed model using GA, the total distance-saving improvements for the classical and weighted TSP models were about 46.68% and 45.74%, respectively. The proposed model can help a driver truck decide the product's sequence delivery nodes.

KEYWORDS: *Travelling Salesman Problem; Route; Genetic Algorithm; Weighted Travelling Salesman Problem*

1.0 INTRODUCTION

Travelling Salesman Problem (TSP) is a challenging problem in Operational Research [1]. Generally, this problem assumes a finite number of nodes, each node is visited only once with each node visited only once, and the distance or the cost to travel between each city is known [2]. The main goal is to find the shortest route with a list of specific destinations (nodes) to the distance travelled or the transportation cost can be minimized.

Perishable products will lose a significant value if stored, and the economic value decreases when late delivery [3]. Some products included as perishable products are fresh fruits and vegetables, flowers, food, and other products with a short lifespan, such as blood, drugs, and concrete [4]. The efficiency in distributing these products is required and challenging. Some previous studies have discussed perishable product distribution problems, such as bakery products [5], newspaper [3], etc. One way is to optimize the delivery route to minimize the distance, reducing distribution costs and increasing company profit.

In the real industry, some weights are required to be considered in TSP [6] based on the preferences of the company. The additional weights on the nodes will complicate the problem compared to the classical TSP. To meet customer orders, perishable products should not be delivered too long after production [4]. As a result, the solution to this problem is interesting. The cost of transportation is also decreased for tours with a lower overall distance covered.

The weight or prioritization of TSP has been discussed in previous studies. Ginting et al. [7] proposed item delivery simulation using Dijkstra Algorithm to find the shortest route for the salesman by considering some priorities. It is in line with previous research [8] that also examined the weight of the nodes during a tour by developing the approximation algorithm and randomized search heuristics.

TSP is fundamental in combinatorial optimization and canonical NP-hard problems [9]. Previous studies have investigated TSP by employing some methods. Xing et al. [10] compared Monte Carlo tree search and deep search neural networks in solving TSP. Another study [11] developed an ant colony optimization method and a self-adaptive discrete particle swarm optimization technique for TSP to attain the smallest sum of distance. Later, a study solved a case study using Anchorage, Alaska's transportation network, to explore the travelling salesman problem in intelligent transportation systems [12]. The goal is to find the route with the lowest cost.

Furthermore, integer linear programming and the branch-and-cut algorithm were developed to solve Steiner TSP [13]. Huang et al. [14] proposed multi-solutions TSP using a niching memetic algorithm. Karaboga and Gorkemli [15] developed a combinatorial artificial bee colony algorithm to solve TSP. In addition, a genetic algorithm (GA) with a modified crossover operator was proposed to find the best routes within 5 to 50 cities [16].

Additionally, employing GA and comparing crossover operators could decrease the route path by altering three variables: the number of cities, the number of generations, and the population size [17]. From those methods, GA is proved more efficient in solving optimization [18]. It is also supported by Vandana et al. [19] who compared GA and dynamic programming, branch and bound, and greedy algorithms to solve TSP. Not only TSP but GA was also successfully implemented in various applications, such as inventory problems [14, 15, 18, 21] , forecasting error [22], scheduling [23], and distribution problem [24].

This study aims to minimize the total distance travelled by taking into account some weights of the nodes classified as stores. The primary contribution of this study is the GA solution proposed for finding the best route while considering the weight of each store. The experiment using GA is run by changing a few of the parameters to discover those optimum values. These parameters included the population size, the probability of crossovers, and the probability of mutations. It investigated the impact of changing those operators on finding the most effective solutions. For managerial insights, the research results can solve the distribution problem for perishable products with minimum travelled distance. This can also assist drivers in determining which stores should be visited based on their priority.

The remainder of this paper is structured as follows. The following section uses a mixed integer programming model to describe the issue in more detail. Section 3.0 describes results and discussion. Finally, Section 4.0 elaborates conclusion and future research.

2.0 PROPOSED MODEL

2.1 Problem description

This research develops the TSP model based on a real case study of a bakery distributor's small and medium-sized enterprise (SME) in Yogyakarta, Indonesia for the distribution of perishable products. Initially, the bakery is regarded as the origin of products (pool) that are prepared for shipment to some stores. The problem with product delivery is that a truck driver frequently reroutes on the same nodes since some nodes have inconsistent store opening times. For instance, some stores are possibly opened in the early morning or afternoon. As a result, unsynchronized delivery nodes make a truck driver do redundant tasks to deliver the product while the product is perishable. Furthermore, this problem can affect to the long-distance travel and directly increase the transportation costs. To solve these problems, some nodes require the weight in a route. The weight in this case study refers to the nodes that should be prioritized based on the store opening time. Therefore, this paper develops the TSP model with priority nodes based on the weight given. The objective of this model is to minimize the distance travelled by determining the optimal sequence delivery nodes in one route. In short, the specification of the proposed model in which representing the case of being studied are defined as follows:

i. There is a single truck in which distributing a single product into 17 nodes.
ii. Each store is visited only once.
iii. The distance to travel between each store is known.
iv. The weight proposed in this model is based on the store opening time.

2.2 Mathematical model

The mathematical model of classical TSP problem could be formulated as follows:

$$Z(X) = \sum_{i=1}^{n} D(X_i, X_{i+1}) + D(X_n, X_1) \quad (1)$$

where, n is the total number of stores, X_1 is considered as the bakery distributor (initial pool). While, X_{i+1} is the store number in position $i + 1$, and $D\left(X_i, X_{j+1}\right)$ is the distance from X_i to X_{i+1} and $D(X_n, X_1) =$ the distance from the last stores to the initial pool .The objective in Eq. (1) is minimizing the total distance of a complete tour by optimizing the sequence of delivery stores. Based on Eq. (1), the weighted (w) TSP model is subsequently developed, which modifies the conventional TSP model by taking prioritized nodes into account:

$$Z(X) = \sum_{i=1}^{n} Dw_i(X_i, X_{i+1}) + Dw_n(X_n, X_1) \quad (2)$$

In practice, these nodes are likely bakeries, schools, supermarkets, and small shops. Because of the products distributed is bread, which is mostly eaten in the morning (high demand and open early morning), so that certain nodes like schools are the most priority ones. Then, the supermarkets are the last node that is distributed, because they are open in the afternoon so that there is no need to re-route. Figure 1 presents the scheme of the proposed TSP model for the bakery distributor's SME system.

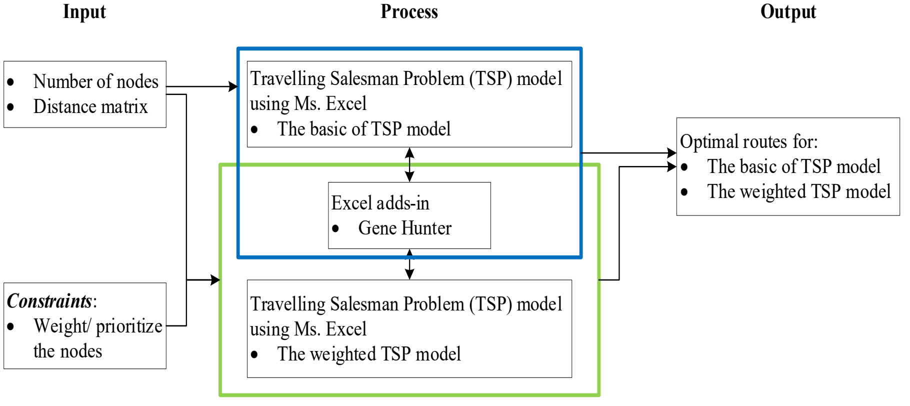


Figure 1: The scheme of the proposed TSP model for the bakery distributor's SME system.

Based on Figure 1, there are input, process, and output. The inputs are the distance matrix and the number of nodes with the constraint given is the weight/ prioritize the nodes. The mathematical model either classical or weighted TSP problem is coded in Microsoft Excel software. This software is compatible because industrial practitioners commonly use this software whose general purpose that can easily solve distribution problems without learning new modeling or programming language, or buy expensive and specific tools, or hire a specialist to do so. In contrast, previous researches employed modeling language (i.e. MATLAB, GAMS, AMPL), or programming language (i.e. Delphi, Java, C), or commercial solvers such as CPLEX which makes the proposed solution difficult to be applied on the real industry. Moreover, to find the near or optimum solution of the TSP model, then the GA based GeneHunter software is used. Therefore, both Microsoft Excel and GeneHunter are employed to conduct experiments to find the best routes with minimum distance for both the classical and weighted TSP model. A detailed discussion of the optimization process using a GA is presented in the next sub-section.

2.3 GA method

As mentioned earlier, the GA method is employed to solve the problem of classical and weighted TSP. The main objective is to minimize the total distance travelled and thereby reduce transportation costs. To start the GA method, the following initial information is required:

i. Population size (N): Sets of the chromosome are kept in each generation.
ii. Crossover rate (Pc): The probability of crossover in the GA method.
iii. Mutation rate (Pm): The probability of mutation in the GA method.

Generally, the steps in the GA method are as follows:

i. Initialization
An initial value of population (N) is generated randomly. In this case, the population consists of several chromosomes that refer to the sequence delivery nodes of a tour (which is gen in GA) as shown in Figure 2. Meanwhile, the population size (N) is determined based on the modeler for each experiment.

X_1	X_2	X_3	…	…	X_{n-1}	X_n

Figure 2: Example of chromosome

ii. Evaluating fitness function
Since GA is categorized as an optimization problem, then a fitness function that is referred to as the objective function needs to be calculated to evaluate the chromosome or solutions in the population. Therefore, the expression of a fitness function is equal to that of TSP model.

iii. Selecting the chromosome
This stage is the selection phase which how the GA chooses the parents for the next generation. It chooses N chromosomes among the parents and the offspring with the best fitness value. There is some selection method, such as roulette wheel, tournament, ranking, and elitist. In this study, the elitist method is used to select the best chromosome.

iv. Performing crossover

This phase is an important part of GA in which two parent chromosomes are paired to create offspring. This research is conducted by selecting randomly a pair of chromosomes from the generation with probability Pc. In this research, the probability of crossover is set into several values to experiment such as 0.95, 0.9, 0.85, 0.8, 0.75, and 0.7. The crossover process has some different types of crossover operators are one-point, two-point, multiple-points, and uniform. This study employs a one-point crossover to generate new offspring. Figure 3 presents a graphical representation of the crossover operations based on the TSP problem. First, a random crossover point is chosen, then split the parents at that point(s), finally, the offsprings are created by exchanging the tails.

v. Performing mutation

The mutation process is required to do as it maintains genetic diversity from one generation of a population so that it ensures a border search space to be searched by GA. By having appropriate mutation probability, the premature convergence can be avoided [25]. The probability of mutation in the experiment uses 0.01, 0.02, 0.025, 0.3, 0.4, and 0.5. Figure 4 illustrates the mutation process.

vi. Termination of the GA process

The last step of GA is to stop the searching process after a solution that is near or optimum has met the user's expectation. This research decides to stop the process of GA after 300 generations. Moreover, the best chromosome with minimum fitness is selected as the near or optimum solution for each experiment.

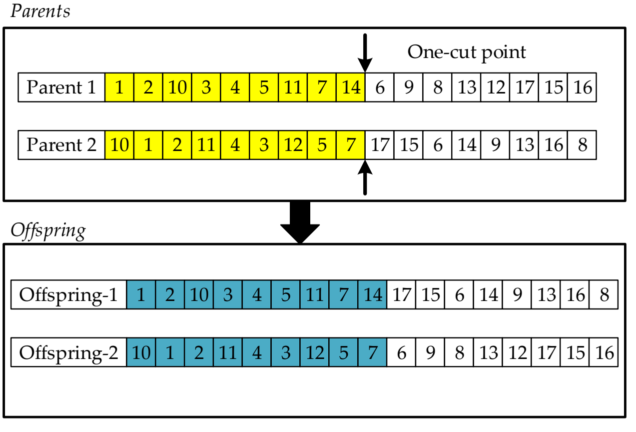


Figure 3: The one-cut point crossover

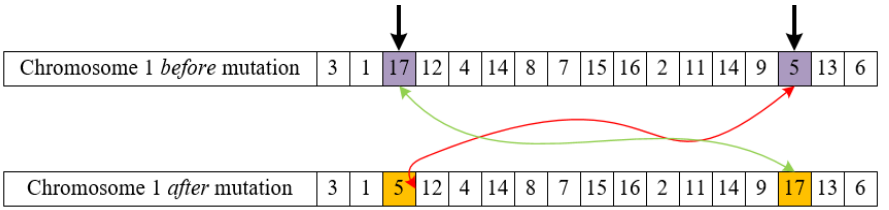


Figure 4: The mutation process

3.0 RESULTS AND DISCUSSION

This section elaborates on the experimental results of the proposed model by evaluating its performances. The data, such as the distance matrix among nodes collected from a real case study, was collected. After that, those data and Eq. (1) are employed to develop the classical and weighted TSP model through GA.

Table 3 presents the experimental results of the classical TSP model and the weighted TSP model. It shows three different experiments (i.e. experiment 1, 2, and 3 for the classical TSP model has the same fitness value even though there are differences in crossover probability, mutation probability, and population size. The different values of GA parameters have experimented with the effect of the performance. In this table, "CPUt" denotes the CPU time of solving the problem in seconds and "Fitness" denotes the fitness value in kilometers.

Table 3: Experimental results: the classical TSP and the weighted TSP

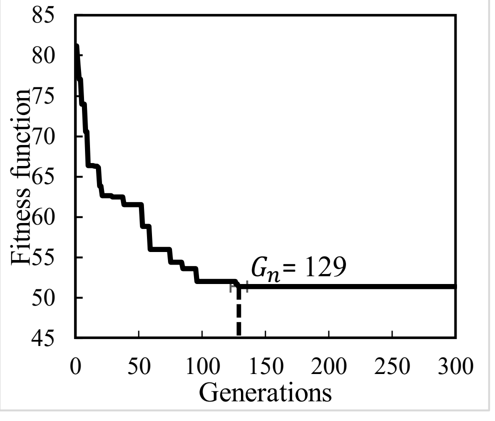
Model	No. of Experiment	Crossover	Mutation	Pop	Fitness	CPUt
The classical TSP model	1	0.95	0.04	80	51.4	20
	2	0.9	0.01	100	51.4	25
	3	0.85	0.03	120	51.4	29
	4	0.8	0.05	140	54.6	32
	5	0.75	0.025	160	53.9	38
	6	0.7	0.02	180	52.2	43
The weighted TSP model	1	0.95	0.04	80	58.8	22
	2	0.9	0.01	100	55.9	28
	3	0.85	0.03	120	52.3	32
	4	0.8	0.05	140	55.5	35
	5	0.75	0.025	160	57.7	40
	6	0.7	0.02	180	59.6	45

For the classical TSP model, the best fitness value is 51.4. It means the total distance traveled in a tour is 51.4 kilometers. Figures 5 shows the trend of fitness value optimization in the classical TSP of the parameter-tuned GA for different crossover probability, mutation probability, and population size. On the other hand, the fitness value optimization for the weighted TSP model is presented in Figure 6.

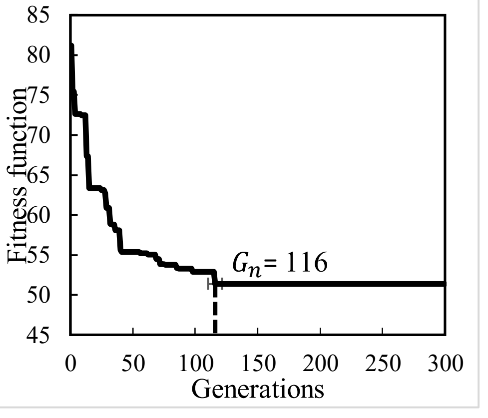
To examine the percentage of fitness value reduction (total distance traveled in a tour) obtained by the implementation of the parameter-tuned GA above as follows.

$$Improvement\ (\%) = \frac{TD_{after} - TD_{before}}{TD_{before}} x100 \quad (3)$$

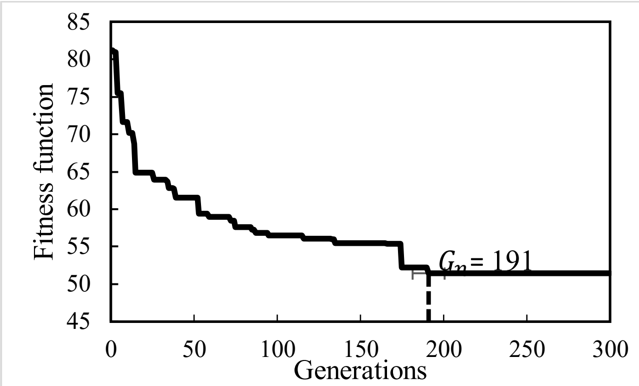
TD_{before} denotes the total distance of the current system without optimization. TD_{after} denotes near-optimal total distance traveled of the parameter-tuned GA. According to the obtained results, there are improvements in total distance saving for the classical TSP model and the weighted TSP model, i.e. 46.68% and 45.74%, respectively. The weighted TSP model has smaller improvement than the classical one as it considers some contraints to minimize the travel distance while considering some prioritizations due to the high demand and the opened nodes or stores in the early morning or afternoon.



(a)



(b)



(c)

Figure 5: The trend of fitness value optimization: The classical TSP model for (a) experiment 1, (b) experiment 2, and (c) experiment 3

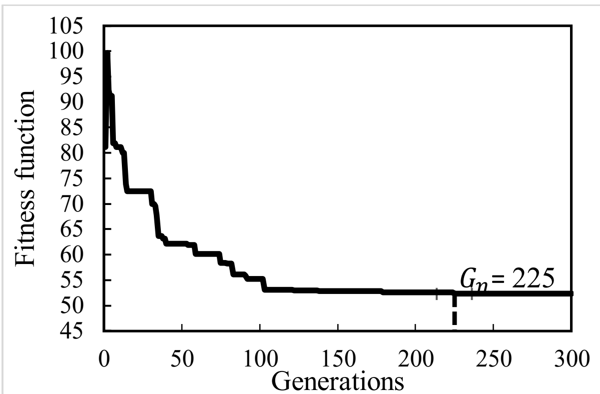


Figure 6: The trend of fitness value optimization: The weighted TSP model for experiment 3

Even though the weighted TSP model has smaller improvement and has higher CPU time (see Table 2) than the classical one, the weighted TSP model is more applicable for bakery distributor's SME in Yogyakarta, Indonesia as this model considers the prioritization of particular nodes to find the optimal sequence of delivery nodes in a tour.

When each store is assigned a priority value that must be met before any others, GA is able to identify the route with the greatest priority value. However, a longer distance is affected by this. Of course, it will affect shipping costs as well. However, the GA solution is still a viable option. This is so that the model can identify the shortest distance while also finding the best route based on a high priority value. Some earlier literature, like da Silva et al [6] and Bossek et al [8] provide additional support for these findings.

4.0 CONCLUSION

In this paper, the TSP model was developed for distribution perishable product under the case study of several nodes or depots in Yogyakarta. The proposed TSP model consists of the classical and weighted TSP model. Specifically, the weighted TSP model is developed by considering the nodes that should be prioritized due to the high demand and the opened nodes or depots in the early morning or afternoon. Hence, the objective of both models is to minimize the distance traveled by finding optimum sequence delivery nodes on a tour. To find near or optimum solution, then GA is employed. Based on the result of experimenting with the proposed model by using GA, then there are improvements on total distance saving for the classical TSP model and the weighted TSP model about 46.68% and 45.74, respectively. It shows that the proposed model can be useful to help a driver truck in deciding the sequence delivery nodes of the product under two conditions, namely un-prioritized and prioritized nodes based on the demand and the opened nodes in a certain time. For future research, this model can be extended into several considerations include, the model can be developed by considering uncertainty in the time of delivery, and the other solution approaches can be applied to solve the model problem, therefore, a comparison among algorithm become interesting topics in term of model performance.

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