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Round Robin-Least Cost Combined Model in City Courier Scheduled Shipping Service

Purba Daru Kusuma and Andrew Brian Osmond
School of Electrical Engineering, Telkom University, West Jawa, Indonesia

Abstract: Nowadays, online motorcycle taxi based city courier service has arising. This provider serves faster delivery time rather than conventional courier service. Unfortunately, the existing motorcycle taxi based city courier service has not accommodated multi customer multi shipping order request. It means that customer must create order one by one if the he wants to send more than one package and each order will be executed by distinct driver. This condition is not efficient. In this research, we propose scheduled shipping model, so that, more than one package from more than one customer will be grouped and each package group will be delivered by distinct driver. The goal is reducing delivery distance, so that, cost that must be paid by sender will be reduced too. This model is developed by combining round robin and least cost method. In this research, we propose three models: non preferred sender maximum distance limitation, maximum number of non preferred sender limitation and weighted non preferred sender distance. In this research, we observe both financial and non financial aspects. Based on the simulation result, these proposed models can reduce total delivery distance and sender cost. The third model produces the highest efficiency while the first model produces the lowest efficiency.

Key words: City courier, scheduled Shipping, Round Robin, least cost, revenue, highest efficiency

INTRODUCTION

Nowadays, the rise of online motorcycle taxi creates many opportunities. One of the opportunities is city courier service. Besides transporting person from one place to another, the taxi driver can be utilized to deliver package around the city. By providing this service, both company and customer take advantage. For company by diversifying service, additional revenue can be generated rather than depended on taxi service only. This service also gives more opportunity to survive. It is because online motorcycle taxi service faces resistance from traditional motorcycle taxi (Freischald, 2015; Budiari, 2015) and the regulation is still in grey area (Anonymous, 2016, 2017). Meanwhile, the city courier service does not face resistance from conventional courier service. In the other hand, city courier service that is handled by online motorcycle taxi can provide faster delivery time. By using regular service that is provided by conventional courier service, package cannot be delivered in the same day when the package is submitted. Meanwhile, by using online motorcycle taxi, package can be delivered in minutes or hours.

Even city courier service is prosperous, the feature is limited. There are many problems that must be solved and many opportunities that should be achieved. In Indonesia where this service is dominated by Go-Jek and Grab as its contender, single order contains single package only. It means, one order means one package from one sender to one receiver. When the sender needs to send more than one packages and each package is for distinct destination/receiver, sender has to create order one by one. Then, each package will be executed by distinct allocated driver. This condition is not efficient. To improve efficiency in the previous research, we have proposed combined shipping model by using random walk and least effort method, so that, packages will be grouped and each grouped will be executed by distinct driver. In this previous research, its finding is that the combined shipping has improved the efficiency by reducing total cost that must be paid by the customer and increasing the average driver's revenue. The other finding is least effort method produces better performance rather than random walk method. In that research, the scenario is single sender sends package to multi receivers. The other condition is what if in the same time, there are many senders that send more than one packages.

In the previous research, there is condition that one driver gets better revenue rather than other driver because this driver sends more packages rather than the others. So, there is opportunity to increase the driver's revenue by adding packages from other sender. So, the research

Corresponding Author: Purba Daru Kusuma, School of Electrical Engineering, Telkom University, West Jawa, Indonesia

question is how to distribute these all packages to allocated drivers, so that, the performance of the proposed model can be compared with the existing model, especially in customer's cost and the average driver's revenue.

Based on these questions, the research purpose of this research is creating the scheduled shipping model that can answer these questions. This model is developed by combining least cost and round robin methods. The least cost method is chosen because in the previous research, this method performs better than random walk method. Fan and Ma (2018) used shortest route, minimum cost and least time constraint in optimizing vehicle distribution route. Arafath *et al*. (2018) interpreted least cost as the least distance and least routing time in routing protocol in wireless sensor networks. Ishida *et al*. (1998) proposed heuristic method in least cost path routing protocol in real time communication service. Kolarov and Hui (1994) used least cost routing in a multirate circuit switched broadband ISDN.

The round robin method is chosen because this method is proven in load balancing and scheduling (Xu *et al*., 2016; You *et al*., 2014; Alali *et al*., 2015; Rao *et al*., 2015; Farooq *et al*., 2017). Generally, round robin method is common method in package scheduling in electronic network. This method is proven to avoid entity occupies network too long, so, other entities cannot utilize network. Xu *et al*. (2016) used Weighted Round Robin (WRR) strategy in AFDX terminal system. You *et al*. (2014) used round-robin scheduling algorithm for load balancing in LVS cluster system. Alali *et al*. (2015) used round-robin method in developing framework for fast simulation and performance evaluation of MPSoC because its simplicity. Rao *et al*. (2015) modified round robin in CPU process scheduling. Farooq *et al*. (2017) used round robin algorithm in CPU process scheduling in embedded system because of its efficiency.

Scheduled shipping: Scheduled shipping is one of shipping method that the package will be delivered in specified schedule. This method is different with the existing motorcycle taxi based city courier service. In the existing system, customer or sender creates the shipment order with specified destination. Then, the system will search the available driver. The allocated driver then arrives to the sender location, picks up the package and delivers the package to the destination or recipient. Based on this method, the package will be delivered in minutes or hours. This existing method provides faster delivery time rather than conventional courier system. Based on this method at one time, system can only dispatch one order because the probability there are more than one package that must be dispatched is low.

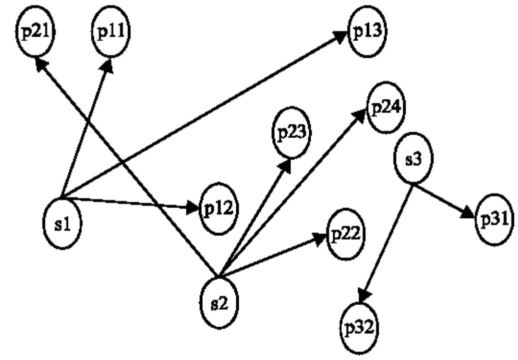

Fig. 1: Senders and packages destination illustration

For some people, they tolerate if their packages do not be sent immediately after the orders are created. For example, many e-Commerce merchants create order at night because of efficiency. They collect purchase order for a day and then after they close the store, they prepare the packages and then send them to the courier service. The other example is a customer who wants to send wedding invitations to specified recipients. Actually, they don't need the packages will be delivered in the same day. They still toletare if the packages that they order today will be picked up and be delivered tomorrow.

This condition makes the opportunity in scheduled shipping service. In scheduled shipping service, the sender adds criteria in what range of time the packages must be picked up. So, the system has opportunity to dispatch packages from many senders in one dispatch session. This service also gives better prediction for the driver about the travel route and revenue opportunity that he will get tomorrow.

The illustration of the scheduled shipping is as follows. Suppose that we have three senders named s_1, s_2 and s_3. s_1 ships three packages $\{p_{11}, p_{12}, p_{13}\}$. s_2 ships four packages $\{p_{21}, p_{22}, p_{23}, p_{24}\}$. s_3 ships two packages $\{p_{31}, p_{32}\}$. The senders and destinations location is shown in Fig. 1.

Based on the previous research (Kusuma, 2018), if we assume that there is one group for each sender and the least effort algorithm is applied, so, each sender will be served by single driver $\{d_1, d_2, d_3\}$. The routing for each group is as follows. Driver d_1 executes packages from s_1 with route is $s_1 \rightarrow p_{11} \rightarrow p_{12} \rightarrow p_{13}$. Driver d_2 executes packages from s_2 with route is $s_2 \rightarrow p_{22} \rightarrow p_{23} \rightarrow p_{24} \rightarrow p_{21}$. Driver d_3 executes packages from s_3 with route is $s_3 \rightarrow p_{31} \rightarrow p_{32}$.

Unfortunately, there is inefficiency where there are packages from different sender but the recipient location is near to each other. For example, p_{11} is near p_{21}. So, it will be more efficient if package p_{11} is executed together with p_{21} by same driver. Package p_{12} is closer to s_2 rather than s_1. Package p_{24} is closer to s_3. Visually, these packages can be clustered into three groups. The first group contains $\{p_{11}, p_{21}\}$. The second group contains $\{p_{12}, p_{23}, p_{22}, p_{32}\}$. The third group contains $\{p_{31}, p_{24}, p_{13}\}$.

If our point of view is based on destination location only, these groups are good. But if we look deeper, there is problem in this group. In this grouping method, sender location parameter is ignored. The result is there is more than one sender in a group. In group one, there are two senders. In group two and group three, there are three senders. In group one, the senders are s_1 and s_2 and the distance between senders is close. This condition may be tolerated. Unfortunately, in group two and group three which the drivers should go to three senders first before delivering packages, pickup distance is too far. Based on this condition, the grouping method must be improved by not ignoring the sender parameter.

MATERIALS AND METHODS

Based on the mentioned problem, we propose the improved least cost algorithm. In this research, we propose three modified models. The first model is least cost algorithm with maximum distance for non preferred sender. The second model is least cost algorithm with maximum number of non preferred senders. The third model is least cost algorithm with weighted non preferred sender distance.

In the first model, the least cost algorithm is combined with the maximum distance for other sender. It means that the driver may execute his non preferred sender's package when the destination location of package is nearest to the driver current location and the distance between the driver's preferred sender and the non preferred sender is lower than the maximum other sender distance. So, the other sender package execution is limited by the maximum other sender's distance (r_{max_os}).

The illustration is as follows. Suppose that driver d_1 is allocated for sender s_1. So, the d_1's preferred sender is s_1. The s_1's packages are p_{11} and p_{12}. The distance of the packages from the sender s_1 is 4 km for p_{11} and 6 km for p_{12}. Meanwhile, there is sender s_2 that its distance to the s_1 is 1 km. Sender s_2 has one package that must be delivered (p_{21}) and the distance between this package and the sender s_1 location is 3 km. The r_{max_os} value is set 2 km. The driver's current location is at sender s_1. The graphical illustration of this condition is shown in Fig. 2.

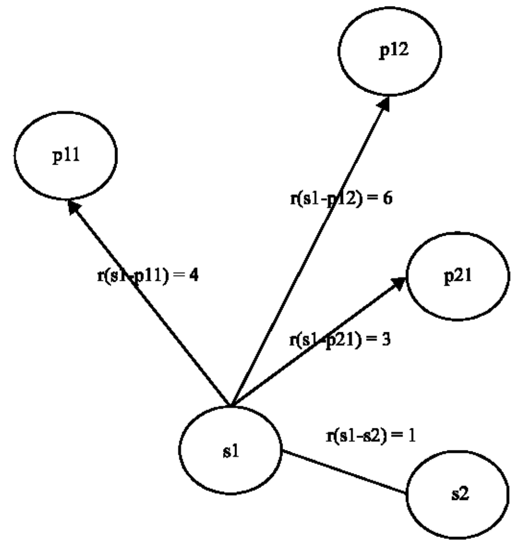

Fig. 2: Least cost algorithm with maximum distance for non preferred sender

Based on this illustration, the driver will choose p_{21} package for his next route. It means that the p_{21} package will be allocated to him. It is because this packages location is the shortest distance among all packages. Even this package is not his preferred sender's package, the distance between the package owner and the driver preferred sender is lower than r_{max_os}. The formulation is described formally in Eq. 1 and 2. In these equations, there are some variables that are used. Variable $p_{next}(i)$ is the next package for driver i. variable $pos_{cur}(i)$ is driver i's current position. Variable $pos(p_i)$ is the position of the package destination. Variable p_i is the package in $P_{cand,i}$ set. Variable $P_{cand,i}$ is a set that contains packages that will be the candidate for next package that will be picked up by driver i. Variable p_d is the driver of package p. Variable s_p is the sender of the package p:

$$p_{next}(i) = \min\left(r\left(pos_{cur}(i)\text{-}pos(p_i)\right)\right) \wedge p_i \in P_{cand,i} \quad (1)$$

$$Pcand,i = p/pd = iV\left(p_d \neq i \wedge r\left(S_i\text{-}S_p\right) \leq r_{max\text{-}os}\right) \quad (2)$$

In the second model, the least cost algorithm is combined with the maximum number of non preferred drivers. It means that rather than limiting the distance between the preferred sender and the non preferred sender, the model limits the number of non preferred senders that is served by the driver. The purpose is the driver does not serve too many non preferred senders. In this model, the method in Eq. 1 is used to determine which package will be the next package but the method that is used to determine the member of the package candidate set follows Eq. 3. In Eq. 3, there are new variables. Variable $P_{non,i}$ is set of non preferred driver for driver i that the their packages has been in the driver i's delivery list. So, n $(P_{non,i})$ is the number of this set member. Variable n_{max_non} is the maximum number of non preferred sender:

$$Pcand,i = p / pd = iV\begin{pmatrix} p_d \neq i \wedge p_d \in P_{non,\,i} \\ \wedge n\left(P_{non,i}\right) \leq n_{max\text{-}non} \end{pmatrix} \quad (3)$$

In the third model, the least cost algorithm is combined with the weighted distance between the preferred sender and non preferred sender. Based on this concept, there is not specified value to limit the number of non preferred sender as it is mentioned in the second model or specified value to limit the non preferred sender distance as it is mentioned in the first model. The next package that will be picked up by the driver is determined by Eq. 4 and 5. Variable r_{cum} (i, p) is the accumulated distance for driver i and the package p. Variable P is set of package that has not been allocated for any driver. Variable ω is the weight factor and its value ranges from 0-1:

$$p_{next}(i) = \min\left(r_{cum}(i,p)\right) \wedge p \in P \quad (4)$$

$$r_{cum}(i,p) = r\left(pos_{cur}(i)-\left(pos(p)\right)\right)+\omega.r\left(s_i-s_p\right) \quad (5)$$

Besides modifying least cost algorithm, we also use round robin method to schedule which driver that can choose package in a session. In this model, the number of entities or drivers that joins the robin robin sequence is depended on the number of senders. If driver reaches his maximum delivery distance then this driver will be replaced by a new driver. The sequence process will end if all packages have been allocated. This process algorithm is shown in Algorithm 1.

Algorithm 1; Round Robin scheduling algorithm:

```
Begin
 token←1
 while (n_na_package > 0)
 begin
  i_package←0
  i_package←findpackage(token)
  if(i_package > 0) then
  begin
   n_na_package ← n_na_package – 1
   allocate-driver(token,p_i)
   if (d_delivery(token)>= d_maxdelivery) then
    replace-driver(token)
  end
  token-pass(token)
 end
end
```

Based on the algorithm that is described in algorithm 1 there are some variables and sub programs that are used in it. Variable token is the position of the token that describes the current sender index. Variable $i_{package}$ is the the package index that will be allocated to the driver. The $i_{package}$ value ranges from 1 to the number of packages $(n_{package})$. Variable $n_{na\_package}$ is the number of packages that have not been allocated. Based on the looping in this algorithm, the looping process will stop only if all packages have been allocated. Variable $d_{delivery}$ is the delivery distance for the specified driver. Variable $d_{maxdelivery}$ is the maximum delivery distance that is allowed for driver.

The sub programs that are used in this algorithm are find package, allocate-driver, replace-driver and token-pass. Find package function is used for finding package that will be allocated for specified driver. If there is package that is successfully chosen then this package will be allocated to the driver by using allocate-driver procedure. When the system uses the first method or the second method, if driver is fail to find package then driver will take the nearest package and ignores the package sender. Replace-driver procedure is used for replacing existing driver that his delivery distance exceeds the maximum delivery distance with new driver. Token-pass procedure is used to move the token to the next driver.

In this model, the cost for each package will be allocated to the sender's of the package. For example, driver A's preferred sender is B. So, if he takes package that belong to C then the cost for this package will be paid by C. The package cost is calculated by multiplying the distance between driver's current position with the package destination location and the cost per kilometer (c_{unit}). The distance value is represented in kilometer and the data type is integer. The cost calculation for driver i and package p is formulated in Eq. 6:

$$c(p,i) = \text{integer}\left(d\left(pos_{cur}(i)\text{-}pos(p)\right)\right)\times c_{unit} \quad (6)$$

RESULTS AND DISCUSSION

Implementation and analysis: The proposed models then are implemented into city courier scheduled shipping simulation application. In this application, the world is a virtual city with its width is 15 km and its length is 15 km. When the simulation starts, some senders are generated. The number of senders that are generated in every simulation session is static. Sender location within the world is generated randomly and the value follows uniform distribution. The number of the packages for every sender is in static too. The package destination location is generated randomly inside the city and follows uniform distribution.

Table 1: The Simulation result of round Robin-least cost combined method with maximum non preferred sender distance limitation

$n_{package}$ (unit)	$d_{revenue}$ (rupiah)	s_{cost} (rupiah)	$d_{tot\_delivery}$ (km)	n_{group} (unit)
10	71.503	71.503	722.000	20.00
20	109.907	109.907	1.114	20.00
30	133.912	137.863	1.400	20.60
40	141.585	159.937	1.627	22.65
50	140.452	179.976	1.834	25.71
60	130.493	196.718	2.008	30.23
70	127.843	213.258	2.180	33.43
80	126.264	225.919	2.313	35.84
90	126.026	234.740	2.407	37.27
100	127.773	248.065	2.546	38.84

Table 2: The simulation result of round Robin-least cost combined method with maximum number of non preferred senders limitation

$n_{package}$ (unit)	$d_{revenue}$ (rupiah)	s_{cost} (rupiah)	$d_{tot\_delivery}$ (km)	n_{group} (unit)
10	60.828	60.828	615.000	20.00
20	92.860	92.860	943.000	20.00
30	112.382	112.382	1.145	20.00
40	131.616	131.616	1.343	20.00
50	143.376	145.844	1.493	20.35
60	149.505	159.337	1.633	21.37
70	144.578	173.280	1.779	24.04
80	137.475	186.161	1.914	27.19
90	132.718	193.031	1.988	29.30
100	123.232	209.179	2.156	34.03

Table 3: The simulation result of round Robin-least cost combined method with weighted non preferred sender distance

$n_{package}$ (unit)	$d_{revenue}$ (rupiah)	s_{cost} (rupiah)	$d_{tot\_delivery}$ (km)	n_{group} (unit)
10	48.259	48.259	4900	20.00
20	72.651	72.651	7400	20.00
30	94.126	94.126	9620	20.00
40	111.268	111.268	1.140	20.00
50	129.136	129.136	1.325	20.00
60	142.404	144.032	1.480	20.23
70	150.806	157.980	1.626	20.96
80	148.259	173.712	1.789	23.55
90	139.096	186.259	1.922	26.93
100	129.306	197.704	2.042	30.68

Table 4: The simulation result of round Robin-least cost combined method from previous model

$n_{package}$ (unit)	$d_{revenue}$ (rupiah)	s_{cost} (rupiah)	$d_{tot\_delivery}$ (km)	n_{group}(unit)
10	80.945	80.945	817.000	20.00
20	118.978	118.978	1.205	20.00
30	146.934	146.934	1.491	20.00
40	166.323	170.224	1.731	20.48
50	144.579	193.105	1.967	26.87
60	119.571	214.981	2.192	36.03
70	117.283	232.427	2.373	39.64
80	123.546	247.091	2.526	40.00
90	130.098	260.196	2.664	40.00
100	136.412	272.823	2.797	40.00

In this research, we have done several tests to observe the performance for every model. The output parameters that are observed include financial aspects and non financial aspects. The financial aspect parameters are average sender's cost (s_{cost}) and average driver's revenue ($d_{revenue}$). The non financial aspect parameters are total driver's delivery distance ($d_{tot\_delivery}$) and number of groups (n_{group}). The tests are done for different number of packages per sender ($n_{package}$).

In this test, variable ω is set 0.5. Variable $d_{maxdelivery}$ is set 100 km. Variable r_{max_os} is set 3 km. Variable n_{max_non} is set 3. There are 20 senders during simulation. The number of packages per sender ranges from 10-100 units. There are 30 simulation sessions for every number of packages per sender value. The result when the simulation uses the first proposed model is shown in Table 1. The result when simulation uses the second proposed model is shown in Table 2. The result when simulation uses the third proposed model is shown in Table 3. The result when the simulation uses the previous model (Kusuma, 2018) is shown in Table 4.

Based on data in Table 1 when system uses round robin-least cost algorithm with maximum non preferred sender distance limitation model, it is seen that the increasing of the number of packages per sender makes the output parameters value increases too. In s_{cost} parameter when the $n_{package}$ is 10 units then the s_{cost} is 71.503 Rp. and when the $n_{package}$ is 100 units then the scost is 248.065 Rp. So, for sender, it is more efficient if he sends more packages. It is because the cost per package is getting lower from 7.150 Rp. if he sends 10 packages to 2.481 Rp. if he sends 100 packages. This result is the consequence from the total delivery distance aspect. Even the total delivery distance increases from 722-2.546 km, the delivery distance per package decreases. The delivery distance per package is 3.61 km if a sender sends 10 packages and become 1.27 km if a sender sends 100 packages. In the other hand, the average driver revenue grows from 71.503 Rp. goes to 141.585 Rp.. Then, the average driver's revenue gets lower and stagnant in 127.773 Rp.. It is because the average driver's revenue is limited by his maximum delivery distance.

Based on data in Table 2 when system uses combined round Robin-least cost algorithm with maximum number of not preferred senders limitation model, it is seen that the increasing of the number of packages per sender makes the output parameters value increases too. In s_{cost} parameter when the $n_{package}$ is 10 units then the s_{cost} is 60.828 Rp. and when the $n_{package}$ is 100 units then the scost is 209.179 Rp. So, for customer, it is more efficient if he sends more packages. It is because the cost per package is getting lower from 6.083 Rp. if he sends 10 packages to 2.092 Rp. if he sends 100 packages. This result is the consequence from the total delivery distance aspect. Even the total delivery distance increases from 615-2.156 km, the delivery distance per package decreases. The delivery distance per package is 3.07 km if a sender sends 10 packages and become 1.08 km if a sender sends 100 packages. In the other hand, the average driver revenue grows from 60.828 Rp. goes to 149.505 Rp. Then, the average driver's revenue gets lowering to 123.232 Rp.

Based on data in Table 3 when system uses round Robin-least cost algorithm with weighted non preferred senders distance model, it is seen that the increasing of the number of packages per sender makes the output parameters value increases too. In s_{cost} parameter when the $n_{package}$ is 10 units then the s_{cost} is 48.259 Rp. and when the $n_{package}$ is 100 units then the s_{cost} is 197.704 Rp. So, for customer, it is more efficient if he sends more packages. It is because the cost per package is getting lower from 4.826 Rp. if he sends 10 packages to 1.977 Rp. if he sends 100 packages. This result is the consequence from the total delivery distance aspect. Even the total delivery distance increases from 490-2.042 km, the delivery distance per package decreases. The delivery distance per package is 2.45 km if a sender sends 10 packages and become 1.02 km if a sender sends 100 packages. In the other hand, the average driver revenue grows from 48.259-150.806 Rp. Then, the average driver's revenue gets lowering to 129.306 Rp.

Based on data in Table 3 when system uses the previous research model (Kusuma, 2018), it is seen that the increasing of the number of packages per sender makes the output parameters value increases too. In s_{cost} parameter when the $n_{package}$ is 10 units then the s_{cost} is 80.945 Rp. and when the $n_{package}$ is 100 units then the s_{cost} is 272.823 Rp. So, for customer, it is more efficient if he sends more packages. It is because the cost per package is getting lower from 8.094 Rp. if he sends 10 packages 2.728 Rp. if he sends 100 packages. This result is the consequence from the total delivery distance aspect. Even the total delivery distance increases from 817-2.797 km, the delivery distance per package decreases. The delivery distance per package is 4.08 km if a sender sends 10 packages and become 1.39 km if a sender sends 100 packages. In the other hand, the average driver revenue fluctuates from 80.945-166.323 Rp.

Based on the result above, then the performance comparison between these proposed models and the previous model are observed. The compared parameters are the sender cost reduction, the total driver's delivery distance reduction and the average driver's revenue reduction. The average sender's cost reduction is shown in Table 5. The average driver's revenue reduction is shown in Table 6.

Based on data in Table 5, it is shown that scheduled shipping model is more efficient in average sender's cost rather than previous non scheduled shipping model even both model implements combined shipping model. It is shown that there is sender's cost reduction in all proposed models. The biggest cost reduction is achieved when system implements round robin-least cost combined model with weighted non preferred sender distance model or the third model. The smallest cost reduction is achieved when system implements round robin-least cost combined model with maximum non preferred sender distance limitation model or the first model. When system uses first model or third model, the increasing of the number of package per sender makes the average sender's cost reduction decreases. Meanwhile, when system uses second model, the increasing of the number of packages per sender does not affect the cost reduction because the average sender's cost reduction fluctuates from 21.95-25.88%.

Table 5: Average sender's cost reduction comparison between proposed models and previous model

	Average sender's cost reduction (%)		
$n_{package}$ (unit)	First model	Second model	Third model
10	11.67	24.85	40.38
20	7.62	21.95	38.94
30	6.17	23.51	35.94
40	6.04	22.68	34.63
50	6.80	24.47	33.13
60	8.50	25.88	33.00
70	8.25	25.45	32.03
80	8.57	24.66	29.70
90	9.78	25.81	28.42
100	9.07	23.33	27.53

Table 6: Average driver's revenue reduction comparison between proposed models and previous model

	Average driver's revenue reduction (%)		
$n_{package}$ (unit)	First model	Second model	Third model
10	11.67	24.85	40.38
20	7.62	21.95	38.94
30	8.86	23.51	35.94
40	14.87	20.87	33.10
50	2.85	0.83	10.68
60	-9.13	-25.03	-19.10
70	-9.00	-23.27	-28.58
80	-2.20	-11.27	-20.00
90	3.13	-2.01	-6.92
100	6.33	9.66	5.21

Based on the data in Table 6, the increasing of the number of packages per sender does not affect the average driver's revenue reduction. It is because the driver's revenue reduction tends to fluctuate. The fluctuation occurs in all proposed models. The highest gap between minimum and maximum reduction occurs when system uses third model. The lowest gap between minimum and maximum reduction occurs when system uses first model.

CONCLUSION

Based on the explanation above, it is shown that the scheduled shipping model has been proposed and has been implemented into the scheduled shipping simulation application. In this research, there are three proposed models. The first model is round Robin-least cost combined method with maximum not preferred sender distance limitation. The second model is round robin-least cost combined method with maximum number of non preferred sender limitation. The third model is round robin-least cost combined method with weighted not preferred sender distance.

Based on the test, generally, all proposed models performs more efficiently rather than the previous model in cost that must be paid by the sender and the total delivery distance. The cost reduction is the consequence of the total delivery distance reduction. So, it can be said that allowing driver to deliver package which the package sender is not his preferred sender, the distance that is needed to deliver all packages within system is reduced. It means that by his willingness to not send package immediately, sender can save money by paying lower delivery cost. Comparing among three models, the most efficient model is the third model because this model produces the lowest total delivery distance and the lowest average sender's cost. Meanwhile, the least efficient model is the first model because this model produces the highest total delivery distance and the highest average sender's cost. It is also found that when the number of packages increases, the average delivery cost per package gets lower.

Even these proposed models have successfully made efficiency, proposing new model in city courier service is still challenging. It is because this service is still growing. Each provider still looks for better business model. New model means proposing new service for customer. New model also means benefiting driver, customer and company. There are many research areas in this business, such as dispatch system, pricing strategy or bundling mechanism. By benefiting all of the stakeholders, the business will be sustainable.

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