Journal of Engineering and Applied Sciences 13 (12): 4518-4524, 2018
ISSN: 1816-949X

Motorcycle Taxi-Minibus Collaborative Model in Local Courier Service

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Abstract: The rising of online motorcycle taxi in Indonesia disrupts the existence of the conventional local transportation modes. Their revenue falls into the lowest level, so that, these conventional transportation modes are not economical to be operated. Meanwhile, the online motorcycle companies diverse their business into local courier service. This strategy triggers new business opportunity, especially in food delivery. Besides food, many products with various dimensions can be delivered. This condition makes local courier service becomes new business potential. So, it will be better for conventional transportation modes to transform their business not only transporting people but also, packages. Based on this need in this research we propose collaborative model between minibus local transportation mode and conventional motorcycle taxi in local courier service system. This proposed model adopts ring topology model that is common in data communication network. In this model, the ring topology represents the closed loop minibus route and the conventional motorcycle taxi pools are attached in this route. This model then is implemented into local courier service simulation application. This model is also, compared with the one on one online motorcycle taxi based local courier service model. During the test, the controlled variable is the number of orders. The observed variables are the total motorcycle taxi delivery distance and the total delivery cost. Based on the result, the lower size route proposed model produces the lowest total motorcycle taxi distance. Meanwhile, the previous model produces the lowest total delivery cost. In all observed variables, the gap among models is still narrow.

Key words: Local courier, motorcycle taxi, minibus, ring topology, collaborative model, e-Commerce

INTRODUCTION

Nowadays, the rise of online based taxi disrupts the conventional transportation modes (Gaskell, 2017; Anonymous, 2017; Zickuhr, 2016). This condition also occurs in Indonesia. This online based taxi is proven in reducing conventional taxi revenue (Zickuhr, 2016). The rise of online motorcycle taxi disrupts the existence of the conventional taxi or popular as "ojek pangkalan" (Natadjaja and Setyawan, 2016). This new service also disrupts the minibus based fixed route transportation mode (Anya, 2017). The online motorcycle taxi provides faster travel time rather than fixed route minibus. This mode also provides door to door service rather than node to node service that is provided by the minibus. Although, fixed route minibus provides lower travel cost, many passengers still tolerate it because of the faster travel time and door to door service that are provided by the online motorcycle taxi.

In other side, this online motorcycle taxi also disrupts conventional motorcycle taxi by solving the conventional motorcycle taxi problems: irrational price and short range distance. It is well known that the motorcycle taxi usually proposes expensive and irrational price. This situation becomes more difficult because though negotiation between passenger and driver must be done first to conclude the price deal. Passenger with low stance usually must pay higher price. Conventional motorcycle taxi usually provides short distance travel. It is because many vehicles that are operated are in bad condition. Some drivers don't have driving license. Many drivers also know only their environment and they are blind with the specific location that is far from their base.

Meanwhile, current navigation technology makes these problems are easily to be solved. By using Google map, the pickup and destination can be submitted into the system, so that, driver can find the passenger's locations easily. So, it does not matter whether driver is blind with the location as long as he activates Google map. Besides navigation, the fixed travel cost can be determined precisely and transparently based on travel distance after the order is created. So, negotiation is not needed anymore.

Based on this explanation, fixed route minibus and conventional motorcycle taxi cannot act as usual. There are two ways that can be done by these transportation modes. First, they must adopt new technology and provide new business process. Second, they must transform their business and find new opportunity. Otherwise, they will go to extinction because their operational cost is not economical anymore.

Meanwhile, online motorcycle taxi expands their business into local courier service. In Indonesia, Go-jek launches go-food (Anonymous, 2018) and Go-Send as its local courier service. Go-food delivers food by collaborating with local restaurants. Meanwhile, Go-Send becomes its portfolio as courier service. As Go-jek main competitor, Grab also launches Grab-food to fight against Go-food (Lim, 2018).

Even local courier service that is provided by online motorcycle taxi is accepted by public, the business model still faces several problems. In one side, local courier service provides faster than common courier service such as JNE or TIKI in Indonesia. There are two problems. First, the business model is single order is for single destination only. This is one source of inefficiency. This problem has been tried to be solved by combined shipping model (Kusuma, 2018) and scheduled shipping model, so that, driver can execute more packages simultaneously. The second problem is the shipment cost is still more expensive. It is because the cost is calculated per kilometer.

This second problem can be business opportunity for conventional transportation modes by providing same day service local courier service with lower shipment cost. By entering this service, conventional transportation modes can increase its vehicle utilization by not only transporting people but also delivering packages.

Based on this problem, the research question is how to develop the local courier service model for conventional fixed route minibus and conventional motorcycle taxi. So, the main goal of this research is proposing collaborative model between motorcycle taxi and fixed route minibus as local courier service. The secondary goal is evaluating this proposed model and comparing its performance with the online motorcycle taxi based local courier service.

This model is developed by adopting ring network topology. It is because minibus route can be seen as single direction ring network. Meanwhile, conventional motorcycle taxi pools can be seen as its nodes. So, delivering package from one place to another can be seen as transmitting package from one node to another node in the ring.

There are many researches in communication network that use ring topology. Yoon *et al.* studied ethernet system in industrial network that uses ring topology. Agata *et al.* (2013) used ring topology in Centralized Radio Access Network (C-RAN) in reducing implementation cost of mobile access network. So, the challenge is implementing ring topology concept in courier modeling.

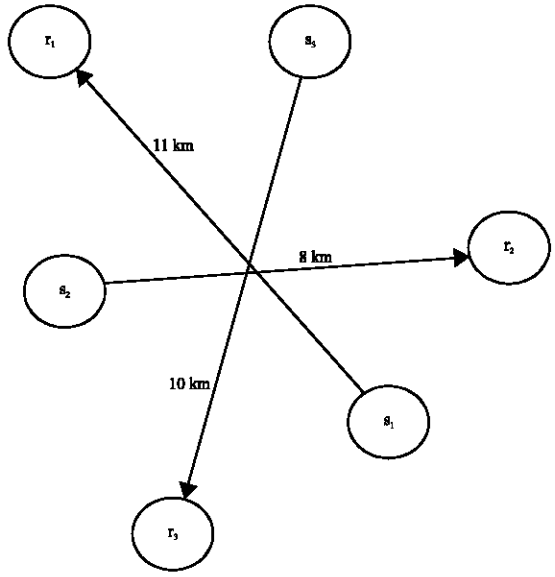

Fig. 1: Current local courier service illustration

Cost problem in current local courier service: In this study, we will discuss the cost problem in current local courier service that is operated by online motorcycle taxi system. As we mentioned in the previous research, the method that is used in delivering goods is same as method that is used in transporting people. The system uses distance based.

The example is as follows; Suppose that there are three packages that must be delivered. The senders are s_1, s_2 and s_3. These packages must be delivered to r_1, r_2 and r_3. The visual illustration is shown in Fig. 1.

Now, suppose that the cost per kilometer that is charged to sender or customer is 1.500 rupiah per kilometer. Based on this unit cost, the delivery costs for package 1-3 will are 16.500; 12.000 and 15.000 rupiah consecutively. For many senders that ship only single package this price is affordable. Although, the shipment cost is cheap, the package can be delivered within minutes. Unfortunately, for some customers who send many packages simultaneously this price is expensive enough.

This price is expensive when it is compared with the common courier service. The shipment cost that is charged for inside city delivery order is usually below 10.000 rupiah. But as it is mentioned in our previous reseach this system adopts star topology and it is difficult to provide same day delivery service. Common courier service usually charges higher cost for faster delivery time. For inside city delivery order, the delivery distance is usually ignored.

MATERIALS AND METHODS

Based on the explained problem in this research, we propose new collaborative model between conventional motorcycle taxi and fixed route minibus. In this system, passenger uses application that is installed in his mobile phone to make order. Similar to the online motorcycle taxi system by using application, customer determines the pickup and destination locations of the package.

There are three entities that are involved in this model: customer, motorcycle taxi and minibus. Customer role is creating shipment order by determining the pickup and destination location. Motorcycle taxi role is picking up the package from the sender/customer to the pool and delivering package from the pool to the destination location. The minibus role is delivering package from pool to pool inside its travel route. The illustration of this environment is shown in Fig. 2.

Basically, there are four steps in the delivery process as it is shown in Fig. 2. The first step is picking up the package from the pickup or sender location by motorcycle taxi. The second step is transporting the package to the nearest motorcycle taxi pool. The third process is transporting the package from the motorcycle taxi pool to another motorcycle taxi pool that is the nearest to the destination location. The fourth step is delivering package from the motorcycle taxi pool to the destination location.

Meanwhile, minibus is not always involved in the process. Minibus is involved only if the sender motorcycle taxi pool is different with the destination motorcycle taxi pool. If the sender pool is same as the destination pool, the package is delivered from the pickup/sender location to the destination location directly.

The relation between minibus route and motorcycle taxi pool can be seen as ring network topology. Minibus route is a single direction closed loop network. Meanwhile, the motorcycle taxi pools can be seen as nodes that are attached in the ring. The illustration is shown in Fig. 3.

The explanation of this model is as follows. Suppose that there is single minibus route that is represented as close loop. It is called close loop because the starting point is same as the end point. The route direction is clock wise. During traveling, the minibus visits eight motorcycle taxi pools: p_1, p_2, … and p_8, consecutively.

Here, the illustration of delivering packages. There are three packages that must be delivered: o_1, o_2 and o_3. Based on the pickup and destination location, the nearest pickup pool and delivery pool can be represented as (p_1, p_2). So, the set that contains pools for all packages are {(p_2, p_6), (p_5, p_3), (p_4, p_4)} consecutively. For package o_1,

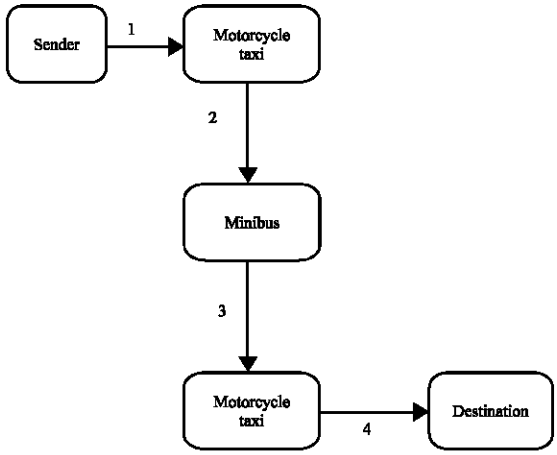

Fig. 2: Process flow

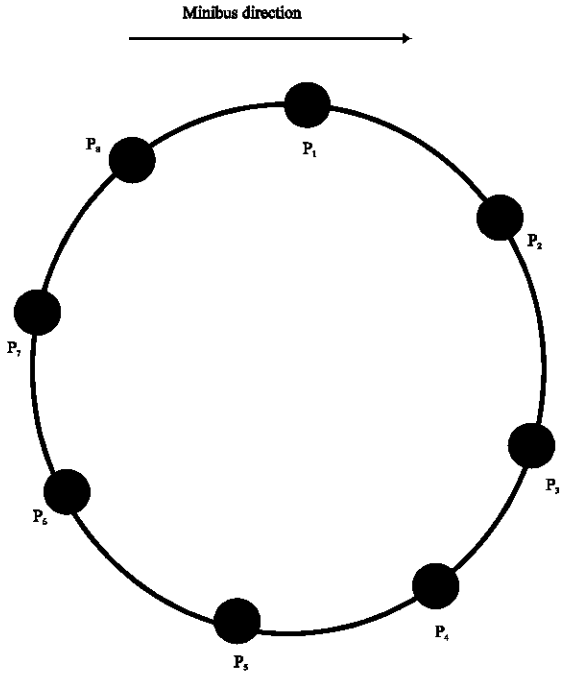

Fig. 3: Ring based collaborative model

the package is transported by the minibus from p_2-p_6 and the minibus also visits p_3, p_4 and p_5. For package o_2, the package is transported by the minibus and the minibus also visits p_6, p_7, p_8, p_1 and p_2. For package o_3 because the pickup pool is same as the delivery pool, the minibus is not involved in its shipment process.

Based on the explanation above, the main algorithm of this model consists of several steps. The first step is determining the pools. The second step is deciding whether the minibus is involved or not. The third step is calculating delivery cost. This main algorithm is shown in Algorithm 1.

Algorithm 1; Main process algorithm:

```
begin
 l_pick←nearestpool(p_pick)
 l_dest← nearestpool(p_dest)
 if p_pickpool = p_destpool then
  calcost_withoutminibus()
 else
  calcost_withminibus()
end
```

In the main process algorithm, some variables and sub programs are used. The l_{pick} is the pickup pool and the l_{dest} is the destination pool. The nearestpool function is used to determine these pools. Variable p_{pick} is the pickup location. Variable p_{dest} is the destination location. Based on the conditional process, if the pickup pool is same as the destination pool then the without minibus cost is calculated by using calcost_withoutminibus procedure. Otherwise, the calcost_withminibus procedure is used.

In the nearestpool function this function will return the pool that its location is the nearest one related to the location that is specified in the input variable. Suppose that the input location/position is represented as p_{input}. So, the output pool is determined by using Eq. 1:

$$l_{output} = l \left| \text{minimum} \right| \left\| l - p_{input} \right\| \wedge l \in L \quad (1)$$

In Eq. 1, it is shown that the output pool is the pool that its Euclidean distance to the input position is the lowest one. Besides that, the pool must be the member of pool set L. This equation then is represented in nearestpool algorithm that is shown in Algorithm 2.

Algorithm 2; Nearest pool algorithm:

```
begin
 l_sel←1
 mindist←calcdist(l_1, p_input)
 for i=2 to n(L) do
 begin
  curdist←calcdist(l_i, p_input)
  if curdist < mindist then
  begin
   mindist←curdist
   l_sel←l_i
  end
 end
 return l_sel
end
```

If the pickup pool is different with the destination pool then the delivery cost is calculated. The total cost consists of three parts: pickup cost (c_{pick}), inter pool cost (c_{inter}) and destination cost (c_{dest}). This delivery cost is determined by using Eq. 2. In this proposed model, the inter pool cost is fix cost while the other costs are variable cost:

$$c_{del} = c_{pick} + c_{inter} + c_{dest} \quad (2)$$

The pickup cost is the cost to deliver package from the pickup location to the pickup pool. This cost is variable cost and it is depended on the distance between the pickup location and the pickup pool. This pickup cost is determined by using Eq. 3 and 4:

$$c_{pick} = \text{int}(d_{pick}).c_{unit} \quad (3)$$

$$d_{pick} = \left\| p_{pick} - l_{pick} \right\| \quad (4)$$

In Eq. 3, the pickup cost is the multiplication between integer value of the distance between the pickup distance and the unit cost. The pickup distance as it is determined by using Eq. 4 is the distance between the pickup location (p_{pick}) and its nearest pool (l_{pick}). The pickup distance is represented in kilometer. The unit cost is the cost that is represented in rupiah per kilometer.

Meanwhile, the destination cost is determined by using Eq. 5 and 6. In Eq. 5, it is shown that the destination cost is the multiplication between the integer value of the destination distance and the unit cost. The destination distance is the Euclidean distance between destination location and its nearest pool:

$$c_{dest} = \text{int}(d_{dest}).c_{unit} \quad (5)$$

$$d_{dest} = \left\| p_{dest} - l_{dest} \right\| \quad (6)$$

Meanwhile, when the calcost_withoutminibus procedure is called, the minibus cost is not included in the delivery cost. The delivery cost is determined by using Eq. 7 and it is variable cost. In Eq. 8, $d_{pickdest}$ is the Euclidean distance between the destination location and the pickup location:

$$c_{det} = \text{int}(d_{pickdest}).c_{unit} \quad (7)$$

$$d_{pickdest} = \left\| p_{dest} - p_{pick} \right\| \quad (8)$$

Implementation: This proposed collaborative model between conventional motorcycle taxi and fixed route minibus then is implemented into local courier service simulation application. This simulation is developed by using PHP language. So, this is a web based application. The result data are the motorcycle taxi delivery distance and total delivery cost. In this simulation, the world is a virtual city. The shape of the city is square. The width and length are 15 km.

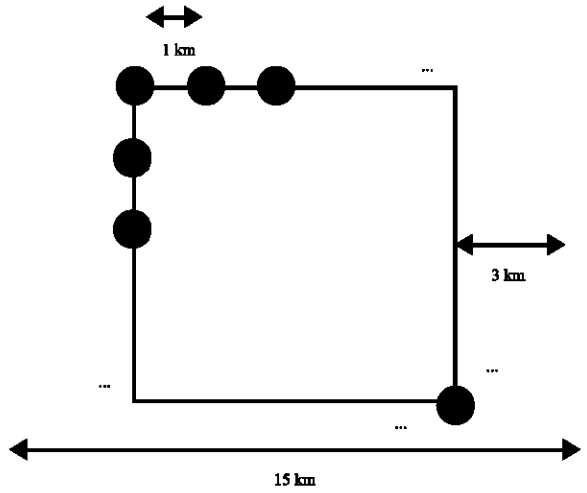

Fig. 4: Collaborative model illustration

The simulation scenario is as follows; at the beginning, some orders are generated. Each order contains its own pickup location and delivery location. After these orders are generated then the delivery execution process begins. During the simulation, every order result data are calculated. In this simulation, there are two types of model that are run and then are compared.

The first model type is the previous direct delivery model. In this previous model, the order is picked up by online based motorcycle taxi driver. It means that the order will be picked up by the nearest available driver relative to the pickup location. Then the driver will deliver the order to the destination location directly.

The second model type is the proposed collaborative model between conventional motorcycle taxi and the fix route minibus. In this model type, there is only one route. The route shape is square. The route center is in the center of the virtual city. In this close loop route, several motorcycle taxi pools are attached. The distance between pools is 1 km. In this collaborative model, we create two route sizes. The first route size is 9 km in width and length. So, this route distance from the edge of the city is 3 km. The second route size is 7 km in width and length. So, this route distance from the edge of the city is 4 km. The illustration of this collaborative model is shown in Fig. 4.

In this simulation, there are two prices that must be set. The first price is the motorcycle taxi unit price. This price value is 1.500 rupiah per kilometer. The second price is minibus price. This price is fixed and the value is 3.000 rupiah per order.

RESULTS AND DISCUSSION

After the proposed model has been implemented into local courier service simulation application then several simulation sessions are run. These simulation sessions are run to observe and to evaluate the result data. In this research, the controlled variable is the number of orders. The number of orders ranges from 20-200 units with the step size is 20 units. There are 10 simulation sessions in every step. The result of the common model is shown in Table 1. The result of the proposed model with 9 km route width is shown in Table 2. The result of the proposed model with 7 km route width is shown in Table 3.

Table 1: Relation between the number of orders with the simulation outputs in one on one model

n_{order} (unit)	Delivery distance (km)	Total cost (rupiah)
20	144	230.400
40	318	508.050
60	480	763.650
80	631	1,008.300
100	789	1,258.650
120	934	1,490.250
140	1,093	1,748.100
160	1,259	2,008.200
180	1,432	2,283.600
200	1,573	2,512.500

Table 2: Relation between number of orders with the simulation output in proposed model with 9 km route width

n_{order} (unit)	Delivery distance (km)	Total cost (rupiah)
20	153	299.400
40	325	630.300
60	478	936.000
80	646	1,269.150
100	812	1,598.700
120	986	1,929.450
140	1,111	2,185.050
160	1,287	2,530.350
180	1,433	2,808.600
200	1,609	3,160.650

Table 3: Relation between number of orders with the simulation output in proposed model with 7 km route width

n_{order} (unit)	Delivery distance (km)	Total cost (rupiah)
20	147	292.950
40	314	611.100
60	454	896.550
80	620	1,231.050
100	773	1,531.200
120	938	1,848.450
140	1,063	2,097.600
160	1,229	2,429.850
180	1,375	2,714.250
200	1,539	3,047.700

Based on data in Table 1, it is shown that the result grows linearly during the linear increasing of the number of orders. This condition occurs both in motorcycle delivery distance and total delivery cost. The motorcycle taxi delivery distance ranges from 144-1,573 km. The total cost ranges from 230.400-2,512.500 rupiah.

Based on data in Table 2, it is shown that the result grows linearly during the linear increasing of the number of orders. This condition occurs both in motorcycle delivery distance and total delivery cost. The motorcycle taxi delivery distance ranges from 153-1,609 km. The total cost ranges from 299.400-3,160.650 rupiah.

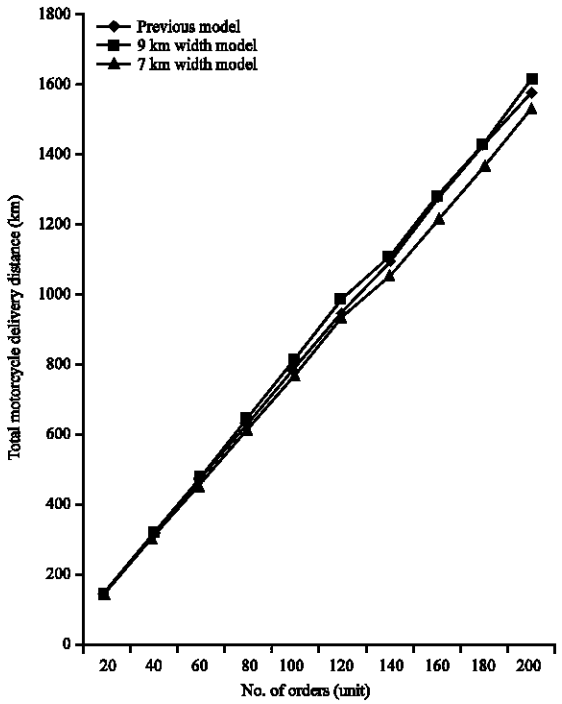

Fig. 5: Motorcycle taxi delivery distance comparison

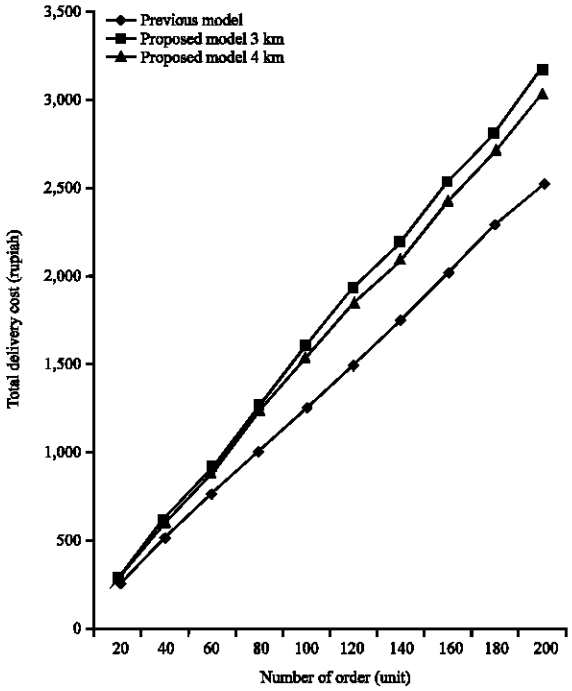

Fig. 6: Total delivery cost comparison

Based on data in Table 3, it is shown that the result grows linearly during the linear increasing of the number of orders. This condition occurs both in motorcycle delivery distance and total delivery cost. The motorcycle taxi delivery distance ranges from 147-1,539 km. The total cost ranges from 292.950-3,047.700 rupiah.

Based on the explanation above, it is shown that all result data grows linearly during the linear increasing of the number of orders. The next analyzes is comparing the total motorcycle taxi delivery distance and total delivery cost among three models. The delivery distance comparison chart is shown in Fig. 5. The total delivery cost comparison chart is shown in Fig. 6.

Based on the comparison in Fig. 5, it is shown that the motorcycle taxi distance difference among three models is very tight. The lowest distance is produced by the 7 km route width proposed model. The highest distance is produced by the 9 km route width proposed model. Even the gap is wider during the increasing number of orders this gap is still tight.

Based on this comparison, it is shown that total delivery cost among models is not so different. Meanwhile, the one on one online motorcycle taxi model still produces the lowest total delivery cost. The proposed collaborative model produces higher total delivery cost. The wider route size produces higher total delivery cost. The total delivery cost gap grows wider during the increasing of the number of orders.

CONCLUSION

Based on the explanation above, the proposed collaborative model has been developed and implemented into local courier service simulation application. The proposed model is developed based on nearest distance concept in order to produce lower delivery cost. During the simulation test, this proposed model is compared with the one on one online motorcycle taxi based local courier service model. In this simulation, the observed data are the total motorcycle taxi distance and the total delivery cost.

Based on the simulation result, the research findings are as follows. The linear increasing of the number of orders makes the linear increasing of the distance and cost in all models. In total motorcycle taxi distance aspect, the smaller fixed route proposed model produces the lowest result. In total delivery cost, the one on one model produces the lowest result. Meanwhile, the gap among models is still narrow. Based on these findings, it can be said that the collaborative model is still competitive relative to the online motorcycle taxi based model.

RECOMMENDATIONS

Some research potentials can be explored as the continuation of this research. It is because even the online motorcycle taxi based local courier service grows rapidly, the existence of the current transportation mode

cannot be denied and marginalized. Multi route based collaborative local courier service is still needed to be explored because in reality, a city consists of many fixed route minibus based transportation mode with lots of intersections. The other problem that is needed to be solved is the inter city local courier service collaborative model.

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