Evaluation of Waste Transportation Routes at Gayamsari and East Semarang Subdistrict

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Abstract. Gayamsari and East Semarang Subdistrict are two subdistricts in Semarang City which are located side by side. According to the policy of Semarang City development in 2011-2031, Gayamsari Subdistrict has a function as an environmental center development, while East Semarang Subdistrict has the main function as office, trade and service. Preliminary studies show that in these two subdistricts the resulting of waste generation in several locations of Temporary Disposal Sites can not all be transported to Jatibarang Final Disposal Site. The purpose of this research is to examine and evaluate the existing condition of waste transportation routes in Gayamsari and East Semarang Subdistrict. This research uses survey research method, using interview, observation, documentation, and routing. Analytical techniques used are quantitative analysis and qualitative analysis. The result of this research shows that in Gayamsari and East Semarang Subdistricts, the level of service of waste transportation has not been optimum since in some locations of the Temporary Disposal Site is still found waste container which is not enough to accommodate the waste and the route far enough to the final disposal place.

Keywords: waste transportation route; Gayamsari; East Semarang.

1 Introduction

The increasing number of population and the increasing of society economic activity in Semarang City have an impact on the increasing amount of waste generation, as happened in Gayamsari and East Semarang Subdistrict. In order to prevent environmental problems, a good waste transport system is needed. The increasing quantity of waste generation, then the transportation system will become more complicated [1]. Important factors in the waste transport system, including quantity, type of equipment, distance, and labor needs [2]. In addition to this, waste transportation time is also an important thing in the waste transportation system [3].

Data obtained from DLH Semarang City [4], in the year 2015 waste produced by residents Gayamsari Subdistrict amounted to 286,85 m³ every day. While the waste transport capacity in the District Gayamsari is only 129,08 m³ per day. This means that the percentage of waste transportation service in Gayamsari sub district only reaches about 45%. In East Semarang Subdistrict, waste production is 237,455 m³ per day, while its transportation capacity is only 189,361 m³ per day. So that the percentage rate of only 79.7% transportation services. Whereas the target of waste management system in the field of transportation according to the National Medium Term Development Plan 2014-2019 is 100%, so the Government of Semarang City, especially in Gayamsari and East Semarang Subdistrict need to make efforts to improve waste service, especially in the field of waste transportation.

Considering the phenomena occurring in Gayamsari and East Semarang Subdistricts, an evaluation of the waste transportation route in the two sub-districts is needed, to increase the percentage of services in the field of current waste transportation to obtain the most optimum route [5].

The purpose of this paper is to examine and evaluate the existing condition of waste transportation routes in Gayamsari and East Semarang Subdistrict, so that it can be found a better waste transportation route (effective and efficient) in order to create low carbon society in development process.

2 Research method

This research uses survey research method, using interview, observation, documentation, and routing. Research site located in Gayamsari and East Semarang Subdistrict.

All garbage trucks in these two subdistricts are used as samples, 5 trucks in Gayamsari Subdistrict and 6 trucks in East Semarang Subdistrict.

Samples in Gayamsari Subdistrict were taken from 11 temporary disposal sites, that located in 7 urban villages, ie.: Pandean Lamper, Gayamsari, Siwalan, Sambirejo, Sawahbesar, Kaligawe, and Tambakrejo.

Samples in Semarang Timur Subdistrict were taken from 12 temporary disposal sites, that located in 10 urban villages, ie.: Kemijen, Rejomulyo, Mlatibaru,
Mlatiharjo, Kebonagung, Bugangan, Sarirejo, Rejosari, Karangturi, Karangtempel.

3 Result and discussion

3.1 Existing condition of waste transportation service in Gayamsari Subdistrict and East Semarang Subdistrict

Based on data from the Central Bureau of Statistics [6], Gayamsari Subdistrict which has wide area 5,25 km² consists of 7 villages, 62 RW, 444 RT, and the amount of population at the end of 2016 is 74,122 people, resulting in a total amount of waste about 350,23 m³ per day, it’s only can be transported as big as 276,80 m³ per day, or it is only served around 79%, with the percentage composition of services as follows:

Fig. 1. Percentage of Waste Transportation Service in Gayamsari Subdistrict

Semarang Timur Subdistrict, with total area of 7.70 km², consists of 10 villages, 77 RW, 574 RT, and the amount of population at the end of 2016 is 76,574 people [7], resulting in a total amount of waste about 237,455 m³ per day, it’s only can be transported as big as 189,361 m³ per day, or it is only served around 79.7%, with the percentage composition of services as follows:

Fig. 2. Percentage of Waste Transportation Service in East Semarang Subdistrict

3.2 Evaluation of Waste transportation route

Enri Damanhuri states that one of the procedures for determining an effective and efficient transport system in a waste transport operation should be to use the shortest possible transport route and with the smallest possible obstacles [8].

3.2.1 Waste Transportation Route at Gayamsari Subdistrict

The existing trucking route from the Environment Agency of Semarang City in Gayamsari Subdistrict can be seen in the following table:

Table 1. Existing Waste Transportation Route From Gayamsari Subdistrict to TPA Jatibarang

| Truck Number | Temporary Disposal Site | Route |
|--------------|-------------------------|-------|
| 1            | PLTG                    | Jl. Majapahit-Jl. Lamper Tengah-Jl. Tentara Pelajar-Jl.Sriwijaya-Jl. Veteran-Jl.Kaligarang-Jl.Simongan-Jl.Un tung Surapati-TPA Jatibarang |
| 2            | Kimar                   | Jl.Brigjen Katamso-Jl.Kompol Maksunm-Jl.Sriwijaya-Jl.Veteran-Jl.Kaligarang-Jl.Simongan-Jl.Un tung Surapati-TPA Jatibarang |
| 3            | Karangingas             | Jl.Soekarno Hatta-Jl. Dr.Cipto-Jl.Brigjen Katamso-Jl.Kompol Maksunm-Jl.Sriwijaya-Jl.Veteran-Jl.Kaligarang-Jl.Simongan-Jl.Un tung Surapati-TPA Jatibarang |
| 4            | Kaligawe                | Jl.Kaligawe Raya-Jl. Raden Patar-Jl. Dr.Cipto-Jl.Brigjen Katamso-Jl.Kompol Maksunm-Jl.Sriwijaya-Jl.Veteran-Jl.Kaligarang-Jl.Simongan-Jl.Un tung Surapati-TPA Jatibarang |
| 5            | Sawah Besar             | Jl.Soekarno Hatta-Jl. Dr.Cipto-Jl.Brigjen Katamso-Jl.Kompol Maksunm-Jl.Sriwijaya-Jl.Veteran-Jl.Kaligarang-Jl.Simongan-Jl.Un tung Surapati-TPA Jatibarang |
| 6            | Gempolsari              | Jl.Sriwijaya-Jl. Veteran-Jl.Kaligarang-Jl.Simongan-Jl.Un tung Surapati-TPA Jatibarang |
| 7            | Sambirejo               | Jl.Gajah Raya-Jl. Lamper Tengah-Jl. Tentara Pelajar-Jl.Sriwijaya-Jl. Veteran-Jl.Kaligarang-Jl.Simongan-Jl.Un tung Surapati-TPA Jatibarang |
| 8            | Tambakrejo              | Jl.Kaligawe Raya-Jl. Raden Patar-Jl. Dr.Cipto-Jl.Brigjen Katamso-Jl.Kompol Maksunm-Jl.Sriwijaya-Jl. Veteran-Jl.Kaligarang-Jl.Simongan-Jl.Un tung Surapati-TPA Jatibarang |
| 9            | Pasar Waru              | Jl.Tentara Pelajar-Jl.Sriwijaya-Jl. Veteran-Jl.Kaligarang-Jl.Simongan-Jl.Un tung Surapati-TPA Jatibarang |

The waste transport route in Table 1 is the usual garbage route passed by garbage trucks from Gayamsari Subdistrict to TPA Jatibarang. The distance and waste transportation time of the existing route can be seen in Table 2 below:

Table 2. Distance and Waste Transportation Time of Existing Route in Gayamsari Subdistrict

| Truck Number | Temporary Disposal Site | Distance (km) | Time (minute) |
|--------------|-------------------------|---------------|---------------|
| 1            | PLTG                    | 27.45         | 90            |
| 2            | Karangingas             | 34.26         | 100           |
| 3            | Kaligawe                | 37.33         | 110           |
| 4            | Sawah Besar             | 35.81         | 105           |
| 5            | Gempolsari              | 27.1          | 90            |
| 6            | Sambirejo               | 29.82         | 92            |
| 7            | Tambakrejo              | 35.17         | 98            |
| 8            | Pasar Waru              | 36.14         | 101           |
The distance and time in Table 2 is based on the existing route from the Environment Agency of Semarang City. The furthest remaining transport route is on the truck number 2. The distance of haul on the existing route can still be streamlined by changing the shorter route lanes and fewer traffic constraints. More efficient transport routes can be seen in Table 3 below:

Table 3. Waste Transportation Route After Efficiency

| Truck Number | Temporary Disposal Site | Route |
|--------------|-------------------------|-------|
| 1            | PLTG                    | Jl.Majapahit-JI.Brigiend Katamso-JI.Admodiroro-JI.Singosari Raya-JI.Sriwijaya-JI.Veteran-JI.Kaligarang-JI.Simongan-JI.Untung Suropati-TPA Jatibarang |
| 2            | Sambirejo               | Jl.Brigiend Katamso-JI.Admodiroro-JI.Singosari Raya-JI.Sriwijaya-JI.Veteran-JI.Kaligarang-JI.Simongan-JI.Untung Suropati-TPA Jatibarang |
| 3            | Siwalan                 | Jl.Brigiend Katamso-JI.Admodiroro-JI.Singosari Raya-JI.Sriwijaya-JI.Veteran-JI.Kaligarang-JI.Simongan-JI.Untung Suropati-TPA Jatibarang |
| 4            | Gempolsari              | Jl.Brigiend Katamso-JI.Admodiroro-JI.Singosari Raya-JI.Sriwijaya-JI.Veteran-JI.Kaligarang-JI.Simongan-JI.Untung Suropati-TPA Jatibarang |
| 5            | Pasar Waru              | Jl.Brigiend Katamso-JI.Admodiroro-JI.Singosari Raya-JI.Sriwijaya-JI.Veteran-JI.Kaligarang-JI.Simongan-JI.Untung Suropati-TPA Jatibarang |

The difference between the distance and time of the truck transport can be determined by comparing the distance and time of the existing route with the distance and time of the efficiency route. The difference between the distance and time of the existing route with the efficiency route can be seen in Table 5 below:

Table 5. Distance and Time Difference After Efficiency

| Truck Number | Distance (km) | Time (minute) |
|--------------|---------------|---------------|
| 1            | 0.65          | 21            |
| 2            | 1.2           | 19            |
| 3            | 0.9           | 25            |
| 4            | 0.5           | 23            |
| 5            | 0.68          | 17            |

The result of distance and time difference calculation in Table 5 shows that the largest distance difference in truck with number 5 serving TPS Sambirejo to TPA Jatibarang has distance of 2.14 km. While the largest distance difference of 26 minutes is on truck number 3 that serves TPJ Siwalan to TPA Jatibarang.

3.2.2 Waste Transportation Route at East Semarang Subdistrict

The existing trucking route from the Environment Agency of Semarang City in East Semarang Subdistrict can be seen in the following table:

Table 4. Distance and Waste Transportation Time After Efficiency

| Truck Number | Temporary Disposal Site | Distance (km) | Time (minute) |
|--------------|-------------------------|---------------|---------------|
| 1            | PLTG                    | 26.8          | 69            |
| 2            | Karangingas             | 33.16         | 81            |
| 3            | Sawah Besar             | 35.16         | 85            |
| 4            | Siwalan                 | 29.63         | 78            |
| 5            | Sambirejo               | 27.68         | 78            |
| 6            | Gempolsari              | 26.6          | 67            |
| 7            | Tambakrejo              | 34.49         | 81            |
| 8            | Pasar Waru              | 35.46         | 85            |

Looking at the results in Table 3, there was a change of waste transport route on the road passed by garbage truck through Admodiroro Road and Singosari Raya Road to go to Sriwijaya Street where this path is a road with little roadblock (traffic jam and less traffic light). The distance and time of transporting waste through the efficient routes can be seen in Table 4 below.
The waste transport route in Table 6 is the usual garbage route passed by garbage trucks from East Semarang Subdistrict to TPA Jatibarang. The distance and waste transportation time of the existing route can be seen in Table 7 below:

| Truck Number | Temporary Disposal Site  | Distance (km) | Time (minute) |
|--------------|--------------------------|----------------|---------------|
| 1            | Pasar Rejomulyo          | 34,4           | 79,8          |
| 2            | Manisharjo               | 32,8           | 81            |
| 3            | Pasar Waru               | 35             | 79,2          |
| 6            | Pasar Dargo              | 29,4           | 81            |

The distance and time in Table 7 is based on the existing route from the Environment Agency of Semarang City. The furthest remaining transport route is on the truck number 1. The distance of haul on the existing route can still be made more efficient by changing the shorter route lanes and fewer traffic constraints. More efficient transport routes can be seen in Table 8 below:

| Truck Number | Temporary Disposal Site  | Distance (km) | Time (minute) |
|--------------|--------------------------|----------------|---------------|
| 1            | Pasar Rejomulyo          | 29,8           | 83,4          |
| 2            | Pasar Karimata           | 29,6           | 79,8          |
| 3            | Bugangan                | 30             | 86,4          |

The waste transport route in Table 6 is the usual garbage route passed by garbage trucks from East Semarang Subdistrict to TPA Jatibarang. The distance and waste transportation time of the existing route can be seen in Table 7 below:

| Truck Number | Temporary Disposal Site  | Distance (km) | Time (minute) |
|--------------|--------------------------|----------------|---------------|
| 1            | Pasar Rejomulyo          | 34,4           | 79,8          |
| 2            | Manisharjo               | 32,8           | 81            |
| 3            | Pasar Waru               | 35             | 79,2          |
| 4            | Pasar Dargo              | 29,4           | 81            |
| 5            | Pasar Karimata           | 28,4           | 87,6          |

The distance and time in Table 7 is based on the existing route from the Environment Agency of Semarang City. The furthest remaining transport route is on the truck number 1. The distance of haul on the existing route can still be made more efficient by changing the shorter route lanes and fewer traffic constraints. More efficient transport routes can be seen in Table 8 below:

| Truck Number | Temporary Disposal Site  | Distance (km) | Time (minute) |
|--------------|--------------------------|----------------|---------------|
| 1            | Pasar Rejomulyo          | 29,8           | 83,4          |
| 2            | Pasar Karimata           | 29,6           | 79,8          |
| 3            | Bugangan                | 30             | 86,4          |
Looking at the results in Table 8, there is a changing of route of waste transportation which is choosing the shortest route by considering the flow of traffic. Shortest route selection is done by cutting the existing path by cutting Jalan Sriwijaya. The shortest route has a difference of one kilometer from the existing route. The distance difference is very good, because it avoids the point of congestion that is in the market area of Peterongan. The distance and time of transporting waste through the efficient route can be seen in Table 9 below:

Table 9. Distance and Waste Transportation Time After Efficiency in East Semarang Subdistrict

| Truck Number | Temporary Disposal Site | Distance (km) | Time (minute) |
|--------------|-------------------------|---------------|---------------|
| 1            | Pasar Rejomulyo         | 33.4          | 58.8          |
|              | Manisharjo              | 31.8          | 63            |
|              | Pasar Waru              | 34            | 60.6          |
| 2            | Pasar Dargo             | 28.4          | 54.6          |
|              | Pasar Karimata          | 27.4          | 52.8          |
| 3            | Rumah Pompa             | 27            | 51.6          |
| 4            | Matilharjo              | 31.4          | 55.2          |
| 5            | Karang Tempel           | 25            | 49.8          |
|              | Matilbaru               | 32.8          | 52.8          |
| 6            | Tirtoyoso IV            | 28.6          | 50.4          |
|              | Tirtoyoso I             | 28.8          | 55.8          |
|              | Bugangan                | 29            | 54.6          |

The difference between the distance and time of the truck transport can be determined by comparing the distance and time of the existing route with the distance and time of the efficiency route. The difference between the distance and time of the existing route with the efficiency route can be seen in Table 10 below:

Table 10. Distance and Time Difference in East Semarang Subdistrict After Efficiency

| Truck Number | Temporary Disposal Site | Distance (km) | Time (minute) |
|--------------|-------------------------|---------------|---------------|
| 1            | Pasar Rejomulyo         | 1             | 21            |
|              | Manisharjo              | 18            | 18.6          |
|              | Pasar Waru              | 1             | 18.6          |
| 2            | Pasar Dargo             | 2             | 26.4          |
|              | Pasar Karimata          | 1             | 34.8          |
| 3            | Rumah Pompa             | 1             | 31.2          |
| 4            | Matilharjo              | 1             | 24.6          |
| 5            | Karang Tempel           | 1             | 34.8          |

The result of distance and time difference calculation in Table 10 shows the result of the same distance difference, which is 1 km on all garbage trucks. While the largest time difference of 34.8 minutes is on trucks number 2 and number 5 that serve TPS Pasar Karimata and TPS Karang Tempel to TPA Jatibarang.

Conclusion

The existing condition of waste transportation system in Gayamsari and East Semarang Subdistricts can still be improved because the percentage of waste transportation service only reaches about 79%. Effective and efficient waste transport system services are carried out with the change of shorter haulage routes and less traffic constraints, with the selection of the route with the consideration of traffic flow that is not crowded and wide access road. The shortest route and the fastest time selection is the first step to start a better waste transport system in these two districts.

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