
PROCEEDINGS

The 4th ASEAN Civil Engineering Conference

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Sigit Priyanto

Organized by:
Department of Civil and Environmental Engineering, Universitas Gadjah Mada (CEE-UGM)
ASEAN University Network/Southeast Asia Engineering Education Development Network (AUN/SEED-Net)

Supported by:
Japan International Cooperation Agency (JICA)

November 22-23, 2011
Yogyakarta, Indonesia
The 4th ASEAN Civil Engineering Conference

Organized by:

AUN/SEED-Net

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Determination of Location and Design for Urban Railway Station (Case: Yogyakarta – Magelang)

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Abstract: Yogyakarta and Magelang is one of the cities in Indonesia, which has huge potential economic development. The tourism sector that is highly favored in the city should be comparable with that provided transportation services as access to reach the desired tourism destination. Yogyakarta-Magelang railway along approximately 45 km is one of the oldest rail line. Because of the potential and the trips number from and to both cities, the reopening of the railway line and railway station is needed. The number of railway station building across Yogyakarta – Magelang are 18 units. 10 units building are as the station, while 8 units as train stop / shelter. In general, that building station and train stop has been switching their function. Some are used by citizens, businesses, as well as police station, Koramil office, public transport station, bus station, and also leased to PDAM. But on the other hand, there is a station building that is not there anymore, but razed to the ground. So that the rebuilding of the railway station should be based on the number of passenger demand which we know from the survey and could also be from the former station locations.

Keywords: Urban Railway, Station, Access.

1. INTRODUCTION

1.1 Background

Transportation is one of the important component of life, especially in terms of movement of peoples, goods, and services from one place to another. It is undeniable that all sectors of life today requires transportation services in the continuity of their activities both in the economic sector, social, and cultural. Yogyakarta-Magelang railway along approximately 45 km is one of the oldest rail line. Since the eruption of Mount Merapi in 1977, the line was damaged and not functioning up to now. The line was operated by NISM, private railway companies the Government of the Netherlands East Indies, on July 1, 1898 to transport tobacco and sugar at the port of Semarang (now the Port of Tanjung Emas). After 34 years do not operate, many rail lines were damaged. Some ex-street did not appear again, some land already changed their function. This line is largely parallel to the highway, so it is not surprising if railway line is closed for the purpose of widening the highway.

In order to meet the demand for transportation in Yogyakarta and Magelang, reconnecting railways Yogyakarta – Magelang, who have dropped out long ago, the community will foster renewed interest in the use of public transport, and reduce the number of private vehicles on the highway in an effort to overcome congestion, hence designed a rail network for Yogyakarta – Magelang which is expected to cover the entire access tourism, downtown, where necessary and other locations in the city of Yogyakarta (MoT, 2009). The route is designed to train in this city of course is also equipped with a station where the train stops at strategic points or important locations in the city of Yogyakarta and Magelang indicated as the most appropriate place as a location that can include all prospective passengers. So that any passenger can easily reach the shelter whose location is not too far from the origin of their activity centers.

1.2 Problems

a) Where is the best and the strategic locations to place the station?

b) What are the facilities in these stations?

1.3 Objectives

The purpose of the designed locations of the station on the railway route of Yogyakarta - Magelang are:

a) Getting Strategic station placement locations that can reach all prospective passengers in the vicinity of the location of station and ease of operation of the railway.

349
b) Make it easier for passengers in the train stops to get the location because the locations of stations well adapted to the strategic locations and vital in the city of Yogyakarta - Magelang.

c) Conducting an analysis of the forms suitable station in accordance with its location.

1.4 Benefits
The benefits from the designed location of the station on railway routes in the city of Yogyakarta - Magelang are:

a) The time required for passengers to reach the station is shorter because stations are placed in the centers of strategic activities.
b) Reduce the use of private vehicles so as to reduce congestion on the highway.

1.5 Research Scope
The purpose of this research is to determine the location of station or train stops and facilities there.

2 LITERATURE REVIEW

2.1 Railway Station
Based on the regulation of the Republic of Indonesia No. 29, 2011 on technical requirement of station building, by the type, railway station consists of:

a) Passengers station
b) Freight station
c) Operation station

According to the size (Subarkah, 1981), station are differentiated by:

a) Small station
b) Medium station
c) Large station

According to its location (Subarkah, 1981), the station is divided into:

a) Suffix station
Trains begin or end a journey at this station. There are locomotive depot and train depot to stay, check, and clean the trains.
b) The station is located on a straight railroad.
c) Junction station, connecting the three major.
d) Cross station, where there are two railroad that intersect.

According to the shape (Subarkah, 1981), the location is divided into:

a) Right angle station
b) Parallel station
c) Island station
d) Peninsula station

2.2 Railway Station Building
Railway station building is a part of the railway station used to serve the railway travel arrangements and train service users. There are the types of railway station buildings:

a) Building for the main activities
Building for the main activities consists of:
1) hall
2) office for station activities
3) ticket office
4) waiting room
5) information room
6) room for general facilities
7) room for safety facilities
8) room for security facilities
9) room for disable and elder facilities
10) room for healthy facilities

b) Building for support activities
Building for support activities consists of:
1) shopping complex
2) restaurant
3) parking area
4) hospitality
5) another room that directly support the activities at the station

c) Building for special service activities
Building for special service activities consists of:
1) passenger waiting room
2) loading and unloading goods
3) warehousing
4) parking area
5) care goods
6) ATM space
7) another space that support either directly or indirectly train station activities.

3 BASIC THEORY

3.1 Railway Station Placement Requirement
Based on the regulation of the Republic of Indonesia No. 29, 2011 on technical requirement of station building, the placement requirements of the railway station are:

a) Building for main activities
1) The location in accordance with train travel operation.
2) Supporting the railways operational system.
3) Layout of space in accordance with the passenger arriving and departing flow process and does not interfere the train travel arrangements.
b) Building for support activities and for special service activities
   1) The location in accordance with train travel operation.
   2) Layout of space in accordance with the passenger arriving and departing flow process and does not interfere the train travel arrangements.
   3) Supporting the activities of the railway station in order to service the users.
   4) Guaranteed security and safety of railway operations.

2) Railway Station Technical Requirement

Building requirements
- Construction, material design, size, and building capacity in accordance with the standards of feasibility, safety, and security so that the entire building station can function reliably.
- Meet the safety and security requirements of the building from the danger of flood, lightning, electricity, and dangers of power construction.
- The installation of the building in accordance with laws and regulations of building, mechanical electrical, and plumbing.
- Building area is set to:
  Building for main activities is calculated with the formula:
  \[ I = 0.64 \text{ m}^2/\text{person} \times V \times LF \]  \hspace{1cm} (1)
  with
  \[ L \] = building area (m²)
  \[ V \] = the average number of passengers per peak hour in one year
  \[ LF \] = load factor (80%)

3) Railway Station Operational Requirement

Building for main activities
- The station building operation should match with the flow process of passenger departure and arrival and not disrupt train travel arrangements.
- Ensure the station buildings can function optimally in terms of layout of building space so that the operation of railways facilities can be made comfortable.
- Operation of the station building in accordance with the train operating hours and availability of human resources.

Building for support activities and for special service activities
- Not interfere with the movement of trains.

2) Not interfere with the movement of passengers and goods.
3) Maintain order and security.
4) Maintain environmental hygiene.
5) Not interfere with the building and the environment around the station and adapted to the capacity and needs.

3.4 Platform Technical Requirement

a) Development requirements
- High
  - High platform, platform height 1000 mm, measured from the head rail.
  - Medium platform, platform height 430 mm, measured from the head rail.
  - Short platform, platform height 180 mm, measured from the head rail.
- The distance from the edge of the platform to center of the track
  - High platform, 1600 mm (for a straight rail) and 1650 mm (for an arch rail).
  - Medium platform, 1350 mm.
  - Short platform, 1200 mm.
- Length of the platform in accordance with the longest passenger train circuit operating.
- Platform width is calculated based on the number of passengers using the following formula:
  \[ b = 0.64 \text{ m}^2/\text{person} \times V \times LF \]  \hspace{1cm} (2)
  with
  \[ b \] = platform width (m)
  \[ V \] = the average number of passengers per peak hour in one year
  \[ LF \] = load factor (80%)
  \[ I \] = length of the platform in accordance with the longest passenger train circuit operating

3) Platform width count results using the formula above can not be less than the provisions of the following minimum platform width.

<table>
<thead>
<tr>
<th>No.</th>
<th>Platform types</th>
<th>Between two lines (island platform)</th>
<th>Side platform</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>High</td>
<td>2 m</td>
<td>1.65 m</td>
</tr>
<tr>
<td>2.</td>
<td>Medium</td>
<td>2.5 m</td>
<td>1.9 m</td>
</tr>
<tr>
<td>3.</td>
<td>Short</td>
<td>2.8 m</td>
<td>2.05 m</td>
</tr>
</tbody>
</table>

Table 1 Minimum platform width
1) Floor of the platform does not use a slippery material
2) Platform equipped with at least:
   - lamp
   - route signage
   - board directions
   - platform safe limits

b) Operational requirements
1) only used as a place for passenger to up and down from the train
2) equipped with platform safe limits
   - High platform, at least 350 from the outer edge to the center of platform.
   - Medium platform, at least 600 from the outer edge to the center of platform.
   - Short platform, at least 750 from the outer edge to the center of platform.

4 RESEARCH METHODOLOGY

4.1 Research Location
This research conducted in Yogyakarta and Magelang which examines where the route will be created and specify the location of stations that will be laid to connect the two cities.

4.2 Number of Samples
Data will be used in this study obtained from surveys and questionnaires distributed to passengers. The questionnaires contain several questions so we will get the most route chosen by the passengers and the number of passenger demand so that we can determine the best location to place the stations. In order to collect secondary data and primary data, questionnaires have previously been formulated. Questionnaires should be able to reflect or accommodate all the required data. The questionnaire was first given to the respondent to read carefully or it can also be done by asking question directly to the respondents by reference to a questionnaire that had previously been formulated (Sugiyono, 2010). The number of questionnaires is 349 sheets with error rate 5%, because the number of population of Yogyakarta and Magelang is more than 1,000,000. The population number of Daerah Istimewa Yogyakarta on 2010 is ± 3,452,390 people and Magelang ± 1,181,916 people. The data was collected in both of the city. In Yogyakarta, the data was taken at Jombor station, Gwangan station, and Tempel station. In Magelang, the data was taken at Magelang Kota Station, and Muntillan station. In the data collection, the following data types and sources of any data required for review of study group according to their characteristics such as socio-economic data, transportation data, and demand data.

5 DEMAND ANALYSIS OF YOGYAKARTA - MAGELANG RAILROAD

5.1 Trips number of Yogyakarta and Magelang
One aspect that is known in order to revive the railway cross Yogyakarta – Magelang is the profile of the movement of passengers through the turnpike Yogyakarta – Magelang and vice versa. These aspects must be known especially to be able to give a concrete demand to revive the railroad cross Yogyakarta – Magelang. The trip data will be compared with the demand data, so we can know how many passengers that will use the Yogyakarta – Magelang train. This is the trip data of Yogyakarta – Magelang.

Table 2. Yogyakarta – Magelang Trips

<table>
<thead>
<tr>
<th>Year</th>
<th>Yogyakarta - Magelang</th>
<th>Magelang - Yogyakarta</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>2001</td>
<td>3,040,588</td>
<td>1,420,519</td>
<td>4,461,107</td>
</tr>
<tr>
<td>2006</td>
<td>5,769,437</td>
<td>650,026</td>
<td>6,419,463</td>
</tr>
</tbody>
</table>

From the data above, the passenger movement of Yogyakarta to Magelang and Magelang to Yogyakarta in 2001 is 4,461,107 trips, and in 2006 is 6,419,463 trips. From that data, we can calculate and estimated the trips number in another year, but first we have to know the growth percentage. So that, based on that data, the trips growth percentage in 5 year (2001-2006) is as follows:

Trip growth percentage/ 5 year
6,419,463 - 4,461,107 x 100% = 43,9%  
(2001-2006)

From the movement of vehicles data in 2001 and 2006, we can calculate the trip growth percentage in travel movements over a period of five years. Presentation obtained from these calculations for five year growth amounted to 43,9%. From these figure, we can find out the growth percentage of the trips movement per years are as follows:

Trip growth percentage / year
43,9 = 8,78%

5
Trip growth percentage per year is 8,78%. From the results of these calculations, it can be seen the number of trips movement from year to year. Table below
shows the amount of trips movement between the years 2001 to 2030. The number of trips that used for the calculation is the number of trips in 2011.

Table 3. Number of Yogyakarta – Magelang Trips Movement

<table>
<thead>
<tr>
<th>Year</th>
<th>Number of Movement (trips)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2001</td>
<td>4,461,107</td>
</tr>
<tr>
<td>2006</td>
<td>6,419,463</td>
</tr>
<tr>
<td>2011</td>
<td>8,377,819</td>
</tr>
<tr>
<td>2015</td>
<td>9,944,504</td>
</tr>
<tr>
<td>2020</td>
<td>11,902,860</td>
</tr>
<tr>
<td>2025</td>
<td>13,861,216</td>
</tr>
<tr>
<td>2030</td>
<td>15,819,572</td>
</tr>
</tbody>
</table>

The table above shows the calculated amount of trip movement in a certain way which is obtained from the area of movement growth per year. The travel movement in 2011 is about 8,377,819 trips and continuous to increase year by year.

5.2 Modes Choice of Transport Across Yogyakarta – Magelang

In order to rebuild railroad of Yogyakarta – Magelang, first we have to know how many people who would choose train as their transportation. It will affect whether the reopening of the railway line of Yogyakarta – Magelang is necessary or not. In this research, we use the closed-form questionnaire to know about various things such as what modes that are most, travel destinations, routes to be selected, etc. From the result of that questionnaire, it will be known what percentage of people who choose train, bus, private vehicle, and other modes as their transportation system. Below are the results of the mode selection percentage in Yogyakarta and Magelang. The percentage in each city will be collaborate in a chart too as follows.

Figure 1. Modes choice of Yogyakarta & Magelang Passengers

From the chart above, passengers mostly chose train as their modes, 41% people chose train, 29% chose motorcycle, 24% chose bus, and 6% chose car. In the other word, the passengers agree with the plan to reopen Yogyakarta-Magelang track.

5.3 Estimated Train Passengers

Based on projected passengers movement of the origin destination movement in 2001 – 2030, and the most modes used by the respondent of Yogyakarta – Magelang, then we can also know the number of Yogyakarta – Magelang trains per day. From the data, is known that the majority of respondents choose train as their mode. It means that it is possible to reopened Yogyakarta – Magelang rail line and there is a possibility of a private vehicle users switch to train. The table below shows the number of passenger train per day in each year.

Table 4. Estimated Train Passengers

<table>
<thead>
<tr>
<th>Years</th>
<th>Public transport passengers</th>
<th>Passengers potential on the location</th>
<th>Bus passengers potential</th>
<th>Private vehicle potential</th>
<th>Train passengers potential</th>
<th>Train passengers / day</th>
<th>Number of train / day</th>
<th>Number of train circuits</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A</td>
<td>B</td>
<td>C = (B*60%)</td>
<td>D = (C*24%)</td>
<td>E = (C*35%)</td>
<td>F = (C*41%)</td>
<td>G = (F/360)</td>
<td>J</td>
</tr>
<tr>
<td>2001</td>
<td>4461107</td>
<td>2676664</td>
<td>642399</td>
<td>936832</td>
<td>1097432</td>
<td>3007</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>2006</td>
<td>6419463</td>
<td>3851678</td>
<td>924403</td>
<td>1348087</td>
<td>1579188</td>
<td>4327</td>
<td>34</td>
<td>17</td>
</tr>
<tr>
<td>2011</td>
<td>8377819</td>
<td>5026691</td>
<td>1206406</td>
<td>1759342</td>
<td>2060943</td>
<td>5646</td>
<td>44</td>
<td>22</td>
</tr>
<tr>
<td>2015</td>
<td>9944504</td>
<td>5966702</td>
<td>1432009</td>
<td>2088346</td>
<td>2446348</td>
<td>6702</td>
<td>53</td>
<td>27</td>
</tr>
<tr>
<td>2020</td>
<td>11902860</td>
<td>7141716</td>
<td>1714012</td>
<td>2499601</td>
<td>2928104</td>
<td>8022</td>
<td>64</td>
<td>32</td>
</tr>
<tr>
<td>2025</td>
<td>13861216</td>
<td>8316729</td>
<td>1996015</td>
<td>2910855</td>
<td>3409859</td>
<td>9342</td>
<td>74</td>
<td>37</td>
</tr>
</tbody>
</table>

353
6 RAILWAY STATION LOCATION

6.1 Route Choices By Passengers
Before determining the location of stations that will be made, the respondents are given three options, which route they thought is best. All of the options is taken from former rail route, and two additional route that have been adapted to the location whom the passengers will visit the most. The routes are:
Route A : Lempuyangan - Tugu - Muntilan - Magelang Kota
Route B : Lempuyangan - Tugu - Muntilan - Magelang Kota - Secang - Temanggung - Parakan
Route C : Lempuyangan - Tugu - Muntilan - Magelang Kota - Secang - Candi Umbul
And there is the result of the respondents choices:

![Routes Choice (Magelang)](image1)

![Routes Choice (Yogyakarta)](image2)

Most of the respondents in both cities chose Route B as their choices. Route B will through Lempuyangan - Tugu - Muntilan - Magelang Kota - Secang - Temanggung - Parakan. It will be one of the consideration for the location where station will be built. But another aspects will influence too, such as downtown in that city, strategic location there, etc.

6.2 Location Determination
In determining where the railway station will be located, the aspect that affected are the result from the questionnaire and the former railway station location. From the questionnaire data, most of respondents chose route B as their choices. Route B is the old route of Yogyakarta – Magelang rail line. That route is representative of passenger destination, where the passenger from Yogyakarta not only go to Magelang, but there are passengers who want to go to another place that trough Magelang city like Temanggung, Sekang, and Parakan. The passengers destination can be seen from the questionnaire data result as follows:

![Trips Destination (Yogyakarta's Respondents)](image3)

![Trips Destination (Magelang's Respondents)](image4)

In the questionnaire, we gave the opened question about the passenger destination. From that data, we knows where is the most destination that passengers will going to go. The answer that are too specific, grouped into a nearby region. While the answer which are distorted or out of the study area, are grouped separately.
Table 5. Yogyakarta – Magelang Station Placement

<table>
<thead>
<tr>
<th>No</th>
<th>Station / Shelter</th>
<th>KM</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Lempuyangan station</td>
<td>0 + 000</td>
<td>Medium station</td>
</tr>
<tr>
<td>2</td>
<td>Tugu station</td>
<td>1 + 307</td>
<td>Large station</td>
</tr>
<tr>
<td>3</td>
<td>Sinduadi Shelter</td>
<td>3 + 000</td>
<td>Shelter</td>
</tr>
<tr>
<td>4</td>
<td>Kutu station</td>
<td>4 + 582</td>
<td>Small station</td>
</tr>
<tr>
<td>5</td>
<td>Jombor shelter</td>
<td>6 + 000</td>
<td>Shelter</td>
</tr>
<tr>
<td>6</td>
<td>Beran station</td>
<td>9 + 487</td>
<td>Small station</td>
</tr>
<tr>
<td>7</td>
<td>Pasar Sleman shelter</td>
<td>12 + 750</td>
<td>Shelter</td>
</tr>
<tr>
<td>8</td>
<td>Medari station</td>
<td>15 + 213</td>
<td>Small station</td>
</tr>
<tr>
<td>9</td>
<td>Tempel station</td>
<td>19 + 688</td>
<td>Small station</td>
</tr>
<tr>
<td>10</td>
<td>Tegalsari station</td>
<td>24 + 652</td>
<td>Small station</td>
</tr>
<tr>
<td>11</td>
<td>Gulon shelter</td>
<td>26 + 400</td>
<td>Shelter</td>
</tr>
<tr>
<td>12</td>
<td>Muntilan station</td>
<td>28 + 545</td>
<td>Medium station</td>
</tr>
<tr>
<td>13</td>
<td>Bojong shelter</td>
<td>31 + 800</td>
<td>Small station</td>
</tr>
<tr>
<td>14</td>
<td>Blabak station</td>
<td>33 + 456</td>
<td>Shelter</td>
</tr>
<tr>
<td>15</td>
<td>Blango shelter</td>
<td>38 + 000</td>
<td>Shelter</td>
</tr>
<tr>
<td>16</td>
<td>Mertoyudan station</td>
<td>40 + 893</td>
<td>Small station</td>
</tr>
<tr>
<td>17</td>
<td>Magelanl shelter</td>
<td>42 + 300</td>
<td>Small station</td>
</tr>
<tr>
<td>18</td>
<td>Magelang Pasar station</td>
<td>44 + 279</td>
<td>Shelter</td>
</tr>
<tr>
<td>19</td>
<td>Magelang Kota station</td>
<td>46 + 855</td>
<td>Large station</td>
</tr>
<tr>
<td>20</td>
<td>Secang station</td>
<td>56 + 040</td>
<td>Small station</td>
</tr>
<tr>
<td>21</td>
<td>Parakan station</td>
<td>74 + 489</td>
<td>Small station</td>
</tr>
<tr>
<td>22</td>
<td>Temanggung station</td>
<td>79 + 696</td>
<td>Medium station</td>
</tr>
</tbody>
</table>

7 CONCLUSIONS

Based on the analysis result, it could be concluded as follows:

a) Trip growth percentage per year is 8.78%. From the results of these calculations, it can be seen the number of trips movement increase from year to year.

b) Passengers mostly choose train as their modes. 41% people choose train, 29% choose motorcycle, 24% choose bus, and 6% choose car. In the other word, the passengers agree with the plan to reactivation of Yogyakarta - Magelang track.

c) Most of the respondents in both cities choose Route B as their choices. Route B will through Lempuyangan - Tugu - Muntilan - Magelang Kota - Secang - Temanggung - Parakan.

d) The most trips destination from Yogyakarta respondent is Magelang which is 43%, Temanggung 24%, Secang 16%, Parakan 5%, and others 12%. Conversely, travel destination chosen by respondents Magelang is Yogyakarta which is 48%, Sleman 27%, Bantul 12%, Kulon Progo 4%, and others 9%.

e) The station location placement is same with the former, with three additional station there are Secang station, Parakan station, and Temanggung station.

REFERENCES


Peraturan Pemerintah Republik Indonesia no.29 , (2011), Persyaratan Teknis Bangunan Stasiun Kereta Api


VIA Transit Sustainability Policy (2007), Station Area Service Guidelines.