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ANALYSIS OF RAIL TRAILERS SELECTION IN SEMARANG CITY

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Abstract

This research was conducted in the city of Semarang with the intention of providing an alternative of land public transportation modes other than two-wheeled vehicles (motorbikes) and four wheels vehicles (cars). The development of the transportation mode in question is a train in the city that can reach certain destinations that have not been reached yet, and at low cost. This development direction plan includes accessibility, cohesiveness, capacity, safety, smoothness and speed, and timeliness of travel. Based on this, there are two alternative routes that are considered to be served in this mode. The results showed that the option, which is estimated to provide convenience, can reach many users at a low cost is the second alternative by using a single track along 10,475 km and a double track with a length of range of 5.8 km.

Keywords: Trailers, Train, Transportation, Rail.

1. Introduction

The majority of aspects of human life in the modern era are influenced by transportation, this can be seen from the element of transportation costs that are included in the calculation of the goods' price, services, and the cost of daily living. The amount of these transportation cost components is various but generally is too large (expensive). The high cost of transportation is commonly caused by the inefficient elements of the transportation system or even due to the improper choice of transportation modes [1].

Land transportation in Semarang City currently has an important and strategic position, so that transportation management policies need to be organized into a unity of land transportation management policy taken by considering the growth of the community's economy [2]. The effectiveness of land transportation management policies in Semarang City really depends on how the City Government handles its land transportation management properly. With proper management policies that include planning, organizing, implementing, and controlling, it is expected that the condition of land transportation in the city of Semarang will also achieve its targets, where currently there is a tendency to develop railway transportation that serves routes in the city [3].

Train is one of the modes of land transportation which has been widely used in Indonesia, especially for the Java Island region, that currently is developing not only conventional inter-city trains but also developing the type of train for transportation inside the city. The advantage of this transportation is that it has its own traffic lane, by using the rails, so that it cannot move in any direction or in other words, its movement follows the rail lines that have been provided [4]. The use of trains as a means of transportation can also reduce the level of congestion that occurs on the road, besides that the capacity of this train is greater than other land transportation means, such as motorbikes or cars and even buses.

The city of Semarang as one of the provincial capitals in Indonesia is currently developing an urban rail transportation network system plan and a cross-city rail network development plan, this is stated in the Semarang City Regional Regulation concerning the Regional Spatial Planning of Semarang City Year 2011-2031 in Article 22 [5].

Development of rail transportation is divided into two plans; those are the development of service networks and development of infrastructure networks. However, seeing the condition of Semarang City in developing the service network will be balanced with the development of infrastructure and vice versa, where the two become interrelated with one another [6]. Several plans for the development of railroad transportation in the city of Semarang are viewed from the development of the Kedungsapur system into a single unit that provides a linkage of movements. This connection is related to the emergence of many commuters from/to areas around the city of Semarang. To facilitate this condition, it is necessary to consider rail-based transportation that accommodates the suburban areas of Semarang City. The current traffic conditions in the Semarang City and road capacity are illustrated in Table 1.

Urban rail transportation development is prepared by paying attention into the railway transportation system policy strategy in the scale of city, Central Java region and National scales as well as existing general problems. The development of rail transportation is divided into two plans, those are the development of service

networks and the development of infrastructure networks [7]. The condition of the existing city planning system affects the transportation model that is applied [1].

Table 1. Existing traffic conditions **in Semarang city.**

No.	Roads	Free Flow Speed (km/hr)	Road Capacity	Volume (pcu/hr)
1	RE Martadinata Street (puri-Kalibanteng intersection) E-W	57,20	3534,96	1619,00
	RE Martadinata Street (puri-Kalibanteng intersection) W-E	57,20	3534,96	1541,00
2	RE Martadinata Street (puri intersection – Madukoro intersection) N-S	57,20	3534,96	1760,00
	RE Martadinata Street (Puri intersection -Madukoro intersection) S-N	57,20	3534,96	2379,00
3	Yos Sudarso Street S-N	57,20	3534,96	2990,00
	Yos Sudarso Street N-S	57,20	3534,96	2668,00
4	Sudirman Street W-E	56,43	4851,00	3525,00
	Sudirman Street E-W	59,17	5025,24	4881,00
5	Madukoro Raya Street (Riverside) S-N	57,82	3350,16	1423,00
	Madukoro Raya Street (Riverside) N-S	57,82	3350,16	720,00
6	Madukoro Raya Street (Government Offices) W-E	57,82	3350,16	774,00
	Madukoro Raya Street (Government Offices) E-W	57,82	3350,16	518,00
7	Madukoro Raya Street (arteri-PRPP) E-W	51,15	3003,00	930,00
	Madukoro Raya Street (arteri-PRPP) W-E	51,15	3003,00	939,00
8	Puri Anjasmoro Street (Arteri-PRPP) S-N	51,15	2838,00	1196,00
	Puri Anjasmoro Street (Arteri-PRPP) N-S	51,15	2838,00	1199,00
9	Puri Anjasmoro Street (PRPP-Bandara Baru) E-W	51,15	3003,00	283,00
	Puri Anjasmoro Street (PRPP-Bandara Baru) W-E	51,15	3003,00	246,00
10	Kokrosono Street S-N	35,20	1450,00	487,00
	Kokrosono Street N-S	30,20	1450,00	343,00
11	Pandanaran Street W-E	27,20	3825,00	1547,00
	Pandanaran Street E-W	37,20	3825,00	1381,00
12	MT Haryono Street S-N	40,00	3300,00	2243,00
13	Gajamada Street S-N	37,00	3300,00	2066,00
14	Pemuda Street W-E	46,43	3000,00	1406,00
	Pemuda Street E-W	29,17	3000,00	1479,00
15	Imam Bonjol Street W-E	37,82	1450,00	727,00
	Imam Bonjol Street E-W	37,82	1450,00	724,00

Source: Survey Results and Data Processed, 2019

A development that tends to focus on regional growth in a certain area will have an impact on the density of transportation that is concentrated in that area. This condition usually goes hand in hand with the development of an industrialized area in there. The development of this industrialized area will be accompanied by the construction of settlements around the buffer areas on the outskirts of the city. So that congestion will appear in these areas, in the end, adequate transportation is needed to support accessibility in the movement to the intended location, both workplaces, residences and other places of activity. Basically, the principles and techniques of demand for transportation services are the transportation needs of users that are used as human or goods transportation, which are used as the basis for evaluating transportation and its facilities.

To make the quality of service the best possible, the transportation system is designed to provide the same level of service quality as that of private vehicles. When public transportation services are not significant, people will try to find alternatives to private vehicles in the form of motorbikes or cars. Along with the need for a person's mobility in their daily life, so that with conditions like this it will further worsen the condition of motorized vehicle density on the road and congestion cannot be avoided [1].

Based on the results of the Semarang City LRT feasibility study in 2017 carried out by the Semarang City Government, there is a rail-based transportation mode development plan, with plans for 8 (eight) Semarang Urban Railway Line corridors and the results of the City Transit Development Oriented (TOD) development study report. Semarang City LRT in 2018 there is an additional corridor 9, which is the development of the Ahmad Yani Airport area, that was originally the access road to the airport through Kali Banteng, which has changed through Madukoro, that is a strategic road that has the potential for TOD development. Apart from the above aspects, the Semarang City Railway line scenario also pays attention to the concept of regional development which aims to reduce travel distances, provide pedestrians as the main mode of relations between land use within communities / regions, provide public transportation to connect movement between regions or security. Regional development and transportation are two systems that must support each other, and its development have to pay attention to these two aspects. In urban areas it is very difficult not to adopt a transit system due to congestion problems, environmental issues, energy issues and so on. So, this research aims to select an alternative route that can provide convenience and comfort for prospective passengers and can reach most of the potential areas in Semarang City.

2. Literature study

Taking into account the work done in order to pioneer this railroad transportation, it can be said that it is a project for urban development. When referring to operational management, a study of project management and the scheduling of a project is categorized as one of the strategic decisions of operational management [2]. The study of project management should ideally treat all aspects of planning, scheduling and control, including behavioural and quantitative issues [3]. Barry Render and Jay Heizer (2017) describe that a project can be defined as a series of related tasks directed toward a major output [2]. In some firms a project organization is developed to make sure existing programs continue to run smoothly on a day-to-day basis while new projects are successfully completed. A project will undergo a series of stages where it brings together people with various abilities,

knowledge and skills, most of whom will remain in touch with the project until the project is completed [4]. As a series of activities to achieve a goal, the project must be managed properly so that the goals can be achieved effectively and efficiently. Key measures or metrics contained in project management include time, cost and work performance, with the determinants of commitment from top to bottom. Various policies have been issued, to minimize the problems of land transportation in Semarang City, but no matter how good the policies are, it will not work optimally as long as the land transportation management is not addressed.

Planning an economical elevated railway structure must fulfil the technical requirements, in terms of safety, comfort and usage plans, is a very important thing to pay attention to.

In technical planning, it is necessary to identify several things, including:

(i) Land use conditions, both those on the supporting roads and those related to the availability of existing land;
(ii) Soil structure, geology and topography as well as river conditions and its behavior;
(iii) Selection of the type of structure and construction materials in accordance with field conditions, availability of materials and existing resources;
(iv) The use of planning technology, implementation methods, tools, materials / ingredients required for planning is available in the market;
(v) Accurate structural analysis with proper analytical methods in order to obtain optimal planning results.

Transportation comes from the Latin *transportare*, where *trans* means across or on the other side and *portare* means transporting or carrying [5]. Another opinion also states that transportation is an effort to shift, to move, to transport, or to divert an object from one place to another, where in another place the object is more useful or can be useful for certain purposes [6].

Miro also classifies land transportation into two types:

(i) Physical Geographic, consist of railroad transportation modes, inland water transportation modes, special transportation modes made of pipes and cables and road transportation modes.
(ii) Administrative Geographic, divided into transportation within cities, rural transportation, inter-city transportation within the province (AKDP), inter-city transportation between provinces (AKAP) and cross-border transportation between countries (international).

Law (UU) Number 23 of 2007 concerning Railways, rail transportation is activities of moving people and / or goods from one place to another by train [7]. The train is on railways with power of motion, either independently or tied up with the other railroad facilities, that will be or are moving on railroad associated with rail travel. Types of trains according to Law (UU) Number 23 of 2007 consist of normal speed trains, high speed trains, monorail trains, linear induction motor trains, air-driven trains, magnetic levitation trains, trams, and cable cars.

Basically, demand for transportation is caused by human needs to travel from other locations with the aim of taking part in a certain activity as well as the need for goods transportation to be used or consumed in other locations [7].

The MRT project is considered by many as a vital element of the transportation system which is expected to become the first modern public transportation system in Semarang, which is expected to solve the problem of traffic jams and increase the capacity of public transportation in Semarang. The congestion problem has prompted several big cities to expand the rail network and create new rail networks [8]. However, there are several things that need to be considered in planning a new rail network, including the length of the tracks and the number and location of stop stations [8]. Rail length will relate to service coverage, capital, and operating costs. The long rail network serves a wide coverage but also requires large capital and operational costs. The short rail network has narrower services, but the capital and operating costs are low and it also shortens travel time. The elements of security, a definite transportation schedule, high speed, and low pollution make the train or rail transportation model necessary to be developed [8-15].

Permenhub RI No. 24 of 2015 concerning technical regulations and provisions, serves as references in making railroad designs [10]. The law correlates to:

(i) Law (UU) No. 23 of 2007 concerning Railways [16].
(ii) Government Regulation No. 56 of 2009 concerning Railway Administration [17].
(iii) Government Regulation No. 72 of 2009 concerning Railway Traffic and Transportation [18].
(iv) Minister of Transportation Regulation No. 11 of 2012 concerning Procedures for Establishing Railway Tracks [19].
(v) Minister of Transportation Regulation No. 60 of 2012 concerning Technical Requirements for Railway Tracks [20, 21].

Meanwhile, the road / rail technical criteria for light rail at least include (Permenhub RI No. PM. 60 of 2012):

(i) Railroad width is 1067 mm which is the minimum distance of both sides of the rail head measured 0 - 14 mm below the top surface of the rail. Acceptable rail width tolerances are +2 mm and -2 mm for new rail roads.
(ii) Road structure type for all tracks is non-ballasted track and direct fixation track.
(iii) The plan speed is 100 km/hr, and the maximum operating speed is 80% of the plan speed.

If the driving of the vehicle is uncomfortable (calm) due to a change in the direction of the vehicle's speed, then actions that need to be taken to reduce the danger caused by the centrifugal force are to raise the outer rail, to create a transitional arch and widen the track as stated in Law No. 60, 2012 (See Table 2).

To provide a public transportation system, it is necessary to pay attention to flexibility and quality because it will affect user behaviour and demands [8]. Demands for public transportation users is influenced by physical and behavioural factors, such as alternative integration of modes to be used, who is the user, travel distance, travel time, travel destination, travel frequency, and government policies. Furthermore, demand for public transport is also influenced by prices, government intervention, geographical characteristics, and travel behaviour and patterns. Similar to Souche which also revealed that the cost of travel and services will greatly influence the choice of transportation mode [8, 9].

Table 2. Geometric criteria for railroad.

No.	Description	Technical Requirements
1	Width of Railroad	1076 mm
2	a. Plan Speed	100 km/hr
	b. Maximum Speed of Operation	80 km/hr
3	Length of Horizontal Curve	
	a. Desirable minimum	60 m
	b. Absolute minimum	50 m
4	Length of Straight Rail	
	a. Desirable minimum	20 m
	b. Absolute minimum	15 m
5	Minimum length of transitional arch	According to calculation
6	Geometric of transitional arch	According to calculation
7	Maximum elevation	
	a. Main Line	110 mm
	b. Platform	70 mm
8	Minimum elevation	20 mm
9	Minimum radius of vertical arc	In accordance with the calculation
10	Maximum Gradient	
	a. On the rail / lane	40‰
	b. At Station	1.5‰
11	Angle of the draft on the rail	1:10
12	Railroad type	Ballastless

Criteria for structure construction

Criteria for the work of the Semarang City railway structure generally refers to the following rules and regulations:

a. Types of construction that are strong/stable, economical and cost efficient by considering:
   (i) Local conditions (topography, geology, etc.);
   (ii) Ease of implementation and maintenance;
   (iii) Building materials that are easily obtained around the job site;
   (iv) Equipment and technical capabilities of field implementers.
b. Security while doing the construction.
c. Meet the standards and requirements in force.
d. The structural design criteria are as follows:
   (i) Soil strength for foundation pile with SPT value> 60;
   (ii) Load analysis must consider live loads, dead loads, wind loads, earthquake loads and other loads that affect the structure;
   (iii) Permissible settlement effect is a maximum of 1/1000 times the span;
   (iv) Minimum concrete grades for the K-300 bore pile, Pier including the K-350 pier head, K-350 floor plate, K-500 girder and slab track;
   (v) Reinforcement steel with an elastic modulus of at least 200,000 MPa;
   (vi) The construction life for the structure is at least 100 years.

It is recommended that the railroad construction plan for superstructure uses prestressed concrete construction. This is because concrete is stronger in compressive conditions, but weak in tensile conditions. The tensile strength of concrete varies from 8 to 14 percent of its compressive strength. The weakness of this weak concrete material in tensile can be overcome by providing compressive

stress to compensate / reduce the tensile stress that arises in the cross-section due to the working load.

There are 2 methods of structural planning, those are:

(i) The ultimate planning method Load Resistant Factor Design (LRFD), where the calculation of the upper structure is generally carried out by the ultimate method by selecting the ultimate load factor according to applicable regulations.
(ii) The Allowable Stress Design (ASD) method, where the allowable stress planning method with workload is generally used for the calculation of the substructure (foundation).

The pre-stressed concrete structure has the following advantages:

(i) It is more waterproof, so that the water in the LRT cross section does not easily absorb.
(ii) Less structural deflection can be obtained, with the formation of a deflection (chamber) of the prestressed cable layout configuration along the element.
(iii) The cross-section of the structure is smaller / slimmer, because the entire cross-sectional area can be used effectively.
(iv) Allows a longer span than reinforced concrete.
(v) Because prestressed cables use high strength steel, their cross-sectional capacity is much larger than ordinary reinforcing bars with the same area of reinforcement.

In determining the substructure for building elevated structures it is influenced by local topographic conditions, the original soil layer structure that is used as a pillar foundation in determining the depth of the foundation. Whereas in determining the superstructure it is influenced by the economic span, the age of the design and the desired aesthetics of the superstructure as shown in Table 3 below.

Table 3. Comparison of economic spans of upper buildings.

0-15m	Flat Slab Concrete	
10-18m	Concrete T girder	
18-25m	Concrete T Girder with Footing	
25-40m	Framed Concrete Box	
25-40m	I Girder	
40-300m	Framed Concrete Box	
40-200m	Iron Frame	
150-400m	Steel Arch	
200-400m	Cabled-Stayed	
300-2000m	Hanged	

In general, aesthetics for superstructure in urban areas need to be considered, so the recommendation for the use of a superstructure on an elevated structure on the Semarang City railway is recommended to use pre-stressed I girder or framed box girder for long spans. The choice of the type of superstructure is also influenced by the complexity of the alignment and the method of implementation in the field related to the availability of working in land.

3. Research methodology

Data collection methods include primary data survey activities and secondary data surveys to obtain the data needed as material for conducting analysis. Primary data includes the implementation of an alternative railroad survey conducted to identify the real condition of the proposed corridors for railroad alignment alternatives that have been identified at an early stage in order to obtain the characteristics of each proposed alternative railroad line that takes into account spatial, environmental and transportation aspects. The research location in this study can be seen in Fig. 1.

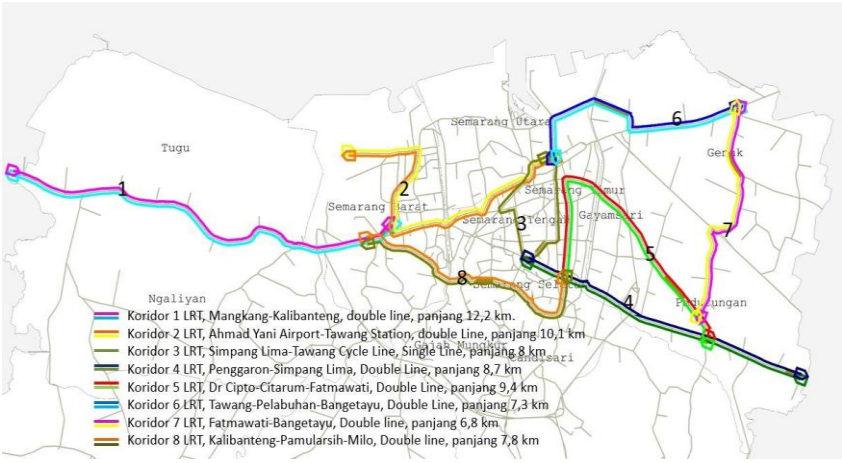

Fig. 1. Semarang urban railway corridor.

To be able to determine the suitability of a railroad track with the technical requirements of a railroad line which generally requires a gradient / incline of less than 1% (generally 3-5 per mile) and the carrying capacity of the ground with a California Bearing Ratio (CBR) for the figure above 8% confirmation is impossible regarding these requirements can be checked through existing secondary maps. At a number of points, it is necessary to have field checks to ensure that the corridor being traversed has sufficient gradient and CBR to build a Railway line. To find out in real terms how big the number of users of the Railway mode is on the railway line development plan (market survey) in order to obtain an overview of the characteristics and behaviour of potential users (passengers and owners of goods) in choosing the mode of transportation to be used. Secondary data includes RTRW, National Transportation Level, Regional Transportation Level, Local Transportation Level, National Logistics System, Feasibility Study and Railway Development Master Plan, Regulations and Legislation, Standards used, maps and other data.

4. Results and Discussion

The results showed that the rail-based transportation development plan in the city of Semarang, the Transit Oriented Development (TOD) is very important. This concept has a major influence on travel demand for public transport users. The Semarang city railway line is planned to be connected with various comprehensive residential activities including apartments in Semarang city. The orientation is service to the community, as well as the fulfilment of the needs of railway operation and maintenance in a more sustainable manner. In the spatial context, the focus of railroad development in several areas that could potentially be developed as TOD is important. Especially in realizing a compact city, as well as reducing the development of coming, going and spreading people to the outside metropolitan of Semarang city. The TOD concept is also an important part of increasing revenue for mass transportation systems that can support operation and maintenance costs.

Based on the research that has been done, there are several plans for the development of railroad transportation in the city of Semarang, those are:

(i) Accessibility

Development of service performance towards the accessibility of the existing railroad network in the city of Semarang by developing rail-based mass transportation for areas that are in direct contact with Semarang city. Regarding this accessibility, existing railroad transportation is also used as commuter transportation in Semarang city and the districts / cities around Semarang city.

(ii) Cohesiveness

Cohesiveness of this mode is more directed by the existence of rail network access to the Tanjung Emas Port area. The integration of this mode is the reuse of the Semarang Gudang station. Another integration is with the connection between the terminals and the stations which are interconnected.

(iii) Capacity

In general, the cross-rail capacity on the Pantura line, including the existing network in the city of Semarang, is congested. The number of trains passing per day has exceeded the capacity that should have been allowed. For this reason, it needs to be developed by increasing the capacity of the existing rail network, one of way is by developing a double track railroad. Other than that, additional train facilities and carriages are also needed to increase transport capacity in several potential corridors for regional and national scale transportation.

(iv) Safety

Railway safety could be realized by developing safety on railroad tracks along the existing rail network in the city of Semarang. One of the main factors that need to be developed is the spatial arrangement around railroad tracks and the development of safety at railroad crossings.

(v) Smoothness and speed

One of the ways to develop smoothness and speed on railroad tracks in Semarang City is by developing an automatic signal system for the eastern part of Semarang city. Apart from that, for smoothness and speed, it is also necessary to separate

the railway line between the west and the east. This is done to avoid train delays due to the crossing of trains that meet at the meeting point.

(vi) Punctuality

To increase the punctuality of this train journey is by controlling the schedule/the timetable. The punctuality of the trip can be controlled by the timeliness that is obeyed in the operation. This punctuality is also based on the Train Travel Chart (Gapeka) which needs to be obeyed.

In general, the TOD concept is applied to areas located around transit points or transportation nodes with a radius of 400 to 800 meters. This radius measure is considered in relation to the scale / measure of walking distance. Therefore, the principle of TOD planning is associated with the ease of reaching urban activity centres from transit points or vice versa. The ease of reaching transit points by walking is supported by an area that is designed friendly with those who walks on the street (pedestrian-friendly).

For the assessment of the best route as a priority, an evaluation of the two alternative routes (alternatives 1 and 2) is carried out. The criteria are based on several aspects, including technical aspects, spatial aspects, aspects of public transportation, aspects of transit-based development (TOD) of activity centres and environmental and social aspects. The technical aspect consists of sub criteria, that are the availability of land in the space that's belong to the railroad tracks or RUMIJA, the difficulty level of construction and the commercial area also the length of the route. The spatial aspect of the area is related to compatibility with RTRW and land use, while the transportation aspect is related to integration with other transportation modes, potential demand and availability of access roads to the station. In general, the comparison of the proposed alternative 1 and alternative 2 of railways are as follows (see Table 4).

Table 4. Comparison of the proposed alternative 1 and alternative 2 railways.

Num.	Description	Alternative - 1	Alternative - 2
1	Length of railway line: a. Single Track b. Double Track	16,200 km. a. 8,600 km. b. 7,600 km.	16,275 km. a. 10,475 km b. 5,800 km
2	Number of Stations	14 Stations	14 Stations
3	Number of curves (radius)	51	58
4	Curves with the smallest radius	R = 30 meters	R = 40 meters
5	Existing road sections that are traversed	16 sections of road	17 sections of road
6	Land acquisition	Some station locations, and track routes utilizes *Rumija*	Some station locations, and track routes utilizes *Rumija*
7	Integration with other modes	Integrated	Integrated
8	Potential for TOD development	Potential	High potential

The selection of the railway line for the city of Semarang must also pay attention to the readiness of land and infrastructure in the field, especially the availability of land for the preparation of railways along with other supporting land for infrastructure such as stations, depots and also the possibility of developing Transit Development Oriented (TOD). It is hoped that the availability of land for the railway line maximizes the use of road space in accordance with the existing road width so that investment costs can be reduced. The railway line to be built will be of an elevated construction that passes through the city center and through the existing road with a ROW of 7–12 meters, so that it does not use large road space and attempts to minimize land acquisition. Based on the above considerations, there are several aspects of the criteria that are considered in the selection of railway lines and the weight of their effects, are as follows:

a.Technical Aspects (25%)

(i) The need for land acquisition for railroad development;

(ii) Difficulty level of construction in the field;

(iii) Rail line length;

b. Spatial Aspects (20%)

(i) The railroad tracks in order to keep up with the development and the development of Semarang city as contained in the RTRW for the City of Semarang.

(ii) The path is adjusted to the existing land use if the route that cross the existing road.

c. Transportation Aspects (25%)

(i) The railway line must be able to be integrated with other public transportation, so as to synergize the operation system of the Semarang City transportation.

(ii) Rail transport is organized with a potential travel demand on the planned route.

(iii) Availability of access roads, especially at station locations.

d. Development Aspect Based on Transit (TOD, 20%).

(i) The railway line can create a new transit system, especially in residential areas, offices, shopping areas or repair of the transit system;

(ii) The station is very close to residential, office, commercial and educational areas.

e. Environmental Aspects (10%)

(i) The railway line does not cross city locations that have been designated as cultural heritage and city conservation areas.

(ii) As far as possible not to reduce environmental disturbances and social impacts.

The weighting will later affect the scoring of each of the sub-criteria in the five aspects. By determining the amount of weight in the sub-criteria for that aspect, then an assessment is carried out with the weighting results as in Table 5.

Table 5. Analysis of the alternative assessment of railway line.

No.	Criteria of Selection	Assessment	Alternative Assessment- 1		Alternative Assessment - 2	
			Description	**Value**	**Description**	**Value**
1	Technical Aspect	25				
A	Need / land acquisition	10	Land acquisition at part of the station	8	Land acquisition at part of the station	8
B	Difficulty level of construction	10	Difficult	6	Medium	7
C	Length of line / road alignment	5	Shortest	5	Longer by 75 meters	4.5
2	Spatial Aspects	20				
A	Suitability with RTRW	10	Suitable	10	Suitable	10
B	Suitability with land use	10	Suitable	10	Suitable	10
3	Aspects of Transport	25				
A	Integrated with other modes	10	Integrated	8	Integrated	9
B	Potential demand	10	Large	9	Larger	10
C	Availability of access roads	5	Mostly available	4	Mostly available	4
4	Development Aspects of TOD	20				
A	Creating a new transit system	10	Potential	8	Very potential	9
B	Station location in residential, office, commercial and educational areas	10	Close	8	Very close	9
5	Environmental aspects	10				
A	Does not use conservation land	5	None	5	None	5
B	Environmental and social disturbances	5	Medium	4	Low	4.5
	Total Value	**100**		**85**		**90**

Based on the results of the assessment above, alternative route II has the highest value, that are 90 and alternative I with a value of 85, so alternative II is the chosen route which includes Ahmad Yani Airport, Madukoro, Customs and Excise Intersection, Madukoro Street then cross to the Sungai Banjir Kanal Barat to the Klitikan Market, Banjir Kanal Barat street, Pasar Bulu with a Double Track 5.80 kilometres long. Furthermore, from Pasar Bulu to Pandanaran street, Simpang Lima, Ahmad Yani street, MT. Hariyono street, Bubaan roundabout, Cendrawasih street, Tawang Station, Mpu Tantular street, Pemuda street, Gendingan street, Imam Bonjol street, Tanjung street, Kapten Tendean street, Imam Bonjol street then headed to Pasar Bulu again with a single track of 10,475 kilo meters as shown in the Figs. 2 and 3.

Fig. 2. Double track railway bandar a yani - pasar bulu.

Fig. 3. Single track railway for pasar bulu - sp.lima - pasar bulu.

To estimate passengers in one day, it is assumed that the train operates for 16 hours with a busy hour factor of 12%, so the average passenger along the corridor is 7,124 passengers per day in 2 directions in 2019.

In estimating travel needs in the planned years, the population growth approach is used in the city of Semarang where the total population of Semarang City for a period of 7 years (2013-2019) as shown in Fig. 4.

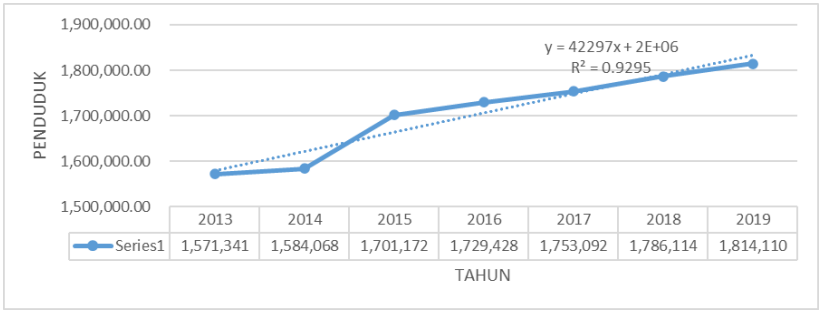

Fig. 4. Chart of Semarang city population growth regression equation.

Many previous studies have an understanding that TOD is an area that can be reached by pedestrian to transit stations, with a distance of about half a mile [22]. Increases in density are also frequently mentioned, particularly in relation to land use and increased accommodation for pedestrians [23].

The location of the station must be supported by the development of new land use to increase transit, pedestrian and bicycle travel users [24]. TOD can be new construction or redevelopment of one or more buildings whose design and orientation facilitate transit use [23].

TOD is more than simply development near transit. Successful TOD creates beautiful vital and walkable neighbourhoods, provides housing, shopping and transportation choices [25, 26]. Therefore, mapping the characteristics of working passengers from the previous estimating travel needs and land use scenario modelling along alternative routes are important for further study.

5. Conclusion

Based on the results of the analysis carried out, it is found that alternative corridors for several segments that pay attention to nine aspects, including topography, geology, land use, transportation potential, and other aspects. The selection of the best corridor is the one that gets the highest weight of value. Based on the results obtained, alternative II includes Ahmad Yani Airport, PRPP, Customs and Excise Intersection, Madukoro Street then crossing to the Sungai Banjir Kanal Barat to Klitikan (Kokrosono) Market, Banjir Kanal Barat street, Pasar Bulu with Double Tracks as long as 5,80 kilometres. Furthermore, from Pasar Bulu to Pandanaran street, Simpang Lima, Ahmad Yani street, MT. Hariyono street, Bubaan roundabout, Cendrawasih street, Tawang Station, Mpu Tantular street, Pemuda street, Gendingan street, Imam Bonjol street, Tanjung street, Kapten Tendean street, Imam Bonjol street then headed to Pasar Bulu again with a Single Track as long as 10,475 kilometres. The projection of rail users as an opportunity for travel demand along the route is 7,124 passengers per day in 2 trips in 2019. Mapping the characteristics of working passengers, especially those who will using the two alternative routes as a work destinations is important for further study. Identification of land use and activity systems along alternative routes, especially at station locations, is very necessary for further study regarding opportunities of applying the TOD concept.

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