PROJECT WORK

IMPROVING SUSTAINABLE TRANSPORTATION IN THE SUBURB WITH CONSIDERING RESIDENTS PREFERENCE

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Publications

No	Journal articles
1	Lasmini, An Approach for Promotion Public Participation in Planning Based on Public Acceptance, *Journal of Faculty of Engineering*, Brawijaya University, Vol. X. No. 3, December 2003, pp.143-154.
2	Lasmini, Hendi, Public participation in Decision Making Process of Transportation Infrastructure Planning Based on Stakeholder Priorities, *Journal of Engineering*, Brawijaya University, Vol. 17. No. 1, April 2005, pp.91
	Lasmini, Indriastuti, An Analysis of The Impediment to Pedestrian Walking a Case Study in Malang City, Indonesia, *Journal of Transportation inter-Universities*, Vol. 25. No. 2, June 2006, pp.25
3	Lasmini, Indriastuti, Ismu, An Influence of The Impediment to Level of Service of Pedestrian Sidewalk and Road Capacity: a Case Study in Malang City, Indonesia, *Journal of Engineering, Brawijaya University*, Vol. 20. No. 1, April 2008
4	Lasmini, Indrastuti, Optimization of safe pedestrian facilities and traffic management, a case study of Malang, Indonesia", *Journal of Economics and Engineering*, Baku, Azerbaijan, No.4, December 2010, 8-14.
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Executive Summary

Local Needs

The Sustainable transport means the transport which can contribute and encourage the sustainable development. Last three decades, most cities in Indonesia had rapid development that has resulted in unforeseen problems of insufficient infrastructure. The new development has occurred in the suburb which is called suburbanization and is depended on the center city activities. Suburbanization has concentrated in most cities of Java Island including Malang Municipality. Malang city has population about 789,348(2005) and area 110.06 km^2.

Suburbanization has impacts such as more dense population in the periphery of city, and high density (61 people/ha) and with similar condition as in thecity center (71-142 people/ha) in 2003. Both Population and vehicles have had a remarkably rapid growth, whereas transport infrastructures have only improved slightly. Concerning individual travel, the number of tripsusing private vehicles is the dominant transport mode such as 16.52% private car, and 47.29 % motor cycle (Lagsita, 2004).

The number of trips from suburban areas particularly Blimbing and Singosari Sub District to the city center are 2,614 pcu (passenger car unit) per hour within the dominance of private car (1,233 vehicles per hour) and motor cycle (1,200 vehicles per hour) which need average travel time 30-45 minutes (Bappeda Malang, 2005, Lagsita,2004). As a result, there are huge traffic loads on most highway networks as the gateway into the city center such as Raya Singosari, A.Yani, LA.Sucipto, MT.Haryono, Supriadi Street. As a consequence, this will decrease the level of service for each road due to unbalance between the number of traffic volume and the capacity of the transport infrastructures. Until 2000, there were 15,400 units of housing built in those areas to meet the needs of the residents. For this reason, it is important to create new areas with a settlement pattern based on smart growth. It is also important to consider the public preferences in participating to achieve sustainability, and to promote sustainable transport. This project work has purposes to assessresidents' travel behavior in the suburb, and to provide improved accessibility for their travel based ontheir preference.

Principles of Residence and Transport Development

Weneger (1995) explained that land use distribution is determined by the location of residents' activities such as housing and job places considering distance, cost, and time to travel to the destination. Integration of land use and transport system is solved by understanding linkage and characteristics of activity place.

Briefly, migration of people to the suburb has some impacts in which local government will have difficulty to supply a transportation network. One effort to control urban sprawl is to create a city based on smart growth. The purpose is to decrease impact of urban sprawl (MOP, 1997). One of the features of smart growth which was established in Los Angeles is developing an alternative transport mode. A main project for developing sustainable transport with improvement of mass transport like bus rapid transit is required for a city in developing country such as Malang Municipality based on the housing development pattern in the suburb.

Bus rapid as Pilot Project

Through the Urban Planning in Department of Municipality Planning and Highway Department Project, a plan for sustainable transport within implementationof bus rapid transit (BRT) will be started in 2012.

The development of settlements in the suburban area will have an impact on the increase of the traffic volume. On the other hand, with the unbalanced real condition of transportation network it will raise the vehicle operational cost, travel time, and pollution cost. Actually, this situation shows the absence of integration between land use and transport for big cities in Indonesia.

The analysis regarding existing travel behavior of people in the suburb reveals that if their residential location (suburb) is far from the city center, local government need to provide adequate facilities in terms of public transport and thereby improvement of the service level. So the residents will consider altering from private vehicles to public transport. If residents consider travel cost and distance in selecting the transport mode, they tend to use the existing public transport (paratransit).

The potential numbers of bus passengers are 698 persons (from North to South route), 553 persons (from North to South East route), 570 passengers (from North West to South route), 303 passenger (from North West to South East route), 15 persons (from North West to East route), one person (from East to South route), 19

passengers (from East to South East) (Bappeda, 2005). The probability of passenger to switch from the existing public transport and private vehicle (car and motor cycle) to BRT is about 18-19%. The traffic volume will decrease, while the level of service of gateway roads to the city center will improve. Most gateway roads tothe city center have better LOS except Tumenggung Suryo, PanglimaSudirman, GatotSubroto, Pasar Besar, MT. Haryono. For this reason, these roads should be improved in their geometry. However, the local government has another plan, which entails the construction of the eastern ring road with the purpose to separate inter and intra trips and thus increase the capacity of these roads.

1. Introduction

This report explains the concept of sustainable transport for residents in big cities of a developing country, the interrelation of residence and transportation development, preparation of a guide for planners and local governments in planning and development of urban infrastructures. This guide is expected to function as a tool to control settlement development suitable in relation to transport networks.

This project will be implemented to achieve a sustainable transport system, bus rapid transit (BRT). The transport model is required for the city, which covers a big area and experiences good economic growth. The availability of BRT will satisfy the high demand of travel considering adequate transport infrastructure supply, the environment and safety. The presence of BRT must be coordinated with the existing public transport system in terms of route, linkages, connectivity and waiting time to transit, in which the existing one will be functioning as a feeder transport mode. There should be no gap of profit between operator of the existing public transport and bus transit planned

In many cities in developing countries such as Indonesia, the urban sprawl with the tendency of housing and business development in the periphery of urban areas is begun in20'th century. This process features increasing and expanding developed areas in the suburbs. The new developments in the suburbs depend intensively on the downtown activities. This pattern impacts on the functional urban area due to increase in traffic generation from households in the suburb, and thus increasing load on the highway network from the suburb to the city center every day. Suburbanization has occurred in the cities of Java Island including Malang Municipality. Malang Municipality is located in the Java Island and is one of the big cities in the East Java Province. It has a population of about 789,348 (2005) and an area 110.06 km^2 (it is shown in Fig 1). It consists of 5 sub-districts (Blimbing, Lowokwaru, Kedungkandang, Sukun, and Klojen). The settlements expand to those areas in four sub-districts, and people activities depend on the city center activities (Klojen activities), as shown in Fig 2.

Fig.1. Malang municipality in East Java Province

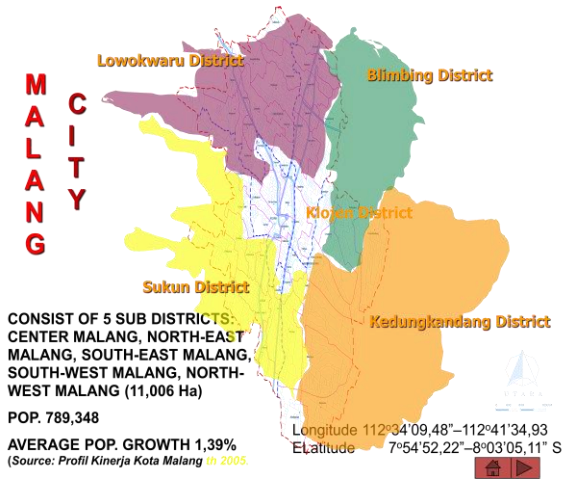

Fig.2. Malang municipality has 5 sub-districts

Malang Municipality government and the other neighboring cities have the intention to establish a mass transport like BRT to cater for the inhabitants' travel needs and to establish a new transport model. These areas (Batu city, Karangploso, Lawang, Singosari, Tumpang, Turen and Tajinan sub district) are included in the Malang District and have high traffic flows going to the city center of Malang municipality (GMTM & PTS, 2001).

In 2000, there were 15,400 home units for supplying the resident needs, most of which most were located in the periphery of Malang municipality and along the boundaries of the other areas (Malang and Batu district). The prediction for 2010 suggests that with the number of inhabitants reaching 806,657 persons there will need for the addition of settlements of approximately 10,986 units compared to the total existing number of 161,331 units. The new settlements will reduce the green areas and the paddy fields that will become built areas as shown in Figure 3.

Generally, the residents need better condition and improved environment for living (road condition, availability of green area, no flood) as figured in Fig 4. They prefer to build their own housing the periphery of the city due to low price/cost of land. On the other hand, they also need high and convenient accessibility to the central business district (CBD). In suburban area, the total of built area increases with about 59.89% (589.26ha), and the population growth is 3.53% (2004).

The increase of traffic volume generated from the settlements in the suburb without improvement of transport infrastructures will decline level of service of all the roads. This situation is shown from LoS (level of service) of road as gateways to the city center such as Intan, Suroso, Sunandar, T.Suryo and Sudirman streets have variable speed (from LoS D to F) and take the traffic load from north side of city. Gajayana and Haryono streets have LoS F (vehicle speeds are severely restricted) and are loaded with traffic flow from west side. The M.Sungkono, Muharto and Ranugrati streets containing LOS C and are used by residents from east side as shown in Figure 5, Sugiono and Supriyadi streets having LOS F and take the traffic load generated by vehicles from settlements on the south side of the city.

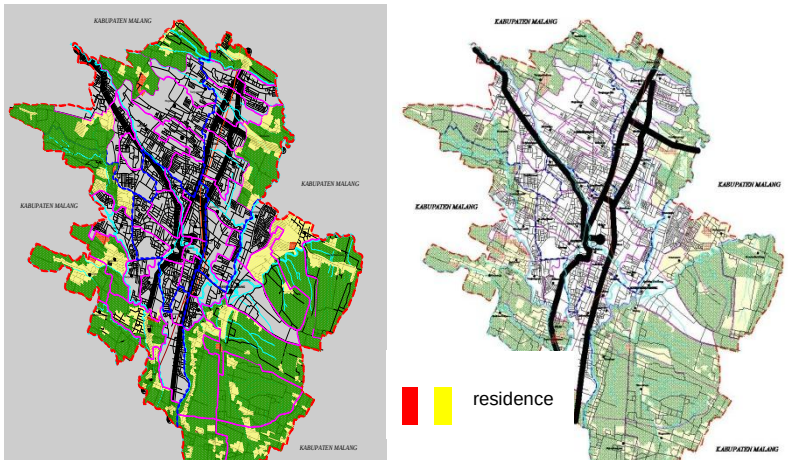

Fig. 3 Difference of land use between 1995 and 2004 for settlement areas

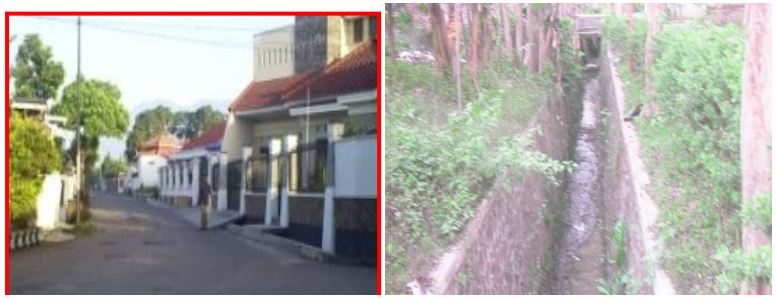

Fig.4 Residence conditions in suburban areas with good drainage and access road

The number of trips from suburban areas (Karangploso, Blimbing, Kepanjen and Pakisaji Sub District) to the center city are 300, 340, 840 and 240 vehicle/day respectively using private vehicles (bymotor cycle (47.29%), private car (16.52%)) (Lagsita 2004, and Bappeda Malang, 2005).

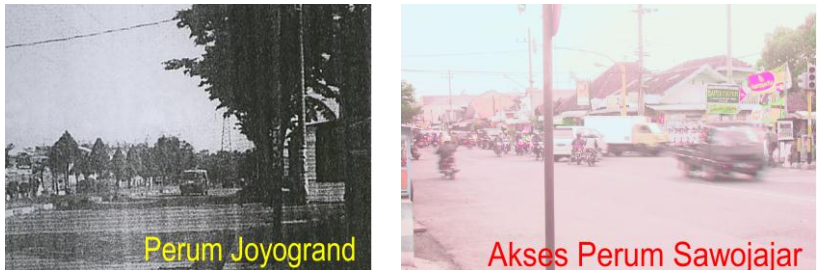

Fig. 5 The exiting public transport and the level of service of access road in the suburb

In order to improve transport infrastructure and provide alternative mode of travel for the residence in the suburbs, there is a need for a friendly mass transport model for the residents' travel to and back from the city center (intra-city travel). Most areas in the suburbs have similar population growth and the same population density with as found in the areas in the city center. The overall goal of this project work is to accommodate intra-city trips in an integrated way with intercity travel for people in Malang Greater (Malang municipality, Malang and Batu district), which has established a bus rapid transit (BRT) to serve those areas. BRT is expected to support people travel needs to the CBD and to enhance the accessibility for the residents in the suburb.

The project dealing with the BRT include the policy objectives as follows: to promote and introduce linkages between intra city and inter-city travel routes; to integrate the provision of transport modes based on residents' preferences and needs; to plan for the sustainable transport system for residents in the suburb.

2. Purposes

The purpose of the planning of a pilot project for bus rapid transits is to increase accessibility and mobility for residents in the suburbs, and to prepare a sustainability index which would measure and indicate transport benefits in terms of the travel pattern, and in reference to the benefits. The new settlements in the suburbs will grow rapidly in future years as shown in Figure 6, which represents the condition in existing new settlements in 2008.

Sustainable transport for residents in the suburb will be supplied through the presence of bus rapid transit (BRT), which has the purposes to decrease traffic volume from suburb to the city center, to reduce frequency of transfer for public transport, to lessen use of private vehicle (car and motor cycle), to supportresidents' activities in the suburb, to improve theroute network for current public transport, to provide for the integration of route network of intercity and intra city travel, to establish a balance between type of public transport modes and the road network, to lessen inefficiency of the operational system and the dissatisfaction concerning the existing public transport costs.

This project is as pilot project of BRT for intercity travel and it aims at providing for the sustainable travel options for residents with considering transport benefits generated from residents travel from the suburb to the city center with the existing public transport in comparison with the establishment of a bus rapid transit (BRT), and with involving citizen preference in understanding their travel attitudes and choices.

From this project, the overall goals are to obtain the guidelines for transport planning and urban planning, which will result in sustainable travel and thereby optimize the local government budget. This project facilitates the balancing of the budget of local government and the settlement development based on integration of urban development with the availability of transport modes and infrastructure provision. The guidelines will support sustainable settlement development, in relation to transport models and infrastructure provisions based on a sustainability index for each settlement.

Fig. 6 Development of new settlements in the suburb

3. Present Situation

The main problem is the location of residential areas, expanding to suburban areas and in relation to the uncontrolled development of settlements not in balance with the transport network. As a consequence, the huge traffic volume will occur on the gateway of roads to the city center, and the level of service of roads continually decreases. The impacts of this development are increasing dominance of private vehicles (cars and motorcycles) in terms of transport modes. Further, it results in additional of travel costs and travel time, the diminishing quality of the environment. Citizens tend to choose the suburban areas as their place of residence due to limited availability of land and the high price of land in the city center. This urban sprawl has to be solved, because the government will face difficulties to provide for a transportation network like highways as well as public transport systems. This issue will be solved by the project which aims at establishing an efficient and friendly public transport system like bus rapid transit (BRT). BRT routes will accommodate residents' travel requirements related to the needs in the suburb for intra-city routes integrated with inter-city routes.

A. Malang Municipality today

To understand the characteristics and identity of the area and people activities in Malang Municipality and the problems and needs in this area, it is important to know the functions of the area and existing conditions. This chapter describes today's situation in Malang Municipality and in the other neighboring cities, the economic activities, housing, transport network and the problems in these terms.

Malang Municipality has 789,348inhabitants and the area 110.06 km^2. It functions as a business center and a center for agroindustry and education.

The Malang Municipality areas have an altitude ranging from 400 to 600 m, and with slopes 0-15% for 96.3% of total areas, and the rest of the area has slope more than 15%.

The use of the existing land according to Urban Spatial Planning includes paddy field (1,162 ha), industry (200 ha) on north side of city, market (14.99 ha) on Gadang, south side, tourism (53.225ha) on west side such as Badut Temple, Brawijaya museum, and Tlogomas swimming pool as shown in Figure 7.

The transport system is planned to develop the railway network with a double track for the routes Surabaya-Malang, and Blitar-Malang and rehabilitation of the route for Dampit-Malang. It will also include the development of the primary collector roads to Lumajang (east side), the Gempol-Malang freeway, and to increase off road parking in the city center.

Fig. 7 Tourism place in the city center

B. Social and Environment

Malang Municipality has some small-sized public open spaces and one park, which are located in the city center such as Alun-alun and Balai Kota (KidulDalem and Klojen villages) as figured in Figure 8. Only very few people use this areas for leisure. One specific feature for Malang is the green space or park built in1893 along certain streets, such as on Trunojoyo, Kertanegara, Tugu, Gajahmada, Merbabu, Ijen, and Suropati. Within developing city, nowadays there is still less green spaces.

In the city center, there are many facilities and infrastructure services such as 2 churches, 1 mosque, 5 shopping center, one park, 4 local government offices, three banks, one big post office, hotel, and five favorite schools. The concentration of many activities in the city center results in heavy traffics load on the road network around the city center. There is a great need for improvements of the public transport system to accommodate residents' travel requirements, and for the development of traffic demand management. This would include establishing off-street parking and improvement of pedestrian facilities, connecting with public transport stops (Lasmini, Indriastuti, 2006).

Fig. 8 Public space in the city center

C. Economic

Malang Municipality is center for agronomics, tourism and education. Productive areas consist of wet paddy filed (1,219 ha), and dry field (3,328 ha). These areas are located on south and east side of city and the production from the paddy fields amounts to about 15 million ton rice per year.

Tourist places are located in a wide spread pattern to all areas of the city for instance the museums in the city center. Other places of importance are the small swimming pool near city center, and a Badut temple on Karangbesuki village (east side of city).

Fig. 9 shopping center around the city center

Industrial areas include factories for cigarette production occupying an area of 172.8 ha. The development area of this industry is on south side of the city (Arjowinangun village). The other business centers consist of general markets, supermarkets, small and intermediate shops within a total number of facilities of 3,522 units as explained in Figure 9.

D. Housing

Malang Municipality consists of 5 sub districts Klojen (center city), Blimbing (north east), Kedungkandang (south east), Sukun (south west), and Lowokwaru (north west). The highest number of inhabitants 170,500 peoples live in Sukun (south side of the city), and the lowest 119,700 peoples live in Klojen sub district (center city). The highest density is 125.15 people/ha in Klojen (center of city).

Since 1980, housing development has changed and development occurred primarily in the periphery of city. 78,000 households (about 50% from the total of settlements) already existed and were located in the suburban area. Each family consists of 3-4 persons on an average. The new settlements in the suburb generally include to the largest extent newly established families with 1-2 children and with parents in the age of 25-50 years. 70% of the households are defined as new families, and the rest are families established earlier

The most common house type in the suburban a single-family house with about 45-70 m^2built area within the total of land about 100-200 square meters in size. These houses are usually made from bricks or concrete blocks with clay or concrete roof, and with the entrance gate facing the street. In the in front or backyard, there is a small garden. A fence is surrounding the plot. Most settlements have an average number of 400-1,000 unit houses. Figure 10 illustrates the situation in this type of suburban settlement.

Each family has on average 2 vehicles; a motor cycle and a car. This provides for high degree of mobility for households in the suburbs, as a consequence, there are huge traffic volumes generating from these settlements.

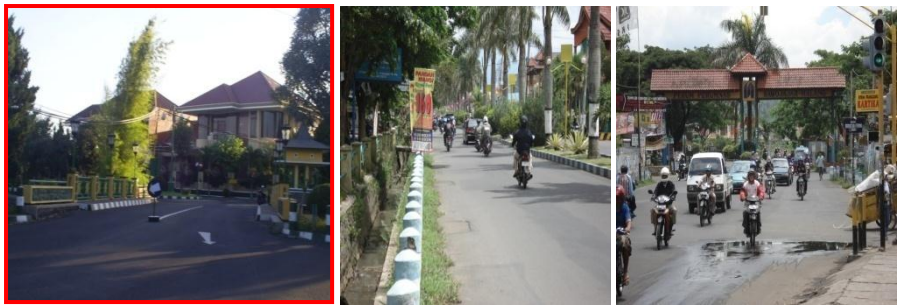

Figure 10 The entrance and drainage condition, and the domination of private vehicle coming from the settlement in the suburb (east side of city)

Informal settlements are located along the Brantas River and the railway reserve (7.59%) in Klojen sub-district for example Dinoyo, Oro-oroDowo, Polehan, Jodipan, Kotalama, Mergosono, Ciptomulyo, Gadang, Bandulan and Bandungrejosari villages. These are poor settlements with high density (71 -142 people/ha) and generally with unhealthy conditions and poor public facilities. There are more than 2,397 families and about 11,986 people living in those areas.

The number of inhabitants in Malang Municipality is predicted to reach to 806,657 persons in 2010. Such a growth will result in a need for an addition of 10,986 housing units on top from the existing 161,331 units. The development of the settlement areas spread towards all sides of cities. Development plans for new settlements are prepared for the north side of city in Balearjosari, Tasikmadu, Tunjungsekar, Tunggulwulung, Mojolangu, Arjosari, Purwantoro and Pandanwangi villages; on the west side areas are considered at Karangbesuki, Pisangcandi, Bandungrejosari, Bangkalankrajan and Mulyorejo; on south side of city areas are to be developed in Gadang, Bumiayu, Tlogowarudan Wonokoyo and on the east side new settlements are planned in Sawojajar, Madyopuro, Cemorokandang, Lesanpuro, Kedungkandang and Buring villages. These settlement areas are far away from the CDB and far away from the working places, thus local government will still have difficulties to provide for the transport network. The new settlements with residential houses in several floors should be introduced in the certain areas, on the other hand, people in Malang have not adapted and are not familiar with this type of housing as it is not part of the culture.

E. Urban Infrastructure

There are three types of main transportation system, highways, railways, and the airways serviced by Abdurahman Saleh airport for Malang-Jakarta route. The regional routes include the highways from/ to Surabaya City (north side), to Batu City (west-north), and to Blitar (south side).

Transportation pattern in the city is radial concentric with an inner ring road (grid model). Since 1990, there was increasing traffic flow of internal traffic in the areas nearest to the city (Batu, Malang) and from nearest city to city center of Malang Municipality. Additional traffic flow put heavy loads on roads such as the gateways to the city center, which is evidenced by increasing traffic density on each road.

Fig. 11Highway network and their functions

Malang Municipality is the center for the distribution of goods and services to the closest area (Malang and Batu District) which are also functioning as a buffer for the Malang Municipality. Its highway network consists of primary and secondary artery roads (length 11.82 and 15.94 km), primary and secondary collector roads (in length 8.16 and 27.09 km), primary and secondary local roads (in length 9.66 and 27.09 km) according to Spatial Planning and Land Use Planning. The highway network is shown in Figure 11.

High traffic volumes often occur on east side of highway network, which is a primary artery for the traffic from the north towards the south side (from Raden Intan, R. Panji Suroso, Letjen Sunandar Priyosudarmo, Tumenggung Suryo, Panglima Sudirman, Gatot Subroto, Laksamana Martadinata, Kolonel Soegiono street until Gadang Terminal). These areas have already been developed as business areas, shops, offices, and warehouses. The traffic flow from the west side towards the city center also leads tocongestion (Landungsari Terminal, Raya Tlogomas, MT. Haryono, Panjaitan, Brigjen Slamet Riadi, Basuki Rachmad and Jakgung Suprapto Street). This congestion is caused by huge traffic volumes from the new settlement and also the location of the traditional market (Dinoyo market) and the universities attracting additional traffic.

Fig.12 Location of station, terminal and sub

Heavy vehicles are only serviced by the road network on the east side of the city. The roads available for heavy vehicles include Intan, Suroso, Sunandar, Tumenggung, Sudirman, Subroto, Martadinata and Sugiono until Gadang terminal to south of the city. This is shown in Figure 11. As a result, the service level of these roads is the worst reaching their capacity.

Malang Municipality has 3 bus terminals, (Arjosari serving traffic from/to north side, Landungsari providing for the traffic from/to north side, Gadang serving traffic from/to south side), and the sub-terminals at Mulyorejo, Madyopura, and Tlogowaru.

The railway system serves two types of travel services. These are firstly the economy class to accommodate the travel from/to Surabaya to/from Blitar going from north to south and secondly the travel from/ to east Malang-Banyuwang. While the other executive class services operate to/from Jakarta. The frequency per day is 23 times. Since railway still has same level with highway, there are level crossings where cause congestion and delays at those crossings located at A.Yani and Laks. Martadinata, where there are high traffic volumes. There are three stations to service passengers and goods, i.e. Kota Baru, Kota lama, and Blimbing Station as illustrated in Figure12.

F. Public Transport

The weaknesses in the existing public transport system are: Inefficient transit route structure, Fragmentation of routes crossing city boundary, Lack of direct connections between certain long-distance services, System over-capacity with load factor approaching 1 (Dishub Malang, 2003).

The transit route network in Malang City has been gradually developed over a long time. The results are inadequate route network coverage and no services to certain parts of city. There are several large residential areas along the city boundary, which have no direct routes to the CBD, although there is a substantial travel demand between these points. A large number of commuters must use more than one trip and different modes of transport for their journeys to CBD. This results in inconvenient travel, increased travel cost, and increased journey time.

Passengers traveling from outside the city boundary to CBD are required to travel by rural transit vehicles to one of the terminals near the boundary of city, and transfer to another intra city transport service for the final stage of their journey. This situation is caused by the distinction in the legislation between the two types of services, and that separate government transport agencies have the responsibility for the issuing of licenses to them.

The existing public transport system has 25 routes with 2,189 units (in 16,981 trips per day) to service intracity travel accommodated through minibuses that have a capacity about 8 passengers. In order to service intracity travel, there are 5 routes from north to south and reverse, 5 routes to accommodate trips north to west and reverse, 4 routes to accommodate trips south to west and reverse, 1 route to accommodate trips north to east and reverse, 2 routes to accommodate trips east to west and reverse, the rest for the other routes.

Another mode of public transport is provided by taxi with 300 units, and by bus for intercity trips which service trips for Surabaya City served by big buses (174 units), for Blitar City (208 units medium buses), and 2,315 units small buses serving Batu or Kediri City.

G. Settlement and Transport Problematic

Concerning population growth and related conditions in the Malang Municipality, the demand for improved transport infrastructure and alternative modes of travel also includes high accessibility for citizens' activities. Change of land use influences the requirements for the transport system. Developing an area from paddy field or green areas to become a settlement area will have an impact on the demand for transport and in terms of travel behaviour.

The problematic issues for transport planning with many settlement developments particularly in the suburbs are

- Increasing travel demand, the public transport need must be balanced with the number of units supplied and the improvement of service levels. The service level includes quality of safety, comfort, waiting time, and travel time.
- The service level of public transport (PT) will influence to use the public transport system. Good service level of PT will increase willingness to use it, which will decrease the load on highways and reduce traffic density. If opposite situation occurs, the number of passengers of PT will significantly decrease, in which case the more intensive road traffic will create friction and competition among drivers resulting in higher speed and less safety.
- The routes for PT should consider road capacity (VCR), and serve directly the passengers from or to the center of attraction and generation.

With the development of new settlements in the suburbs, the people have to travel daily to the city center. The distribution on types of transport is as follows: motor cycle (47.29%), public transit (32.19%), private car (16.52%), and taxi (3.99%) respectively. Generally, travelling with the use of private vehicles need 30-45 minutes, which is faster than by public transport. The length of travel by car is about 1-10 km to the center city (Lagsita, 2004). Other research, suggests that travelling to the CBD (central business district) takes place using private vehicles (24%), public transport (56%), taxi (2%), pedicab (14%), and walking (4%) (Lasmini, 2006).As a consequence, the service level of roads as the gateways to the center city continually decreases (VCR > 0.85), and congestions occurs often.

Other impacts are the increase of the vehicle operational cost, travel time, travel cost and pollution cost. Actually these conditions indicate the lack of integration between land use and transport of all cities in Indonesia.

With the expansion of settlements in the suburbs, huge traffic volumes will occur on the gateway roads that lead to the city center. There is an increase in volumes with a distribution on transport modes, which is dominated by private vehicle (car and motor cycle).The consequences include additional travel costs and travel

time and diminishing quality of the environment. The citizens tend to choose to live in the suburbs due to limited availability of land in the city center. The urban sprawl has to be solved, because the government will have difficulties to provide the transport network, and the service level of roads does continually decrease as explained in Table 1 (the problem tree of this project).

The aim of the project is to solve this issue through the establishment of an efficient and user-friendly public transport system based on bus rapid transit (BRT). BRT routes will accommodate intercity travel for residents in the suburbs and will be integrated with intercity travel serving the nearby cities (Batu and Malang District).

The responsibility of the target group (the residents) will be the willingness to change preferred transport mode from private vehicles to BRT. All residents within low, medium and high income who live in the suburb should be encouraged to alter their travel behavior. It is necessary to invite representatives of each group of stakeholders to participate in this project and to coordinate among them. This is particularly important due to the existing lack of integration between the authorities involved inland use planning and transport planning. This process is needed to provide for better Spatial Planning and to integrate with establishing regulations for the permission of housing developments in the suburban areas. A traffic impact fee should be imposed to housing developers due to the additional traffic volumes generated by the new settlements.

EFFECT	High consuming fuel and health cost					
	Consume high cost and time of transportation			Health of resident along the corridor of road and the passenger from suburban decrease		
	High pollution of air and noise during peak hour at corridor of road as gateway to city center					
	Decreasing speed (20-25 km/hour)	Long delay (20-45 minute) on the intersection and road		Resident on suburban depart early (05.30) and arrive late to working and school (18.00-19.00)		
	Huge traffic volume and Traffic jam on the gateway of roads to city center (06.00-08.00 or 15.00-17.00)					
PROBLEM	**Limitation and unfriendly of Public Transport for resident on suburban**					
CAUSE	Bad LoS (level of service) of the existing public transport				Custom and dominant using private car	
	Stop anywhere to load passenger	Long waiting time	Load factor >1	Unbalancing between Public transport supply with their demand	Availability of flexible vehicle (47% of resident use motor cycle)	Private car property > 1 unit
	Driver needs many passengers and benefit (no basic salary for driver, rental system)			Bad management of establishing public transport	Minimum travel time and cost / Need high mobility	Dual income
	Almost of public transport undertaken by private company				No restriction for private car property and usage	
	Limitation of financing Local government to establish BRT				No regulation of private vehicle	
	No coordination between private company, operator, local government , and Dept. of transportation and Lack of coordination for planning of land use, and establishing public transport suitable with traffic generated from residence					

Table 1. Problem

Tree of the Project

4. Analysis

4.1 Increasing the accessibility for residents in the suburbs

Travel pattern in Malang Municipality occurs due to trips from all areas close to this city, not only from the passengers or user living in this city. Figure 13 (Gordon line) shows huge traffic volumes attracted to the CBD of Malang Municipality from several areas in Malang and Batu District particularly Karangploso, Lawang, Singosari, Tumpang, Tajinan, Turen and Kepanjen areas. Thus, it is necessary to understand the distribution of all trips coming from or to all areas close in Malang Municipality.

BRT is expected to connect all main places that generates or attracts of trips (travel demand). BRT has high potency to serve strategic routes in Greater Malang (including Malang Municipality, Malang and Batu District) through the primary road network. The existing public transport system with capacity of 8-seater buses is proposed to continue as a feeder system to support the establishment of BRT in which it is expected to pass onto the secondary roads.

To balance the increasing traffic volumes from housing developments, which are mostly located in the suburban areas, the local government of Greater Malang Area plans the BRT which is called a semi rapid transit bus. This transport mode is designed to use medium-sized buses with 24 sitting passenger capacity. These buses will have fixed schedules and passenger will only get in or out of the vehicle at certain bus stops. To make sure that the bus will only stop at bus stops, the bus is designed with high entrance, so the passenger could not go in or out of this vehicle, unless in the bus stop. The bus stops will also be specially designed to accommodate this type of vehicles. The payment system is one ticket for all directions, means that the passengers do not need to pay more as long as they are still inside the bus stop building. They can transfer from one route to the other route on any bus stop at the crossing routes. There is no private lane for these buses, so it must move together with other vehicles on the road, so the speed and travel time will depend on the general traffic condition. For this reason, these buses are called the semi-rapid transit bus. Semi BRT routes should pass the passenger demand aspect, the traffic flow aspect, the road geometric aspect, the social aspect, the economics aspect and the accessibility respectively (Nugraha, et.al, 2004) as seen in Figure 14. There are seven routes planned for the semi BRT as follows:

1. Lawang-Malang-Kepanjen (North to South)
2. Lawang-Malang-Dampit (North to South east)
3. Batu-Malang-Kepanjen (North west to South)
4. Batu-Malang-Dampit (North west to South east)
5. Batu-Malang-Tumpang (North west to East)
6. Tumpang-Malang-Kepanjen (East to South)
7. Tumpang-Malang-Dampit (East to South east).

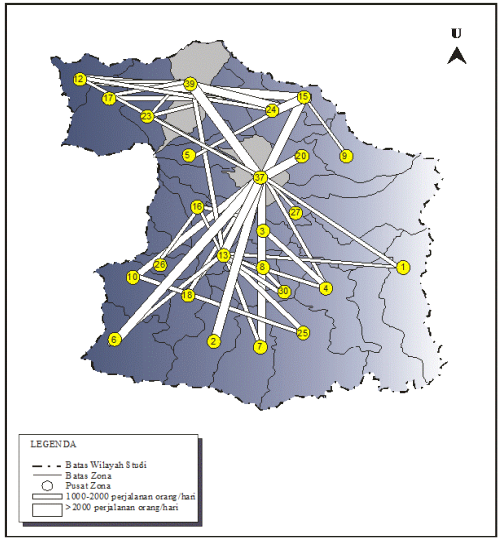

Fig.13. Gordon lines of travel demand

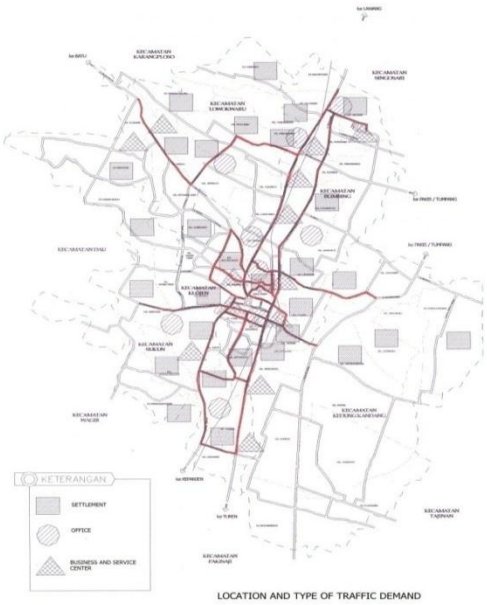

Fig.14. Location and type of travel demand

4.2. Travel Characteristic for resident in the suburb

Passenger Characteristic

An investigation, which was conducted by distribution of 351 questionnaires in 9 locations at CBD revealed the preferences. The passengers who have to travel every day from the suburbs (housing areas) to the city centre have some unique characteristics.51% are male (20-29 years of age), the highest proportion in profession as private employers (57%), with graduation from senior high school (54.13%), mostly have income about 500,000–1,000,000 Rupiahs (41.60%), holding driving license (47.01%), and up to 72% of them own a private vehicle (car or motor cycle). From passenger characteristics, it means that most users who live in the suburb need transport mode more flexible like motor cycle.

Trip Characteristic

Most travellers from the suburb residents that are going to the city centre have on average a travel distance of 5.1 – 7.5 km (33.62%).The purpose for travel is mainly for work (72.36%), the average travel time is 15 – 30 minutes (38.46%), the average travel cost per day is 2,000–4,000 (52.42%).The majority carry luggage 54.13%, and most travel alone with no one accompanying them during the travel (57.55%).

The travel distance, time and costs are essential variables in determining the choice of transport mode to the city center. Since the distance to travel is more than 5 km, most employers travel coming from periphery of city by motor cycle which needs 0.5-1 liter gasoline.

Factor Influencing Transport Mode Choice

From the questionnaires, it is found that there are three factors affecting respondents to choose among the transportation mode options, as follows: mode availability, travel time, and travel cost, with influential factors 40.17%, 24.79%, and 14.53% respectively.

Thus, the proportions of transportation mode chosen from the revealed preference survey are motorcycle (47.29%), para-transit (32.19%), private car (16.52%), and taxi (3.99%) respectively.

Transportation mode availability is the most determining factor in the choice of transport mode because of the flexibility due to activity time and trip route.

From survey also reveals that passengers need 18.4 minutes (motor cycle), 21.3 minutes (car), 32.6 minutes (paratransit), and 18.5 minutes (taxi). The travel costs are approximately Rp.1, 947 (motor cycle), Rp 10,846 (car), Rp. 2,246 (paratransit), Rp.24, 444 (taxi)

respectively for the travel distance of 5-7 km from the suburban area to the city center.

4.3. Model of Transport Mode Choice

To develop the model for the transport mode choice, it is necessary to analyse the passengers' travel behaviour. The analysis of the questionnaires that were distributed is done by using Nominal Logistic Regression analysis. From this analysis it is possible to known the degree of importance of the factors, which influence the choice of transport mode. Each respondent was asked about variables which influence choosing transport mode for their trip. The 351 samples were used to obtain a relationship between the transport mode choice and explanatory variables.

The variables are of socio economic characteristics, transport chacteristics, and transport mode characteristics. From the statistical test, it can be revealed that the variables, which affect transportation mode choice are trip length, travel time, and travel cost.

Total cost has minimum effect in terms of the choice of transportation mode, because consumer will choose transportation mode, which has the minimum cost for traveling at a certain time and for a certain distance. Concerning the distance, consumers will choose paratransit or public transportation rather than others if the distance is great. People who travel for a certain distance will choose transportation mode affected by the total km of distance traveled.

From analysis of multinomial logic model, it is suggested that the variables influencing the choice of transportation mode, such as travel time, cost and distance for worker going to the city center are very important. Probabilities in terms of the choice of transportation mode are 49.9% using motor cycle, 36.5% choosing public transportation, 12% driving car, and 1.7% choosing taxi respectively.

Since paratransit as a representation of public transport lays in the second priority of transportation mode choice, the public transit facilities in Malang City must be well-planned in order to fulfill passenger' needs. The arrangement of public transit facilities must consider distance, time and cost spent by the commuters. The public transit must cover the residents' needs living in the suburb, which are far from the city center, to encourage residents to alter from private vehicle to public transit. The result is in line with the government's plan to provide for the new public transit alternative. Public transit service quality improvement is expected to magnetize the commuters from suburban areas to the city center. Therefore, this can reduce the usage of private vehicle and minimize the congestion on the gateway roads.

From analysis of the arrangements for mass transport in the Great Malang (commuter train project) information is obtained regarding people who routinely travel to the city center. About 72 % don't have private vehicles, and as a consequence, they always use public transport (paratransit). This is because the travel costs for using paratransit is low. With improving the public transport service quality through the reduction of travel cost and travel time which will be the results of the implementation of the BRT plan. While reducing travel time is conducted from saving time of waiting time. The saving time with the assumption that the bus waiting time is about 5 minutes at each terminal would be about 10 minutes (for North to South route), 15 minutes (for North to South East route), 15 minutes (for North west to South route), 20 minutes (for North west to South East route), 20 minutes (for North west to East route), 20 minutes (for East to South route), 25 minutes (for East to South East route) in sequence. The differences of waiting time is caused by the fact that the paratransit arrangements for loading passenger up to 10-12 passengers that exceeds its capacity (8 passengers).

The semi-BRT plan is expected to accommodate the passengers' demand. By conducting stated preference survey, the travel cost attribute was found to be the main factor of influence in transport mode choice. The utility functions of transport modes choice is $\mathbf{U_{(paratransit\text{-}bus)} = -0.059 + 0.001\,\Delta\,travel\ cost.}$ Furthermore, the prediction of the bus passenger altering from para-transit to semi-BRT is as follows: Lawang-Malang-Kepanjenroute approximately 89.1% within assumption Rp 7,500 of bus ticket; Lawang-Malang-Dampit route 75 % (within Rp 9,500 of bus ticket), Batu-Malang-Kepanjen route 99 % (within Rp 4,500 of bus ticket), Batu-Malang-Dampit route 89.1% (within Rp 9,500 of bus ticket), Tumpang-Malang-Kepanjen route 99 % (within Rp 4,000 of bus ticket), Tumpang-Malang-Dampit route 83.2 % (within Rp 9,000 of bus ticket), Batu-Malang-Tumpang route 52.5 % (within Rp 6,500 of bus ticket).

From that model, it is assessed that the potential for number of bus passengers are 698 persons (for North to South route), 553 persons (for North to South East route), 570 passengers (for North west to South route), 303 passenger (for North west to South East route), 15 persons (for North west to East route), one person (for East to South route), 19 passengers (for East to South East).

The altering of passengers from paratransit and private vehicle (car and motorcycle) to semi-BRT transport will decrease the traffic volumes on the gateway roads with about 18%-19%. This condition will increase the road level of service, as shown in Table 2.

From Table 2, it is revealed that improving transportation mode facilities by arranging semi-BRT will decrease traffic volumes and improve the level of service (LoS) of the gateway roads to the city center. Most the gateway roads to the city center have better service level, except on Tumenggung Suryo, Panglima Sudirman, Gatot Subroto, Pasar Besar, and MT. Haryono. Since there are no improvements of the level of services of these roads due to the operational provisions for the semi BRT, as a consequence, there must be a plan to develop the geometry of the roads, in order to raise their capacity. Most of these roads are located on east side of city, which is overloaded by mixed traffic with combinations of light and heavy vehicles. Local government has prepared plans to build a new ring road on east side of city, the establishment of BRT has to be coordinated with and taken into account in the design of the new ring road plan as seen in Figure 15.

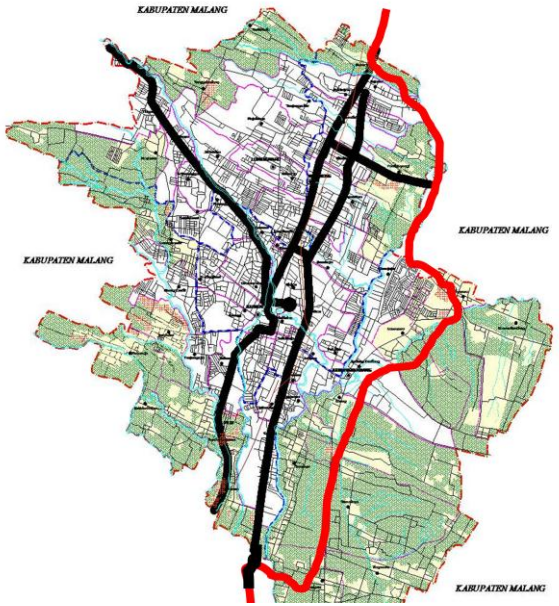

Fig.15. Eastern ring road plan

Table 2 Level of service (LOS) existing and with bus planning

No	Road	Capacity (pcu/hour)	volume (pcu/hr)	Decre-asing volume	LOS With bus	LOS of existing road
1	RadenIntan	5422	4012.98	3250.5	C	D
2	R.PanjiSuroso	3135	3018.6	2445.07	D	E
3	SunandarPriyo S	2794	2640.2	2138.4	C	E
4	*T. Suryo*	*3067*	*4074.25*	*3300.14*	*F*	*F*
5	*P. Sudirman*	*3339*	*4598.85*	*3725.07*	*F*	*F*
6	*GatotSubroto*	*3105*	*4518.23*	*3659.77*	*F*	*F*
7	Laks. Martadinata	3105	2771.35	2244.79	C	D
8	Sutoyo	5422	4719.25	3869.79	C	D
9	S. Parman	5422	4248.40	3483.69	C	D
10	BasukiRahmad	5080	4442.98	3598.81	C	D
11	Kauman	3681	3231.45	2649.79	C	D
12	AriefMargono	3101	2586.45	2095.02	C	D
13	*PasarBesar*	*2317*	*3409.9*	*2762.02*	*F*	*F*
14	Ade Irma	4824	871.83	714.9	A	A
15	B. Katamso	2158	1856.53	1503.79	C	D
16	Gajayana	1252	1396.43	1131.11	E	F
17	Ranugrati	2562	1092.20	884.68	B	C
18	M. Sungkono	1281	1061.03	859.43	C	D
19	A. Yani	5422	4137.68	3351.52	C	C
20	S. Supriadi	2208	2615.48	2118.54	E	F
21	*MT.Haryono*	*1874*	*3139.00*	*2542.59*	*F*	*F*
22	JA. Suprapto	5599	5108.40	4137.81	C	E
23	AdiSucipto	2158	1395.35	1144.19	B	C
24	Kol. Sugiono	2999	3184.15	2579.16	D	F
25	SatsuitTubun	2290	1936.08	1587.59	C	D

The new public transport provision (semi BRT) is expected to serve passengers from the main places (settlements)of travel demand to the city center, thus the residents are expected alter from private vehicles to the public transport mode. The altering commuters will reduce the traffic volumes on the gateway roads of Malang City. This will be one of the sustainability transportation concept applied in Greater Malang, to minimize the consequence of urban sprawl in the Malang City.

4.4. Sustainable Index assessing from resident travel behaviour in the suburb

Based on responses to the questionnaires which are distributed to residents in the suburb sit will be possible to obtain their knowledge about the travel behavior. The questionnaires consist of 30 questions about the residents' travel characteristics, satisfaction index and the residents' willingness to pay for transport infrastructure and for the improved mode facilities.

From the survey, the residents in the suburbs have high mobility in their travel to the city center due to vehicle ownership. They have minimum one motor cycle, or 2 motor cycles, or a car and a motor cycle. They travel alone or together with their children for different activities such as for working or/and going to school and for shopping.

The measurements of travel time and travel cost is needed to assess the residents travel benefit from the different settlements of city to the city center of each type of transport means. Another assessment that is done by approaching the issue of residents' preferences in terms of the willingness to pay for their travel and their satisfaction level serves the purpose to interpret transport mode service quality as explained in Table 3.

Note : MC=motor cycle, PT= public transport, SI= sustainable index, WTP= willingness to pay, SL=Satisfaction Level

From table 3 it can be concluded that housing areas in east and south side of city has bad accessibility in terms of each type of transport mode. This means that there is a need for improved devices to allow new housing development in the certain areas. New settlements with the existing highway network in south side of city can be developed, on the other hand, in the east and north areas of city there should be controlled and protected new settlements. It is also required to build a new ring road. In the other side of the city, in the western areas, new settlements can be developed combined with the improvement of the highway network as seen in Figure 15.

	Transport Benefit from travel time			Transport Benefit from travel cost				WTP			SI		
Area	MC	Car	PT	MC	Car	PT	SL	MC	Car	PT	MC	Car	PT
East	1,696	1,935	2,106	2,800	6,750	5,000	0.76	2,650	5,000	3,000	2.25	2.30	3.14
South	970	1,070	1,524	3,500	5,437	3,750	0.78	2,986	3,437	2,875	1.91	2.42	2.34
West	1,332	1,432	2,369	3,062	4,500	3,750	0.78	2,281	3,500	2,500	2.46	2.16	3.12
North	3,377	3,659	4,735	2,500	3,375	2,500	0.80	1,875	2,500	1,750	**3.92**	**3.52**	**5.17**

This assessment has been useful to establish sustainable travel options for residents in the periphery of the city in order to point out transport benefits and to find out the preference of the inhabitants and to understand their travel behaviors. This index is expected to provide guidelines for planning urban transportation particularly in relation to the expanding new settlements in the periphery, while optimizing the local government budget.

4. Analysis of a User-Friendly Transport Mode for Malang Municipality Transport

SWOT

In order to analyze user-friendly public transport, it is also necessary to assess the integrated approach based on SWOT analysis (Strength, Weakness, Opportunities, and Threats). The SWOT analysis cast light on the most important characteristics of the area.

i. Strength

– This project will be supported by the Regional Authority (East Java Province) and the Department of Municipality Planning and Developing Bureau, the Department of Transportation, and the Local Government for surrounding cities (Greater Malang (Batu, and Malang municipality, and Malang District to establish the result of the project to facilitate public transport for Greater Malang

– Passengers (70%) of the existing public transport agreed with the planning of BRT, and the potential for altering to BRT is more than 50% of each one of the routes.

– There are two projects which support the BRT plan namely the new ring road plan on the east side of city (main priority) and west side (second priority)

ii. Weakness

- This project needs much attention and participation from many stakeholders, especially passengers and residents from the suburbs.
- Contradictory opinions between drivers and owners of the existing public transport facilities in terms of the establishing BRT, which may reduce their income and overlapping their routes.

- The driver and owner of the existing public transport facilities disagree with BRT planning (< 30%)
- Need for partnership with private sector companies to implement BRT

iii. Opportunity

- This project needs coordination with others: the Regional and Local Government, the Department of Highway, the Transportation, the Department of Housing and Infrastructure, the Department of Tax, Environment, Land, Spatial Planning Department
- The finance to establish BRT is supported by East Java Province budget
- Dissemination is needed to promote BRT
- There is a coordination among the drivers and owners of the existing public transportation as well as prospective investors
- Linkage between: Land Use Planning and the Improvement Sustainable Public Transport, Housing and Public Transportation Development, Rural and Urban Transport System, Intercity and Intra city travel

iv. Threats

– The result of the sustainable index must be updated, if there are improvements and changes of infrastructure and mode of transport.

5. Achievement of BRT Plan of Malang Municipality

This project will be implemented in three periods 2010-2015-2020 with the establishment of several alternative routes (two routes: Lawang – Malang – Kepanjen (north to south, north-east-south), one route: Lawang – Malang – Dampit (north to south east), one route:Batu – Malang – Kepanjen (west east to south)) as shown in Figure 16. To implement this plan, there is a need for intense coordination and dissemination of the BRT planning. Today the achievements include, that the local government tries to reduce additions of the existing public transportation. The other effort related to BRT plan, establishing pedestrian facilities, and bus stop places for BRT will be done. Nowadays, there is a continual workshop for the coordination of BRT planning among Regional Authority (East Java Province), Municipality planning and Developing Bureau, Department of Transportation, Local Government for closest city, (Greater Malang (Batu, and Malang Municipality, and Malang District).

The further achievements is expected to provide for agreements in terms of the control of new housing development related to and coordinated with the transport network plan, Enforcement of the Legislation for New Housing Development, establishing an impact assessment procedure for traffic and environment, introducing a traffic impact fee which is imposed to housing developers.

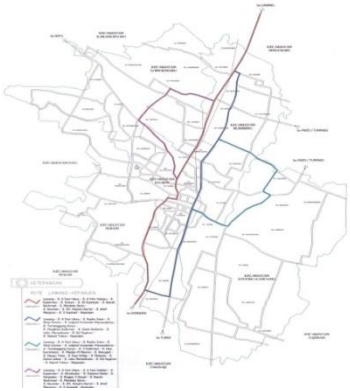

Fig.16. Routes and prototype of BRT

6. Conclusion

- Establish alternative routes for BRT as follows two routes: Lawang – Malang – Kepanjen (north to south, north-east-south), one route : Lawang – Malang – Dampit (north to south east), one route : Batu – Malang – Kepanjen (west east to south)
- Establishing a linkage route between intercity and intra city travel
- Linkage route between the existing public transport as a feeder system for the BRT routes
- Residents on east and north side experience the worst situation and by using existing transport mode and lack sustainable transport solutions.
- By BRT plan, sustainable index for residents in the suburb hasn't assessed yet, it is needed dissemination about BRT plan to accommodate their intercity trip
- Requirement to concentrate housing development in the certain areas with considering the improvement of transport network.

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