

Analyzing Benefits of Urban Development and City Tourism with Light Rail Transit in Kaohsiung

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Abstract: *Rail transit is an important part of the urban public transportation and plays a decisive role in the public transportation system. Rail transit has an accuracy rate, high driving speed, and low power consumption. Light rail transit is a part of rail-way transportation running on the ground, carrying passengers to cruise in the city streets with the relaxed and non-pollution way. Light rail transit has four greatest perceived benefits which are reducing traffic congestion, reducing pollution, increasing property values and fostering economic development, and providing a means of transportation for the poor. Due to low construction costs and shorter construction period of light rail transit, Kaohsiung can quickly build a public transportation network with lower cost. Promoting the light rail transit construction and integrating mass rapid transit system to construct a public transportation network are the important goals of Kaohsiung. It can improve traffic, reduce pollution, and promote urban and tourism development.*

Keywords: *urban, public transportation system, light rail transit, mass rapid transit, tourism*

I. Introduction

Rail transit development has been recognized an effective investment way to enhance the attractiveness and competitiveness of public transportation for riders and drivers switch from driving to transit (Bhattacharjee, and Goetz, 2012; Cao, and Schoner, 2014). Rail transit is an important part of the urban public transportation and plays a decisive role in the public transportation system. Rail transit has an accuracy rate, high driving speed, and low power consumption. Many developed cities with mature of public transportation, such as Hong Kong, Singapore and Tokyo, have more than 80% public transportation usage during peak hours. Main part of usage is contributed by the rail transit.

It should be based on the overall road network developing whether the public transportation systems will grow or not. Before the public transportation network has not been developed, the citizen get used to move by car or scooter. The correct way to let the citizen transfer the moving way by car or scooter to public transportation is gradually establish a comprehensive road network and expand the scope of services by spreading the road network, connecting of the railway transportation and developing the transfer road network.

Light rail transit (LRT) is a part of rail-way transportation running on the ground, carrying passengers to cruise in the city streets with the relaxed and non-pollution way. At least 400 light rail transit systems have been developed all over around the world recently. There are light rail transit systems in many cities. Basically, we transmit the electricity of the light rail transit by using the traditional overhead line or the newer technology without the overhead line. It can keep the blue sky and the complete skyline of the city by using the way of not install the cables. Knowles, (1996) demonstrated that the case of Manchester (England) is worth mentioning as an example of a positive LRT successful experience because of its low fares, direct connections with the city center (lower In Vehicle Time) and high frequency of service. Mackett, and Edwards, (1998) indicated that LRT has lower operating costs than the bus due to greater capacity.

Kaohsiung City is a special municipality in Taiwan. It is by area at 2,951.85 km² and second most populous with a population of approximately 2.77 million. Kaohsiung Mass Rapid Transit (MRT) has red and orange line which have been completed for operation in 2008. However, due to a long-standing habit to use private transportation and inadequate public transportation facilities, public transportation system in Kaohsiung has lower usage.

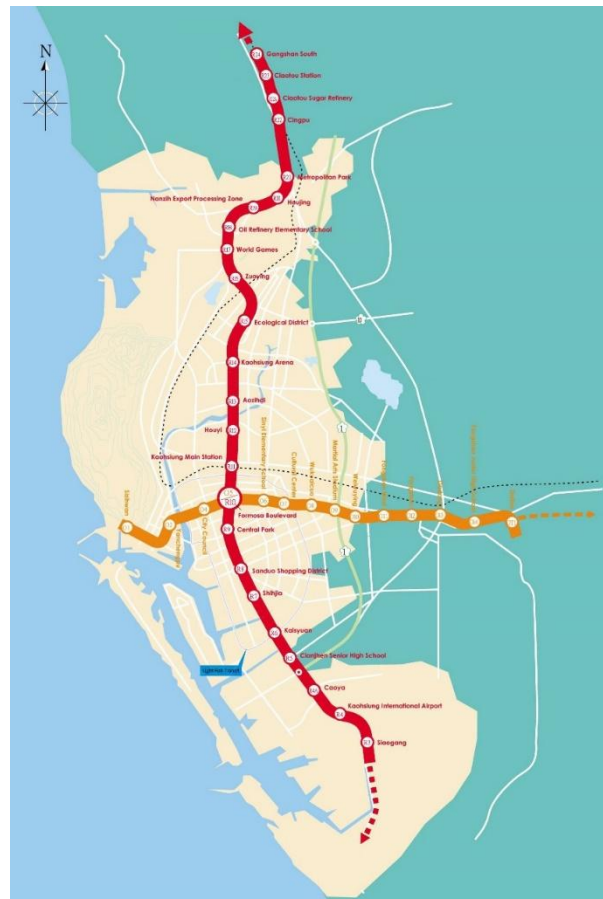


Figure 1 The Kaohsiung Mass Rapid Transit System

There are about 400 light rail transit systems. More than 30 light rail transit systems are on construction in the world. Light rail transit has four greatest perceived benefits which are reducing traffic congestion, reducing pollution, increasing property values and fostering economic development, and providing a means of transportation for the poor. Due to low construction costs and shorter construction period of light rail transit, Kaohsiung can quickly build a public transportation network with lower cost. Promoting the light rail transit construction and integrating MRT system to construct a public transportation network are the important goals of Kaohsiung. It can improve traffic, reduce pollution, and promote urban and tourism development.

II. Literature Review

Due to overgrowth of population and its accumulation in city centers, public transportation has become one of the most important infrastructural investments. The most efficient solutions to public transportation are MRT and LRT systems. Urban rail transit is a various types of local rail systems providing passenger service within and around urban or suburban areas. Hanson, and Giuliano, (2004) indicated that rail transit is often planned to supply good transit service and high transit demand. Litman, (2004) indicated that rail transit systems provide economic, social and environmental benefits to increase as a system expands and matures.

Over the past several decades, the rapid expansion in city suburbs and a more environmentally conscious public have led researchers to believe that light rail transit can help alleviate traffic congestion and pollution. Cervero, (1984) indicated that light rail transit is found to have substantial potential for shaping urban development. By comparison, a bus has a hard time operating efficiently with volumes greater than 6,000 passengers per hour, and 20,000 passengers per hour is considered the minimum hourly volume to warrant a rail rapid transit investment. In sum, then, light rail transit falls about midway between bus/trolley and rail rapid modes in terms of general operating features and carrying capacity (Gunduz, et al., 2011). Dell'Olio, et al., (2012) indicated that LRT is more efficient because it has shorter in-vehicle times than the bus as it uses its own reserved space and has right of way and the value for out-of-vehicle time is higher for the LRT users than for the bus users.

Over the last few decades, there has been an increase in the number of publications on LRT. Vuchic, (2005) indicated that LRT systems play a central role in urban economic development to improve the environment and promote people to focus on urban environment. Kim, et al., (2007) indicated that LRT has

increased in popularity due to its safety record, efficiency, high capacity and respect for the environment. Stokes, et al., (2008) discussed the potential role of light rail transit (LRT) systems for increasing exercise patterns and reducing obesity rates.

In this paper, we

III. Benefits Of Light Rail Transit (LRT)

Generally speaking, the Right-of-Way of public transportation system can divide into three types depends on the condition of using the traffic lane and the isolation level to other transportations. The three types of the Right-of-Way are as follows, Exclusive Right-of-Way, Reserved Right-of-Way and Shared Right-of-Way (Ben-Akiva, and Morikawa, 2002; Hensher, 2000; Gunnarsson, and Löfgren, 2001).

- **Exclusive right-of-way**

Exclusive right-of-way have its own space with physical barrier to prevent intrusion. It has priority in crossings and intersection and can hardly be bothered by congestion.

- **Reserved right-of-way**

Reserved right-of-way means that there is a specific space left in the street for the vehicle, but other traffic modes is able to use this space, such as when cars have to make a turn to the left, but there is no physical barrier to prevent intrusion on the tracks. There can be priority incrossings and intersections. This right-of-way can be, but it is rare, bothered by congestion and caught in traffic jams.

- **Shared right-of way**

Shared right-of way means that the rail going vehicle have to share the space with other traffic modes in the street, such as cars, bicycles and trucks. There is no priority at crossings and intersections, and can be caught in traffic jams and bothered by congestion as any other traffic mode.

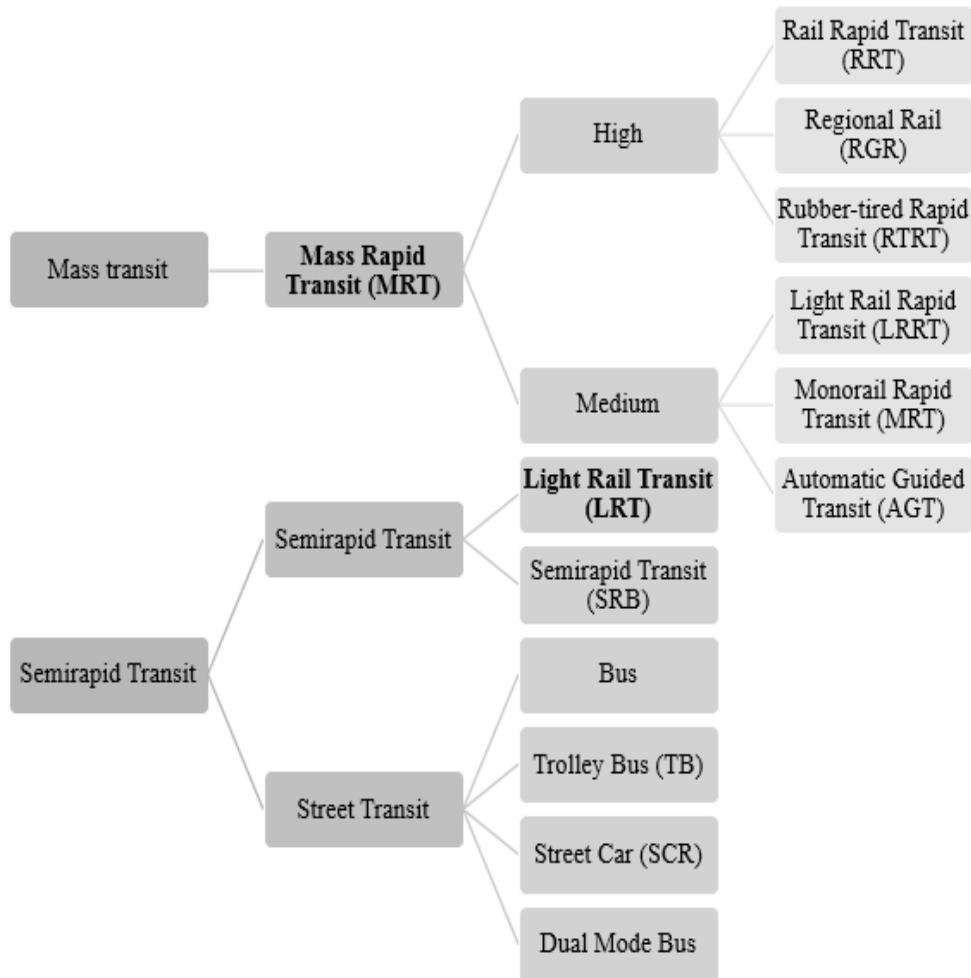


Figure 2 The category of public transportation system

LRT is one of the railway transportation systems. It is also the most flexible type of railway transportation in public transportation in downtown. In the early time, LRT is the Street Car or Tramway mixed with general road widespread in Europe. But the operating efficiency can't satisfy the demand in metropolis. Recently, with the growing science technology, LRT has developed into the characteristics of the bus and the traditional transit because its railway carriage is lighter, it can run in general road, the bridges or the streets with other transportations together. Because LRT has the big flexible in transit internal design, transit composition, construction types, control systems and the types of Right-of-Way and can design follow the local environment and demand characteristics, is regard as the extreme cost- effective and space-effective public transportation system (Boorse, 2001). On the other hand, the amount of traffic in the light rail transit is lower than the heavy rail, but higher than the ordinary bus or trolleybus, so we classify the light rail transit to the scope of the medium amount of traffic in the transportation system.

LRT has two most important characteristics. One is flexibility of ad hoc approach and another is possibility of growing and changing. In these two important properties, Barry, (1991) included seven characteristics of light rail transit:

- (1). It is a rail transit of urban public transportation systems
- (2). It is a flexible transit on the streets and can run at a smaller turning radius and the smaller slope
- (3). It is operated by the overhead-line which supplies electricity to transit
- (4). It is a simple transit system and usually has no gate of charging system, simply station
- (5). It is the use of modern high-volume transit vehicle
- (6). It does not share the right of way to other road users
- (7). It is also possible at high speed in the suburbs

Meyer, and Gomez-Ibanez, (1981) indicated that rail transit has the associated benefits of energy conservation and air quality improvements. Tennyson, (1982) indicated that sphere of influence of heavy rail transit might encompass a radius of 2,000 feet (three to four city blocks) or more, but light rail transit's seems to be somewhat less, perhaps one or two city blocks at most. Hurst, and West, (2014) indicated that proponents of LRT argue that it reduces vehicle dependency and emissions and induces land use change and urban redevelopment. By providing a travel alternative, light rail transit decreases transportation costs in areas close to stations, creating the incentive for households to locate near it.

LRT belongs to medium and low capacity transportation system. It applies to the scope of a one-way rail and 6,000 to 30,000 passengers in the peak hours. It can not only fulfill the gap between the bus and mass rapid transit, but also combine city renew and elevate the attractiveness of public transport. Compare to MRT, LRT has the following characteristics.

1. Low cost, Short construction period, Reduce the risk of MRT construction

It is easy to construct LRT system than MRT. Meanwhile, LRT build with less equipment and low cost. The construction cost of LRT is approximately 1/3 of MRT. Because of small investment and relatively short construction period, light rail transit system can avoid the risk of high cost in MRT construction and ensure the city sustainable development.

2. Flexible System, Strong adaptability in topography and environment

Light rail transit is flexible in train combination. It can be composed depending on local demand and also extra add different amount of trains according to the frequency of departure. It makes that light rail transit system has a wide scope of capacity. Light rail transit is good at climbing and turning around, so it can adapt to poor road conditions.

3. Beautiful, Comfortable, Environmental Protection

Most modern LRT used the design of low level boarding. The passengers get off very easy. It uses the technology of track less shake, the passengers will feel more comfort when sitting. Light rail transit uses large glass window, so it is good lighting in the train making passengers feel spacious and bright. Also, passengers can enjoy along the city landscape. The train built with the big amount of insulating material, silencer and other facilities. It can run with less noise. Light rail transit has the streamline train, beautiful color and unique style. We build the lawn track on the ground for light rail transit to create the feeling of "Green Space", becoming a beautiful landscape running inside the city.

Table 1/Public Transportation System (Zhang, 2009; Deng, and Nelson, 2011)

	MRT	LRT	Bus Rapid Transit (BRT)	Bus
capacity	High	Medium and Low	Medium and Low	Low
right-of-way	Exclusive right-of-way	Reserved right-of-way	Shared right-of way	Shared right-of way
cost	High	Medium	Medium and Low	Low
speed	High	Medium	Medium and Low	Low

IV. Urban Development And City Tourism in Kaohsiung

Kaohsiung is a functional city. Located in the southern part of Taiwan, Kaohsiung city is the Taiwan's largest industrial center. Due to the regulating effects of the marine climate, Kaohsiung is generally sunny and enjoys pleasant weather year-round. Known as "Taiwan's Maritime Capital," the city has worked hard in recent years to develop its tourism industry, including through beautification of the urban landscape.

In this research, we collected more than 1500 questionnaires to analyze the acceptable time, from departure to public transportation station and from public transportation station to destination, which people can accept. The result is shown as Figure 3.

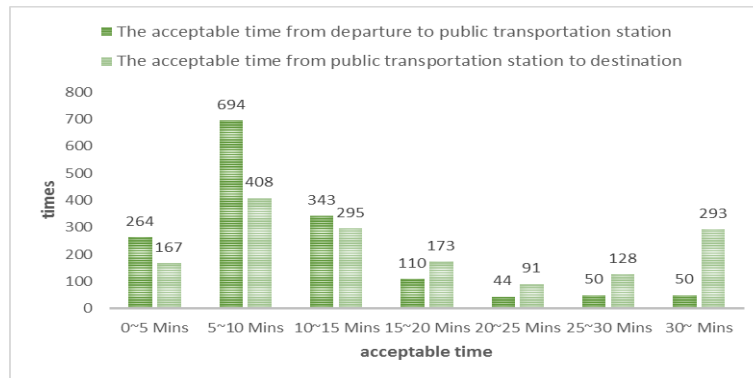


Figure 3 Behavior analysis on acceptable time

From figure 3 we can find that over 60% people can accept 15 minutes distance from public transportation location to departure or destination. It can be seen that the density of public transportation affect people using public transportation. According to Transportation Bureau, Kaohsiung City Government statistics, there are 2.77 million population with more than 200 million scooters and 86 hundred thousand cars in Kaohsiung. The average of a family with one car and two scooters. The percentage of individual transportation in Kaohsiung 83 %, indicating that the public transport isn't the main choice of people living in Kaohsiung. The two financial centers in the world, Hong Kong and Manhattan, 90% of Hong Kong people use public transportation while only 5% of New York people use their individual cars for commuting. The habits of people using public transportation in Kaohsiung should be improved.

Kaohsiung District road planning and completion of large neat checkerboard ring road system in Taiwan during Japanese rule, with the most complete road system. In checkerboard road network, based in Manhattan, New York City, approximately classes checkerboard road planning, extension built to be made, a wider road width, road width Kaohsiung are consistent. Checkerboard road planning, so that passers-by when selecting a different road to the end, the time required to spend not too much difference, and in addition to the larger outer lane main roads, secondary roads is almost the same width to each other, thus forming an effective shunt so not overly crowded roads. In this perfect road planning environment, the future will be towards diversification of Kaohsiung with public transport development.

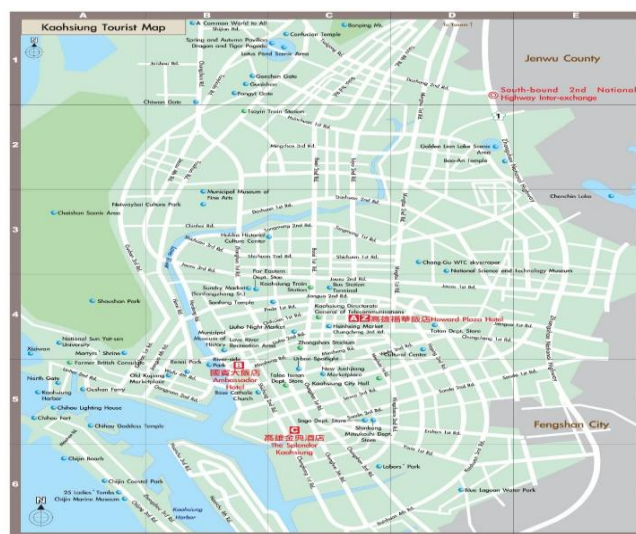


Figure 4 Kaohsiung Street Map

LRT is fast, convenient, friendly, punctual and high volume of freight. The construction cost is lower than the subway. LRT is the first choice for small and medium urban to be used to develop public transportation system. In addition, LRT is not just a means of transport, but also it has a huge impact for urban planning and development, social civilization and life.

- **change of population distribution**

The features of LRT are the large volume, speed, accuracy and comfort to shorten the distance and time. LRT can not only ease the traffic pressure of downtown and disperse population in downtown, but also shorten time from suburbs to downtown. With convenient LRT, people will no longer stay the city center and can live in the suburban which has good environment. The population density of downtown area will be reduced. More and more green space and gardens can be built in downtown and the environment will be improved.

- **influence of estate and business activities**

LRT changes the population distribution of city. At the same time, these places near the light rail transit station will bring about estate development and commercial development. Agglomeration effects on population and business are formed.

Economy of suburbs will be directly affected by downtown to change and enhance. The traffic problems are solved. And then, more and more people focus on the light rail transit station to live. Business opportunities will appear with these phenomenon. With increasing population density, the purchasing power will gradually increase. These places will become the new shop location.

- **promotion of social civilization**

Friendly facility is the characteristic of the LRT. High quality services and friendly facilities can meet the diverse transportation requirements. On the other hand, light rail transit must share the road resources with other vehicles. Therefore, city should develop a good traffic priority and implement public transportation policy. Constructing LRT systems can enhance the quality of public transportation services and promote public transportation and private transportation with a separate driveway. Public transportation, walking and cycling will become the core of urban traffic. This way can reduce people's dependence on private transportation and accomplish convenience, safety, environmental protection and people-orientation of society civilized environment.



Figure 5 The Kaohsiung Light Rapid Transit System

Kaohsiung located in southern-western Taiwan and facing the Taiwan Strait, it is by area at 2,951.85 km². There is a rich and diverse culture history, natural scenery, agricultural and fishing specialty and other characteristics of tourism resources. A complete and convenient transportation network with International Airport, MRT, LRT, seaports, highways, will have great potential development in tourism. Currently, Kaohsiung public transportation systems include long-range and short-range transportation for citizens and tourists with requirement to use. But for the convenience of tourists, it still needs to improve availability and frequency of public transportation network.

With the challenges of international tourism trends, Kaohsiung provides additional tourist attractions, promotes multiple leisure activities, integrates tourism resources, property, creates a friendly tourist environment, upgrades the tourism industry and expands the international tourism market, so that Kaohsiung has become everywhere sightseeing tour of choice of all.

Integrating Kaohsiung LRT system, MRT system and bus, will be important niche with the public transportation network and services to develop tourism of the city. Robust and convenient transportation system will attract more domestic and foreign individual travelers to Kaohsiung with depth experience tourism. Kaohsiung will develop into the core area of tourism in southern Taiwan.

Kaohsiung LRT is the world's first light rail line without the overhead line, is also Taiwan's first construction of LRT. LRT is connected not only to the major urban construction, but also with MRT to combine with attractions and shopping mall. Kaohsiung sightseeing will bound to drive transformation and innovation.

It is obvious that Kaohsiung dedicated in promoting green transportation. The road C-bike, Kaohsiung bicycle, has been 755 km. Meanwhile, there are 159 bicycle rental stations. CNN ranked it as the top 5 country that suitable for riding in Asia. Besides, there are electric buses, solar-powered boat and Taiwan's first light rail transit in Kaohsiung. We hope that we can increase citizens' willing for using green transportation by developing these traffic ecosystems.

V. Conclusion

Many countries advocate "right of way" campaign to aim at reducing accident of course. With rapid population growth, it is an issue of concern for most cities which is how to elastically use road area and raise awareness of the right of way.

The development of the city rail transportation requires not only the huge capital and a long time, also accompanies the risk of uncertain demand. We can't evaluate its reasonable only by economic benefit as the indicator. The development and evolution of public transportation system can regard as the symbol and the indicator of the modern city whether has competitiveness or not. To the view of society and environmental sustainability, long term planning rail construction is the permanent assets to the modern city.

First, light rail transit is the most efficient transportation system that can relieve traffic of city, reduce air pollution, improve environmental quality and promote the image of the city. Second, it can promote the development of related industries, satisfy the social and economic demand and promote the local industrial structure adjusted. Light rail transit builds 30 minutes living circle to satisfy the transportation requirement of citizen, increase social labor productivity and bring the energy to the city. Overall, light rail transit will bring the positive impact to the city, society, economic, landscape and the development in ecology. No doubt, it reaches the requirements of sustainable development in Kaohsiung.

LRT combines MRT that can effectively connect touring sites and shopping district. With the high-speed railway, Taiwan railway, bus and other transfer facilities, urban traffic road network will start to develop a clearer or certain form. The complete public transportation will promote activation and development of land, enhance economic development and promote the tourism opportunities. The result can be not only convenient for passengers, but also bring more effective solution to environmental pollution and reduce the traffic burden and shock.

Transportation is the key of economic and tourism development. Convenient and safe public transportation system can facilitate city development. Continuing to promote LRT and MRT construction and a more complete and convenient public transportation network can be in addition to drive urban development and construct a green modern city. There has a positive benefit for urban development, tourism development, tourism marketing and tourism quality.

MRT supports the core of Kaohsiung public transportation. LRT connects economic development in Bay Area. BRT upgrades service energy of public transportation. Bus offers low pollution and high-quality public transport services. In order to balanced regional development, Kaohsiung will be developed with the direction of various public transportations in the future.

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