臺中都會區捷運公車(TTJ)

策略研擬及績效評估

臺中市政府交通局交通規劃科

盧佳佳專員

（研究期間：100 年 3 月至 101 年 2 月）

中華民國 101 年 8 月 31 日

A benefit assessment of bus promoting project

(Taichung Transit Jet) in Taichung city

Chia-Chia Lu[1]

Abstract

It's no doubt that "trips" has been regarded as the most important index for assessing a bus promoting project for a long time. Sometimes, a large amount of trips are generated by a specific activity. It seems to be not related to energy saving and carbon emission reduction. Therefore, the objective of this study is creating a brand new concept to assess the benefit of a bus promoting project by analyzing the change of commuters.

Taichung Transit Jet project, executed in 2010, is the main research case for this study. By means of analyzing electronic transaction data before and after TTJ, the different commuters can be identified. According to the assumption of the behavior for different passengers, the population of commuter grew obviously. Through these approaches, the benefit of TTJ can be verified clearly.

[1] Executive Officer of Transportation Bureau, Taichung City Government。

1. Introduction

With the urban economy growing rapidly and the rising of social economy activities, it stimulates the possession of personal vehicles for the residents. Within the city limits of space in developing its public transportation system, the local authorities are putting efforts on developing a comprehension transport system that meets all kind of transport needs. And this has been the primary policy for the local government.

The Taichung Transit Jet (called for short “TTJ”) has been carried out by the Taichung municipal government since 2009 with a budget of two hundred million every year in order to improve the utilization of public transportation. It has been two years since the TTJ was executed, and the monthly volume of urban bus upgrade from 2.2 million people to 3.3 million people. In addition of the increase of bus volume, the Taichung municipal government considers that it’s necessary to have a further understanding on the population growth of public transportation before and after implementing the TTJ. However, it is hard to interpret the cause of the raise of trips merely based on the bus volume. It cannot be identified whether the increasing trips are contributed from rising of long-term commuter or non-routine bus users.

Since 2004, the Government has been promoting the bus electronic ticketing system, the monthly report of traffic data had been gathered on the grounds of electronic credit card usage instead of manually counting in terms of passenger trips. Therefore, it greatly reduces man-made discrepancy. However, the analysis of the bus volume still considers its passenger trips as an indicator in measurement.

Since the bus e-ticket has been implemented, it is able to record bus travel card number, card type, bus routes, boarding time, drop-off time, drop off location, transaction record on buses and off buses, and transfer of buses, etc. Normally an individual will possess one bus e-ticket card, thus each card is presumed as one bus user. The Government is committed to improve the population of public transport users according to the data of e-ticketing system. Furthermore, more data is gathered by dividing the bus users into different groups according to various trip features to help the Government to have a more comprehensive understanding of the use of public transportation. The data shows that the bus utilization rate in the urban areas is more than 70% with a high utilization rate of commuters of workers and students, and the information from the bus e-ticket users could be an index of the commuter population for the bus usage.

This study is the first analysis of the electronic ticket information screening the

population of commuters using public transportation. In addition to using the existing e-ticket screening analysis of the statistics of the number of bus user population, and further in accordance with different trip characteristics to analyze the situation of each group changes, to better understand the usage of public transportation in order to more effectively enhance the bus traffic, and also feedback on the future policy as references. For instance, 10 trips in one week may be contributed from the same person taking the bus two times a day in 5 days; it may also be five different people taking the bus two times a day each, the former represents commuter trips, and the latter represents a tourist (visitor) trip. And the information conveys a variety of meanings and views for the future bus policy. Assume that a bus route will pass through the school district; the needs of bus service from students will rise, so there will be a need to increase the bus service near the schools especially in the time when students go to schools and go home. On the other hand, increase the low floor bus service with a bus route passing through the residential areas with high density of elders would more effectively meet seniors' needs. All of these are advantages of in-depth analysis of bus commuter groups with different passenger features.

2. Introduction of the network planning of Taichung Transit Jet (TTJ)

On May 18th, 2009 the department of executive approved the construction plan of the Taichung MRT green line. Since then, there had been a debate on the future bus volume in which might lead to a revenue shortage and financial problems due to insufficient volume while operating. In order to increase the population of public transportation user, Taichung city government had been working on the program to improve the number of bus user since the year of 2009 with a budget of two hundred million NTD each year with a five-year period. Hoping that will stimulate existing bus users to transfer to MRT system users and this is the original of TTJ project was generated.

2.1 Program content

1. Open up seven routes at the same time to build a comprehensive road network.
2. The government cooperates with the transport company which wins the bid in the public tender. The government pays that transport company by monthly rental [rental is calculated as following: $38.883 (every kilometer per car) × total operating mileage, then minus the reduction in bus mileage that is caused by reduction in bus service.] transport companies sometimes are anxious about the operating loss that is caused by new open-up routes in the early stage, and are unwilling to give it a try on developing new bus lines. Fortunately, the municipal government is taking the responsibility of the risks and loss that might be generated in the early stage.
3. Free ride (passengers needed to use e-ticket to take the bus in 2009, cash was not acceptable on the bus, e-tickets could be purchased from the bus drivers on board. E-ticket just recorded trip information but was not charging credit. In 2010, passengers did not need to use e-ticket to take the bus.)
4. To raise the public's intention of taking TTJ, TTJ services the public with high-intensive bus service(bus service in every 10 minutes during rush hour, every 15 minutes during off-hour), and came in the promotion of free ride for one-day pass.
5. In 2009, it had been operated in the way of TTJ operating mode in which the TTJ stopped only at main bus stops. In every bus stops that TTJ had been to there were 『TTJ』signs on the bus stop poles as well as in the shelters. In 2010, the TTJ operated in the operating mode that stopped at every bus stop.

6. The TTJ long-term rental policy ensured the operating income for the transport companies and stimulated these companies to purchase new buses (low-floor buses).

7. The TTJ routes are similar with the bus routes in Taichung City center. When the contract expires, the original operating transport company has the priority to have the right of franchise of TTJ routes.

2.2 TTJ features

1. It creates a brand new version for buses

   ―Name and package: TTJ is also called 『TianTianZuo』(which sounds like "everyday bus" in Chinese) bus, for its simple and easy name, it injected new life into the buses.

   ―Identification of bus image: All buses were decorated on a unified outlook. They were colored according to the routes, enhanced bus identification, and created a brand new version of bus. The bus decoration also went along with the municipal marketing, and it was fully supported by the mayor. Refer to Figure 1.

   ―Overall marketing: Celebrity endorsement, which got more exposed to the public thus got more attentions from the public, and reinforced marketing.

2. Build a comprehensive route network

   ―In 2009, more lines were opened up, such as Yingcai-Shuangshi line (route 51), Zhongming-Jinhua line (route 52), Wenxin line (route 53), Liming line (route 54), Beitun-Guoguang line (route 55), and Wuquan line (route 56). In 2010, one more Chongde line (route 58) was opened up, and extended the route 51 to reach the Taiping area, as well as extended the route 55 to reach the Dali area.

3. Passengers must use their bus cards to board the bus, and this would collect information for the future review of operating performance and as a reference for the further route network planning and adjustment. (Passengers could not board the bus without using cards in 2009)

4. Draw straws: in order to stimulate more TTJ users as well as collect passengers' information as sample survey in the future. (One foldable bicycle valued $20,000 been given away as a drawing prize every day in the year of 2009, and two foldable bicycles valued $40,000 NTD each were given away every week in 2010.) And there were about 15,000 people signed up for being the members.

2.3 TTJ's operation

The road network of Taichung City urban planning was centered on Taichung Train Station, it was heading northwest in a radial shape with several ring-shape roads to make a road network. In the early time in Taichung City, the bus routes were concentrated in Beitun Road, Sanmin Road, Situn Road, Nantun Road, and Fuxing Road sections. These routes were centered on Taichung train station, and heading outward in a radial shape. Every transfer needs to be taken in the Taichung train station in order to reach another destination. In 2009, seven TTJ routes were opened up as shown in Figure 2. As you can see from the figure, there are four circles and three axes of bus lines to form the network. The circles include Yingcai-Shuangshi line (route 51), Zhongming-Jinhua line (route 52), Wenxin line (route 53), Liming line (route 54), Beitun-Guoguang line (route 55), Wuquan line (route 56), and Taichung Port line (route 57). After the TTJ has been built, there was an overall network for the Taichung city bus network.

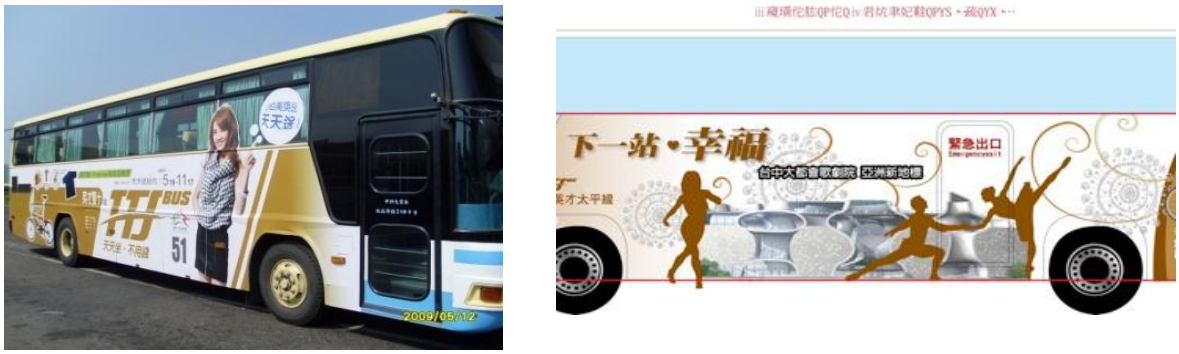

Figure 1 TTJ visual schematic diagram on 2009 and 2010

Figure 2 TTJ route network on 2009 and 2010

In 2009, the seven TTJ buses leave from the bus station every 15 minutes from 6 a.m. to 10 p.m. And the TTJ buses only stop at main bus stops in which there are [TTJ] signs in the bus shelters and on bus stop poles. There were even free rides in the early stage in order to increase TTJ users. The Taichung city government cooperated with the transport company which was chosen from the public tender. The transport company takes advantages in such operating mode, because it does not to risk the operating loss. This will also enhance the punctuality of the bus service.

In 2010, the TTJ network had changed the [Shuangshi-Yingcai] line into [Yingai-Taiping] line and extended the line to reach Taiping area. The [Beitun-Guoguang] line (route 55) was extended to the Dali area, and it was renamed [Beitun-Dali] line. [Chongde Line] which is route 58 was opened up as well. The route 57 [Taichung Port line] and route52 [Zhongming-Jinhua] line were changed into the normal city bus lines.

Bus service for the six TTJ routes was increased in 2010. Buses leave the station every 10 minutes during the rush hours, and 15 minutes during off-hour from 6 a.m. to 10 p.m. Responding to the demand from the public, the TTJ began to stop at every bus stop.

2.4 Introduction of TTJ overall performance

From the Table 1 and Figure 3, we can review the monthly city bus volume in Taichung city for the last five years. As you can see from the table, the average monthly volume in 2006 is about 1.4 million, 1.52 million in 2007 (120 thousands more people than in the previous year), 1.8 million in 2008 (280 thousands more trips than in the previous year), 2.2 million in 2009 (400 thousands more people than in the previous year, and 2.89 million in 2010 (690 thousands more people than in 2009).

There were no major polices in the year of 2006 and 2007, the average monthly growth number of passengers was about 130 thousands of people. As a consequence of raise in fuel price, the average monthly growth number of passengers was about 280 thousands of people in the second half of year 2008.

The average monthly growth number of passengers was about 400 thousands of people in 2009 and 690 thousands in 2010. It can be seen clearly that the average monthly growth numbers of passengers in 2009 and 2010 were greatly more than in 2007 and 2008. And this was assumed as the outcome of the TTJ program.

Table 1　Monthly trip volume of Taichung city bus (including TTJ)

unit：10K trips

year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Average	monthly growth
2006	112	112	139	135	141	133	132	142	152	157	154	168	140	
2007	148	120	163	148	156	146	135	153	153	157	165	182	152	13
2008	164	139	173	168	180	165	168	195	181	209	205	219	181	28
2009	185	195	217	199	212	206	224	223	234	246	238	263	220	40
2010	255	217	291	291	301	278	292	299	291	324	303	330	289	69
2011	309	296	388	379									343	54

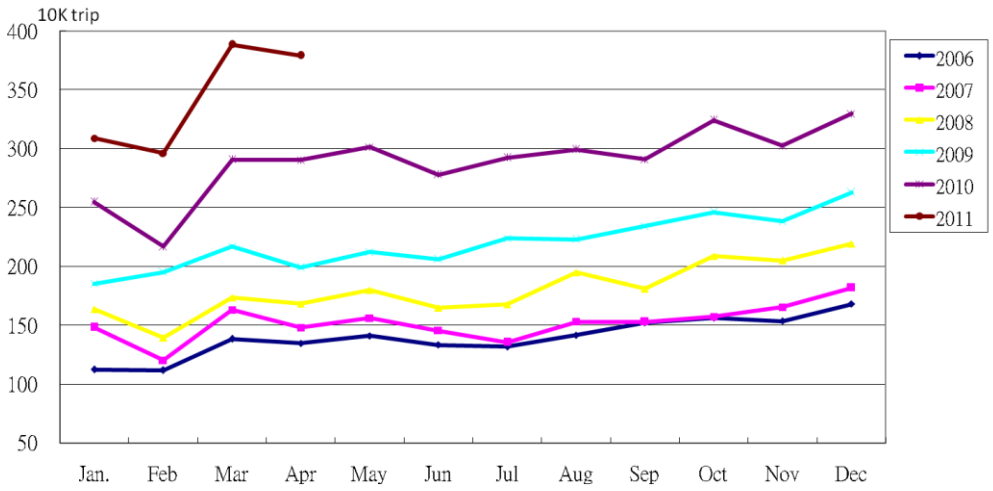

Figure 3　A variation diagram of monthly trip volumn on Taichung city bus (including TTJ)

For analysis, we divided the bus monthly volume into two parts, one is the “TTJ volume” and another is the “City bus volume (not included TTJ volume)”. Before the TTJ was implemented (April 2009), the monthly volume was 1.99 million trips, and it reached to 3.3 million of people after the TTJ had been put into practice (December 2010), which showed a great increase in volume. As in the Figure 4, it shows the growth of volume within Taichung city bus and TTJ. It also shows that there were a huge increase in TTJ volume during the implementation of TTJ, but there were no significant growth in the volume of other city transports. Thus we can presume that the increase in TTJ volume might come from a better service and adequate routes that TTJ offered. And this attracted more new bus user.

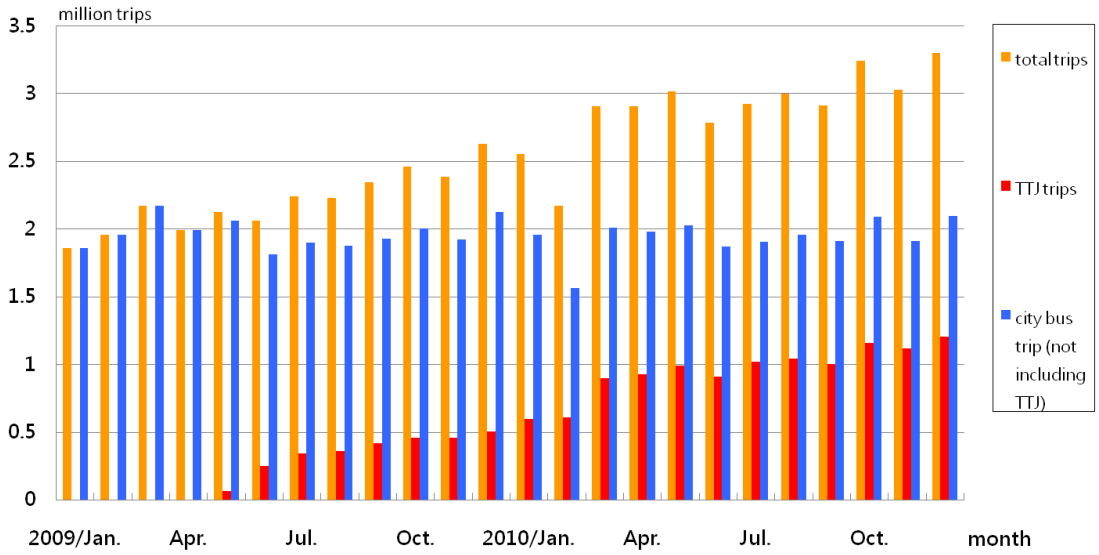

Figure 4 The growth diagram of Taichung city bus and TTJ

3. Research method

In order to have a comprehensive understanding in the effect on the bus population that TTJ had conducted before and after implementation. This research studied the information that was collected through e-ticketing system, and each e-ticket is presumed as one bus user. It analyzed the growth of general trips, commuters and students who take bus in some particular routes respectively. The analysis method was shown in Figure 5

3.1 The scope of the route research.

For instance, the city bus route 88 in Taichung city which departures from the Tung Hai University travels through Taichung Port Road to Taichung train station, as well as through Shuangshi Road and end in Yizhong shopping district. The operating mileage of this bus which travels in Taichung Port Road (through Tung Hai University to Taichung Train Station) is about 13 kilometers, and the mileage through Taichung Train Station to Yizhong shopping district is about 5 kilometers, the sum of these two trips takes 28% in the total mileage. The traffic volume within the trip between Taichung Train Station and Yizhong shopping district has 33 percentage points (this number could be higher) of the total volume. This shows the traffic within the Taichung Train Station and the Yizhong shopping district has contributed more in the traffic volume of route 88 than in the trip between Tung Hai University and Taichung Train Station. Therefore, it is inadequate to assess the bus volume in Taichung Port Road just by the bus volume of route 88; it has to be evaluated through different bus routes which are divided by different regional features.

TTJ network was throughout Taichung city, it even got deeper into some townships and villages near by the Taichung County. In order to obtain a better analysis, we chose some roads that would favor our research and were also commonly used by the local people.

3.2 Study period

In order to understand and analyze the changes before and after the TTJ implementation, we used the e-ticket information which was collected one month before and after the implementation. We referred to some months which have similar number of days, and were not affected by the summer or winter vacation. We also considered the changes of volume that occurred in each month. To have a contrast, we gathered e-ticket information that was

collected from two different months before and after the TTJ implementation as well.

3.3 Analysis steps on passenger population

3.3.1Analysis of full-price ticket

The priority of promoting public transportation is to increase the population of commuters. Because they contribute a steady numbers of trips, and those trips are usually habitual. In another word, if we change a commuter from using his or her own vehicle to take the public transportation, it would benefit the traffic environment more than those seniors and travelers would do.

According to the e-ticket data gathered from January 1st to 16th in 2011, full-price tickets accounted for a 72.79 percentage of total tickets, seniors and disable accounted for 17.71%, school association accounted for 8.38%, and half-price ticket accounted for 1.12%.This research is analyzed on the base of full-ticket data.

3.3.2 Analysis of Bus users (trips more or equal to 15 times)

The analysis showed that there was a large portion of full-price passengers who appeared seldom in each month. This type of passengers showed up just once or twice in a researching month period, and they are considered as visitors or visitor trips. In order to have a better understanding on changes of the bus users in this route, we analyzed only the passengers who paid in full price and took bus more than 15 times per month. These types of passengers are considered as commuters.

3.3.3 Analysis of student commuters and regular commuters (8:40)

Student commuters and regular commuters usually take the bus as a routine. They have fixed pattern of behavior of taking the bus. When a passenger buys full-price ticket and takes the bus more than 15 times in a month during weekdays, and once got off the bus before 7:20 a.m. (for student commuters) or 8:40 a.m. (for regular commuters), that passenger is qualified for the research. Thus the student commuters and regular commuters can be identified.

3.3.4 Analysis of student commuters (7:20)

Passengers who get off the bus before 7:20 are defined as student commuters. And the population of student commuters was studied for a discussion of changes in population before and after the TTJ implementation.

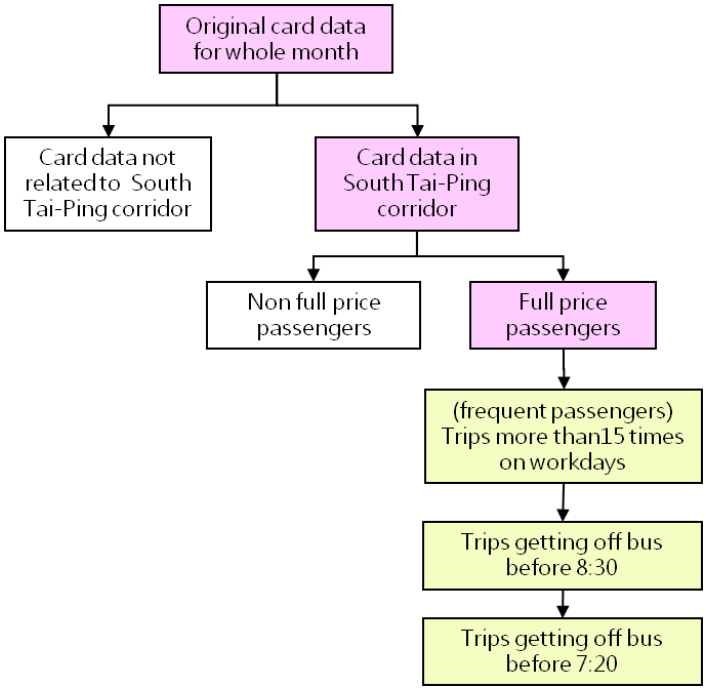

Figure 5 The research procedure diagram

4. The case study of TTJ-51 in Taiping line

4.1 Introduction of Taichung City

Taichung City is in the west of Taiwan, and it locates in longitude 120.58 E, latitude 24.17 N. And it had become a direct-controlled municipality since December 25th 2010. It has a land area of 2,215 km², with an average temperature of 23°C and annual rainfall of 1,700 mm. There are 8,507,431 households, and the population is about 2.56 million (according to the statistic in 2004). The average number of people in each household is 3.09 people, male population is about 1.32 million, the female is about 1.33 million, and the population of people who are more than 20 years old is about 1.99 million. The average annual income for each family is about 1.04 million (according to the statistic in 2009).

There are about 760 thousands of private vehicles and 1.7 million of motorbikes in Taichung city. In average, every household has 0.9 private vehicle and 1.99 motorbikes. Due to the excellent weather in Taichung, the utilization rate of private vehicles and motor is relatively high. As you can see from the Figure 6 (the comparison of public transportation utilization), the overall utilization rate of public transportation in Taiwan is 13.9%. The utilization rate of public transportation in Taichung is 6.8%, it is ranked as the7th high rate within other twenty cities national wide. The first six places are taken as following in order: Taipei City, Keelung City, New Taipei City, Taoyuan County, Hsinchu County, and Miaoli County. Refer to Figure 7.

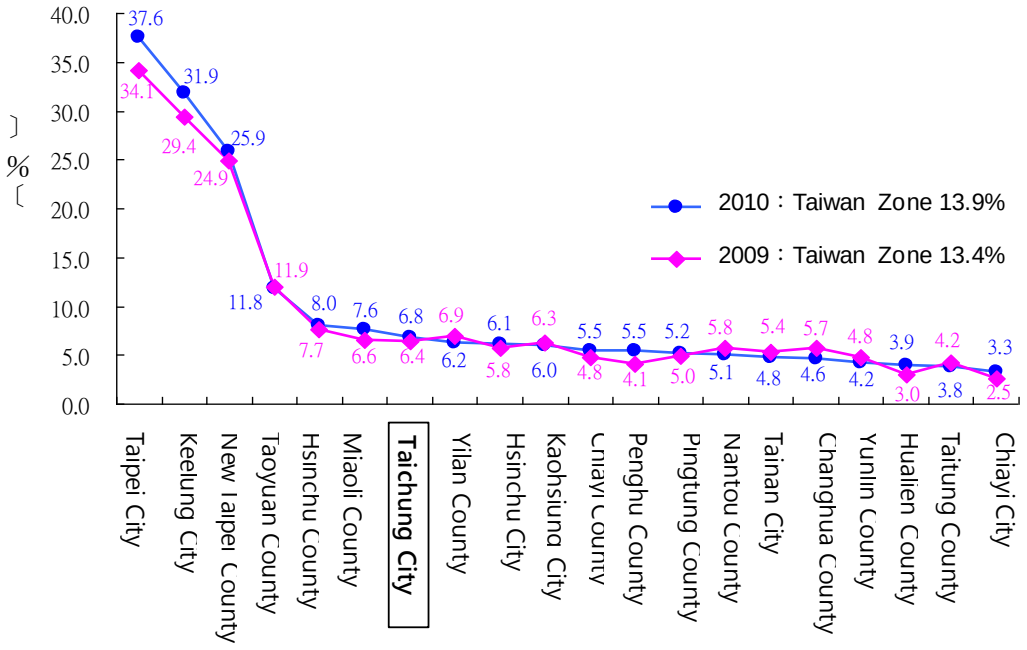

Figure 6 Comparison on utilization rate of public transportation between different zones in Taiwan

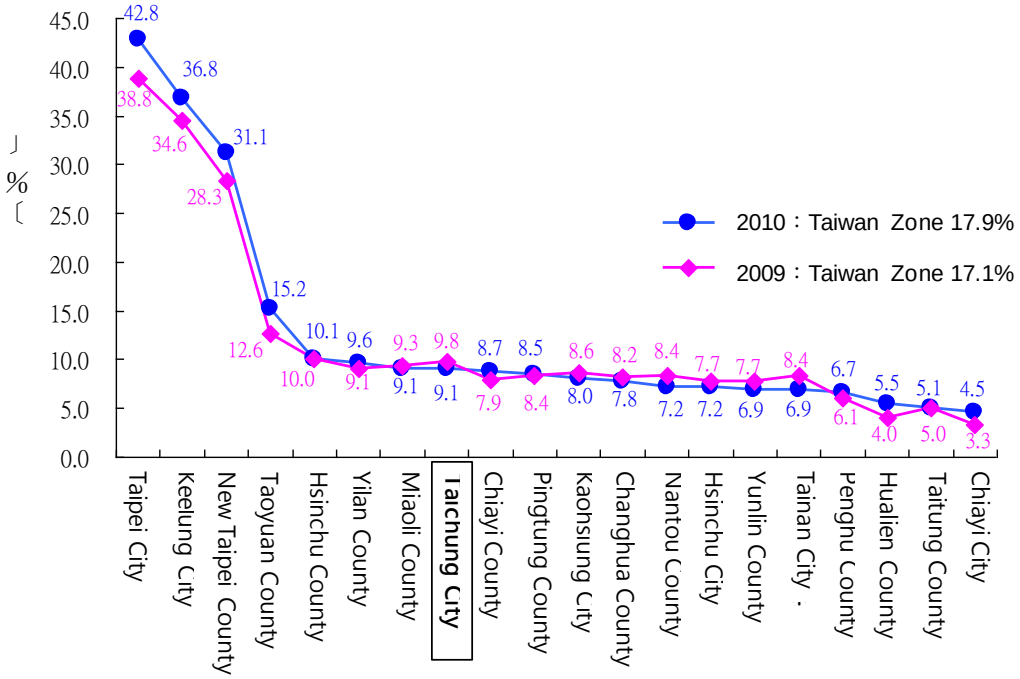

Figure 7 Comparison on utilization rate of public transportation for computers and students between different zones in Taiwan

4.2 Research in TTJ lines

The TTJ network is throughout the entire Taichung city, thus there are a variety of bus route alternatives for the public. For the purpose of analysis, TTJ lines should be divided into different sections according to their line features first.

The Taiping area is located nearby the southeast of Taichung city. It was Taiping County before and was one of the satellite towns in the old Taichung City. The population in Taiping area is about 190 thousands. There were just two major arteries, which were Zhongshan Road (North of Taiping) and Zhongxing East Road (South of Taiping) being connected to the Taichung city. The network was very simple at that time. Before the TTJ-51 had been extended to reach the Taiping are, the southern Taiping line had been operated by Fengyuan Transport Companyoffering five bus routes services. They are route 6510 [Taichung-Taiping-Canding], route 6512 [Taichung-Zhuzikeng], route 6513 [Taichung-Taiping- Maopu], route 6514 [Taichung – Taiping – Bat Cave], and route 6517 [Taichung – Taiping – Dongping community]. The route 6512 leaves the station every 10～15 minutes during rush hours and every 15-20 during off-hour. There are about 73 buses services to serve the public every day for these five routes.

In 2010, the route of TTJ-51 was extended to reach the Taiping area. The total operating line is about 16.5 km. The operating hour is from 6 a.m. to 10 p.m., and the bus departures every 10 minutes during the rush hours, 15 minutes during the off-hour. There are 74 buses to serve daily. Heading West of Taichung train station, TTJ-51 mainly drives through Yingcai road and Linsen road. And it serves mainly around Yizhong shopping area, the Cultural Center, and Taichung train station. Passengers might be from the north or west of Taichung. Heading East of Taichung train station, the TTJ mainly go through the Taichung road, Zhengxing road, Taiping road, Zhongxing East road, Qingyi University, and the Art and Culture Center. It serves as the main access from the southern Taiping to Taichung.

The scope of this research is shown as in Figure 8. The road section which is in the eastern of the Taichung train station was analyzed in this research. We analyzed trips that were heading east from Taichung train station in route 51 as well as the trips in those five routes mentioned in last paragraph. They are studied to help us understand the increase of commuters before and after the implementation of TTJ.

The features of the road section which is located in the eastern of the Taichung train station:

1. This section of road is the main artery for the residents in southern Taiping to get into

Taichung city and there is no other alternative road. Thus this road is very independent from the other roads.

2. Before the implementation of TTJ, there were five bus routes operating in this road section. They were all within the scope of this research.

3. The five bus routes were operated by the same transport company. Data of bus trips in these routes was collected completely, thus could be an adequate reference for the analysis of the TTJ implementation before and after. The overlap proportion of TTJ-51 and the five original bus routes is over 30%.However; TTJ had raised twice the bus service in the southern Taiping road section since it joined together with the bus operating.

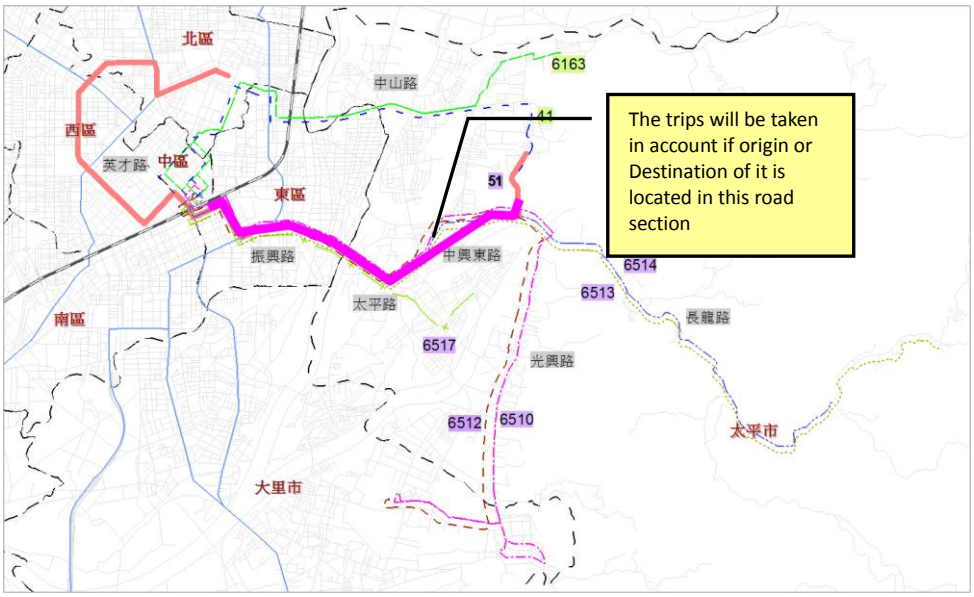

Figure 8 Original bus routes in south Tai-Ping corridor and TTJ-51 network

4.3 Research months

Since January 1st 2010, the route TTJ-51 had been extended to the southern Taiping area, and was through the Qingyi University and the North Art and Culture Center. The free ride policy was put over in the end of year 2010. Since 2011, TTJ-51 began to operate as a city transport route and charge the bus fee. Due to the passengers did not need to use the card to board the bus in 2010, the bus card usage rate is just 10%. Thus the data of bus card usage in 2010 was not used in this research.

March 2009, December 2009 and March 2011 are the three studied months in this research. The comparison of March 2009 and December 2009 is a contrast analysis for the nature growth of bus users in a condition of no any policies is implemented.

The research takes the whole month in December 2009 and March 2011 data of e-ticket as a base of analysis. It is because March and December are in the mid-term of the semester, and it is not either during the summer vacation or winter vacation, as the vacations or holidays might affect the bus volume. There were 9 holidays and 20 workdays in the month of March in 2009; there were 8 holidays and 23 workdays in the month of December in 2009; and there were 8 holidays and 23 workdays in March in 2011. The numbers of workdays in these months are pretty similar.

Due to the bus monthly volume is easily affected by different months. Without any major policies are implemented, the monthly bus volume is growing regularly in Taichung city. The analysis shows that the average monthly volume grew by 130 thousands of people each year. December had the peak volume of the year.

Table 2 shows the growth in March and December in Taichung city bus volume. It illustrates that there was 19% more bus volume in December than in March in the past six years. The bus volume in December had a similar volume number as in March of the next year, and this is an increase that resulted from the TTJ.

Table 2 Comparison on the growth of Taichung city bus trip volume on March and December for recent years.

year	Mar (10K trips)	Dec (10K	Dec,this year/ Mar,this year	Dec,next year/ Mar,this year
2006	139	168	1.21	0.97
2007	163	182	1.12	0.95
2008	173	219	1.26	0.99
2009	217	263	1.21	1.11
2010	291	330	1.13	1.18
100年	388			
average			1.19	1.04

4.4 Analysis of total trips of TTJ-51 in southern Taiping road section before and after the implementation

As you can see from the Table 3, there were only five bus routes in southern Taiping road section in March 2009, and total volume at this time was 41,715 people (included e-ticket and cash trips). In December 2009, the total trips in this section were up to 58,000

people. This section has an average monthly growth of 4.34 %[(58000-41715)/ 41715/ 9months], without any policies were executed.

Since route TTJ-51 had joined in the operation in January 2010, its volume grows regularly. In December 2010, the total trips within this section reached to 121,208 people, with an average monthly growth of 9.08 %[(121,208-58000)/ 58000/ 12 months]. In addition, there were about 73% (88612/ 121208) of trips generated through TTJ-51, and 27% (32596/ 121208) trips were through the five transport routes. Although there was a decrease in the transport volume of the five original bus routes, the route TTJ-51 had increased the monthly volume for the whole road section in southern Taiping road. Route TTJ-51 not only improved the bus service, but also provided more routes, and which increased the trip convenience and demands for TTJ users. It also benefits in expanding the bus market.

Since in March 2011, route TTJ-51 began to charge the bus fee. The total trips in this section in December 2010 were 121,208. And the total trips in this section were 101,697, which decreased by 16.10% [(101697-121208)/ 121208/ 1month]. About 64% of the 101,697 trips were generated by the route TTJ-51, and 36% (36957/ 101697) of the trips were due to the original five bus routes.

The southern Taiping road section had been charging its bus fare since 2011. It's assumed that the decline of a 16.10% of the 121,208 people in December 2010 was due to the sensitivity of changing in free ride. There is a conclusion that has been derived a 16.10 percent of loss trips due to free ride policy.

Table 3 Variation of bus trip volume in south Tai-Ping corridor before and after TTJ-51 implementation

Period	month	route	south Tai-Ping corridor trips		
			route trips	corridor trips	monthly growth
before TTJ	Mar,2009	five original bus	41,715	41,715	
	Dec,2009	five original bus	58,000	58,000	4.34%
TTJ period	Dec,2010	five original bus	32,596		
		TTJ-51	88,612		
		total trips		121,208	9.08%
after TTJ	Mar,2011	five original bus	36,957		
		TTJ-51	64,740		
		total trips		101,697	-16.10%

According to the analysis of OD in trips, the five original bus routes' OD points all located within southern Taiping road section. Route TTJ-51 extended to west to reach the

Yingcai road in western area and Wuquan road in the northern area. We separated the trips in TTJ-51 route into three categories, one is [Shuangshi-Yingcai section] that OD points are within Yingcai road or Wuquan road, another one is [Shuang- Taiping section] that OD points are within southern Taiping road section, and the last one is the [Yingcai-Taiping section] that one of the OD points is either in Yingcai road or in Wuquan road.

As shown in Table 4, the total trips volume of TTJ-51 route was 101,399 people in March 2011. In which, the [O-D all in Yingcai section] accounted for 36%, the [O-D all in Taiping section] accounted for 30%, and the [Yingcai-Taiping section] accounted for 34%. This means that the trips from southern Taiping area to Yingcai road are more than the trips with OD points all within southern Taiping area. This also illustrates that there are more than 50% of the trips were heading to Yingcai road. It proved that building a comprehensive network and routes that meet the public demand would greatly improve the bus volume rather than just increasing the bus service.

Table 4 Distribution of passengers' O-D on TTJ-51

month	route	route total trips			total
		O-D all in Yingcai section	O-D all in Taiping section	Yingcai-Taiping section	
Mar,2011	TTJ-51	36,659	30,161	34,579	101,399
	(百分比)	(36%)	(30%)	(34%)	(100%)

4.5 Analysis of bus user population of route TTJ-51 in Southern Taiping road section

4.5.1 The growth of bus users of route TTJ-51 in southern Taiping road section before TTJ implementation

To understand the distribution of public transportation population, each card represents as an individual user in this research. It analyzed the total bus-user population and the flow users according to the card numbers that were taken on board. Refer to Figure 9 for the population of bus users and its flow in this road section.

Before TTJ had been implemented, there were 3,529 people taking the bus in March 2009, and there were 4,191 people taking the bus in December 2009. 1,460 people of

these passengers had been recorded as taking the bus in March and December in 2009. And these passengers are assumed as fixed passengers.

There were 2,069 passengers had been recorded as taking the bus in March, but there were no records for them in December. And these passengers are assumed as loss passengers. There were 2,731 passengers not being recorded on board in March, but they were recorded on board in December. These passengers are assumed as new passengers.

Without any polices are executed, the population growth rate of bus user was about 18.76 %[(4191-3529)/ 3529]. And the average monthly growth rate was about 2%.

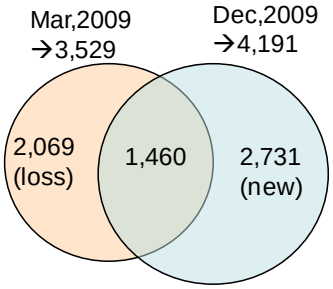

Figure 9 Variation of bus users before TTJ implementation in south Tai-Ping corridor

4.5.2 The growth of bus-user population of TTJ-51 in southern Taiping road section after TTJ joined in the operation

As the Figure 10 shows, after TTJ was executed, there were in total of 8,439 people taking the bus in March. And 1,528 of these people also had been recorded as on board before TTJ implementation. And these passengers are assumed as fixed passengers. Another 6,911 people of these passengers had not been recorded as on board before the implementation (December 2009), and they are assumed as new passengers.

After the TTJ-51 bus joined up with the southern Taiping bus operating, the growth rate of bus-user population is 101.36% [(8439-4191)/ 4191]. And the average monthly growth rate is about 6.76% which is more than the natural growth rate (2%).

The study separated the bus-user population into two parts. One refers to the TTJ-51 and another one refers to the original five bus routes. After the implementation of TTJ, there were once 6,028 using the route 51. And 919 people of these passengers had been recorded as on board before the TTJ implementation, and they are assumed as original

passengers. Thus the rest 5,109 people are new passengers after the TTJ implementation. As for the original passenger from the five bus routes, there were still 3,829 people taking the bus after TTJ had been executed. The 1,111 people of these people had been recorded as taking the bus before the TTJ implementation, and these people are assumed as original passengers. Thus the 2,718 people are the new passengers after the TTJ implementation.

According to the data from above, some passengers may choose to take route 51 or the original five buses, these passengers accounted for a 16.8 percentage [(6,028+3,829-8,439)/ 8,439]. The new passengers that are attracted by route 51 accounted for 84.8% [5109/ 6028]. And the new passengers that are generated from the five original bus routes accounted for 71% [2718/ 3829], this means the most passengers from route 51 are new passengers. And the percentage is clearly more than the percentage of the five original road buses.

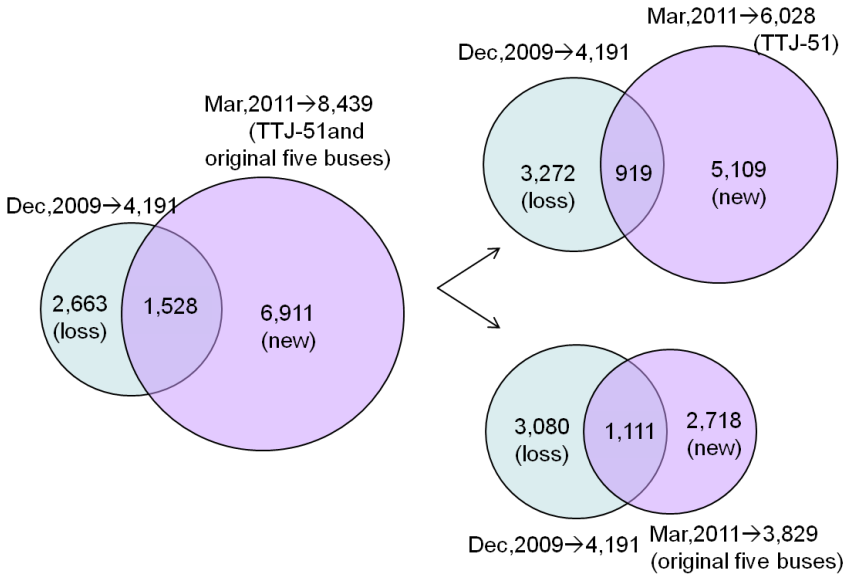

Figure 10 Variation of bus users after TTJ implementation in south Tai-Ping corridor

4.6 The analysis of full-price ticket population of TTJ-51 in southern Taiping road section before and after the implementation

According to the results of analyzing e-ticket data in December 2009, the population of full-price ticket accounted for 67.93% of the total passenger population. This research mainly studied on school commuters and normal commuters. This group of commuters belongs to the full-price ticket population. This group of people usually takes the bus

during weekdays. Thus the analysis is based on the data of bus card using during weekdays in March and December of 2009, and in March of 2011. We divided the bus card data into two terms: one is [the monthly frequency of card usage that is equal to 1 or more than 1 time (people that once took the bus)], another one is [the monthly frequency of card usage that is equal or more than 15 times (people who usually take the bus)].

4.6.1 The full-price ticket population growth of monthly frequency of card usage is equal or more than one time

As shown in Table 5, the full-price ticket population that once took the bus in this road section is 1,412 in March 2009 and it was 180 people in December. The growth rate during the nine months is 54.39% [(2180-1412)/ 1412]. Therefore, the average monthly growth rate is 6.04% (54.39%/ 9months) before the TTJ-51 had extended to this road section.

After the TTJ-51 had extended to reach the Taiping road section, the full-price ticket population of people once took the bus in March 2011 is 4,493 people. It grew by 106.10% [(4493-2180)/ 2180] compared with the growth in December 2009.The average monthly growth rate is 7.07%. This means the growth rate of full-price ticket population increased by 1.03% (7.07%-6.04%) after the TTJ implementation.

Table 5 Statistics of full price people before and after TTJ implementation in south Tai-Ping corridor (unit : people)

TTJ	month	full-price ticket population	growth rate	average monthly growth rate	growth rate of full-price ticket population increased
before	Mar,2009	1,412			
	Dec,2009	2,180	54.39%	6.04%	
after	Mar,2011	4,493	106.10%	7.07%	1.03%

For a further analysis on whether the full-price ticket passengers would continue to take the bus. We compared the e-ticket card number during two periods of time; March of 2009 and December of 2011 before and after the implementation. We also compared the e-ticket card number in March and December in 2009 as a contrast in the condition of

no TTJ implementation.

The result of analysis is as shown in Figure 11; there were a total of 1,412 full-ticket passengers taking bus during the weekdays in March 2009. The 886 people of these passengers did not continue taking the bus in December of 2009, and they are assumed as loss passengers, but there were 526 people still taking the bus. There were 1,654 people as new passengers in December 2009. In the condition of no TTJ was operated, the new passengers increased by 117.14% (1654/ 1412). After the TTJ was operated, the new passengers increased by 60.75 %(177.89%-117.14%).

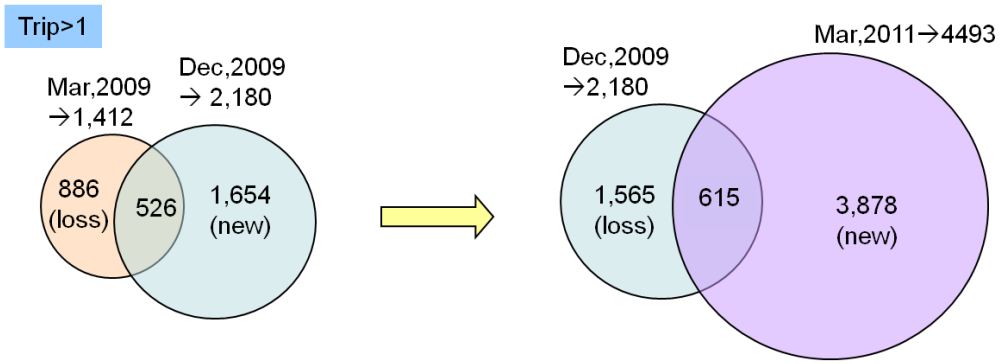

Figure 11 Variation of full price people before and after TTJ in south Tai-Ping corridor

4.6.2 The full-price ticket population growth of monthly frequency of card usage is equal or more than 15 times

Through analyzing for a whole month, we found out that there is a large portion of people who took the bus just one or two times. Therefore, the analysis of population growth would not be adequate unless it also studied the passengers of visitors and travelers who seldom take the bus. This research mainly studied the population of school commuters and normal commuters. This group of people has a higher frequency of using the bus per month. Moreover, we analyzed trips that occurred only during the weekdays, and the passengers who took the bus more than 15 times per month.

As the Table 6 shows that the full-price ticket population who took the bus more than 15 times per month in March 2009 is 243 people and 372 people in December in the same year. The population grew by 53.09% [(372-243)/ 243] within nine months, and the average monthly growth rate is 5.90%.

Since route TTJ-51 had extended to the Taiping road section, the full-price ticket population is 961 people in March 2011, which increased by 158.33% [(961-372)/ 372]

compared with the population in December 2009. The average monthly growth rate is 10.56%. This illustrates that the full-price ticket population growth (of people who used the bus card more than 15 times) increased by 4.66% [10.56%-5.90%] before the implementation.

Table 6 Statistics of full price people taking bus more than 15 times per month before and after TTJ implementation in south Tai-Ping corridor(unit:people)

TTJ	month	full-price ticket population	growth rate	average monthly growth rate	growth rate of full-price ticket population increased
before	Mar,2009	243			
	Dec,2009	372	53.09%	5.90%	
after	Mar,2011	961	158.33%	10.56%	4.66%

For further review, we analyzed the flow of full-price ticket passengers during the weekdays in March 2009; the result is as shown in Figure 12. The full-price ticket population of people who took the bus more than 15 times in March 2009 is 243 people. And 109 people of these passengers did not continue taking the bus in December 2009, they are assumed as loss passengers, but the other 134 people were still taking the bus. There were 238 passengers that showed up in December 2009 but did not show up in March, they are assumed as new passengers. Therefore, the new passengers increased by 97.94% [238/ 243] without TTJ operating. And it increased by 214.52% [798/ 372] after the TTJ had been executed. In another word, the new passengers increased by 116.57% [214.52%-97.94%] after the TTJ implementation. The growth rate of full-price ticket population of people who took the bus more than 15 times is clearly more than those who took the bus more than once. (116.57% > 60.57%).

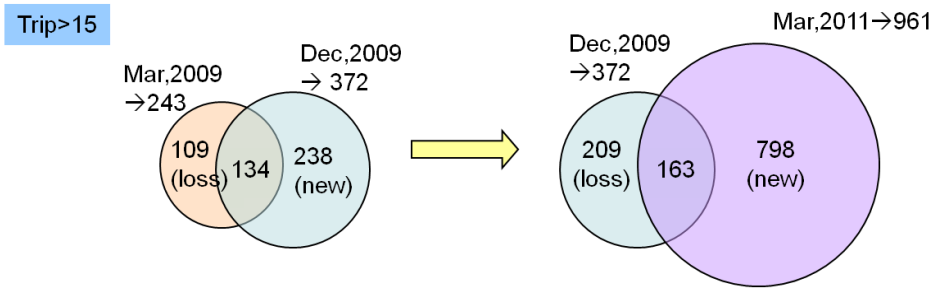

Figure 12 Variation of full price people taking bus more than 15 times before and after TTJ implementation in south Tai-Ping corridor

4.7 The analysis of normal commuters and school commuters of TTJ-51 in southern Taiping road section before and after the TTJ implementation. (Get off the bus before 8:40 a.m.)

Normally, most companies start work before 9 a.m. This research analyzed the characteristics of those commuters. We assumed that people got off the bus before 8:40 a.m. during the weekdays. We allowed a margin of twenty minutes as the time for people to walk to the office or prepare for work.

Trips occurred during the peak hours in the morning were usually contributed by people who go to work or school. In this section, we analyzed full-price ticket trips which had been recorded before 8:40 a.m. during the weekdays. And we divided the trips into two categories for analyzing; one is [the monthly frequency of card usage is equal to or more than one time (people that once took the bus)], and [the monthly frequency of card usage is equal to or more than 15 times (people that often took the bus).

4.7.1 The study of the full-price ticket population growth that was once got off the bus before 8:40

The Table 7 shows that before the TTJ had extended this road section, there was a full-price ticket population of 355 people that had been recorded as they once got off the bus before 8:40 a.m. in this road section during weekdays in March of 2009. And in December of the same year, the population of this type of passengers was 459. The population increased by 29.30 %[(459-355)/ 355] in nine months, and the average monthly growth rate was 3.26%.

After the TTJ had been extended to the Taiping road section, the number of people (full-price ticket) that once got off the bus before 8:40 during the weekdays in March of 2011 is 1084. It increased by 136.17 %[(1084-459)/ 459] compared with the same nature of population in December of 2009. And the average monthly growth rate is 9.08%. This illustrates that the full-price ticket population growth rate increased by 5.82% [9.08%-3.26%] after the TTJ was operated.

Table 7 Statistics of full price people getting off bus before 8:40 at least once per month before and after TTJ implementation in south Tai-Ping corridor(unit:people)

TTJ	month	full-price ticket population	growth rate	average monthly growth rate	growth rate of full-price ticket population increased
before	Mar,2009	355			
	Dec,2009	459	29.30%	3.26%	
after	Mar,2011	1,084	136.17%	9.08%	5.82%

For a better understanding of the flow of full-price ticket passengers, the research analyzed in [original passengers],[new passengers] and [loss passengers]. As the result shown in Figure 13, there were 202 people (out of 355 people, who belong to full-price ticket population that once got off the bus before 8:40) did not take the bus in December of 2009, and these people are assumed as loss passengers. There were 306 people appeared in December of 2009 but not in March 2009, they are assumed as new passengers. Thus, the average growth of new commuters is 34 people per month [306/ 9months] in terms of no TTJ implementation. But after the TTJ implementation, the average growth of new passengers is 61.8 people per month [927 people/ 15 months]. And the average monthly growth rate of new passengers is 27.8 people (61.8-34).

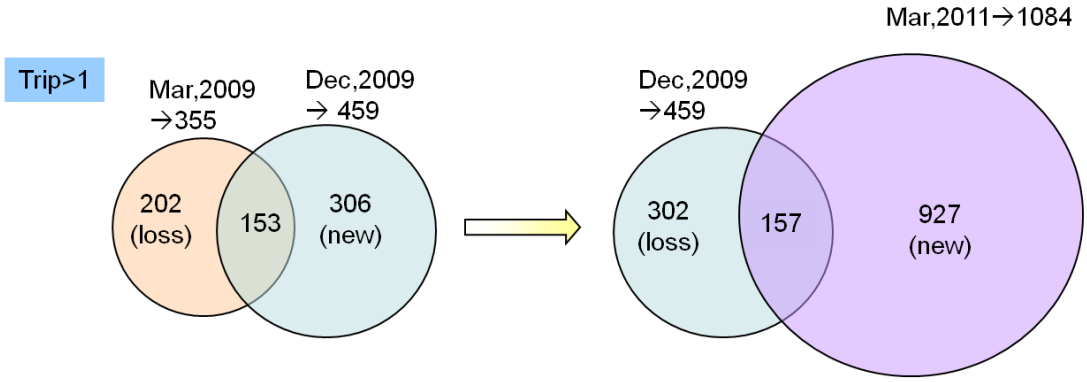

Figure 13 Variation of full price people getting off bus before 8:40 at least once per month before and after TTJ implementation in south Tai-Ping corridor(unit:people)

4.7.2 The study of full-price ticket population of people who used the card more than 15 times per month and one or more than one of the trips was occurred before 8:40

This research analyzed further in the full-price ticket passengers who had more than 15 trips during the weekdays per month, and they were recorded as getting off the bus before 8:40.

Before the route TTJ-51 had been extended to this road section, the number of passengers who took the bus more than 15 times and had been recorded as getting off the bus before 8:40 is 241 people in December of 2009. This number increased by 38.5% [(241-174)/ 174] compared with the number in March of 2009. It grew by 4.28% in average per month. After the route TTJ-51 was extended to reach the Taiping road section, the number of this type of passenger as described above is 594 people in March 2011. The average monthly growth rate is 9.76% [(594-241)/ 241 / 15 months], as shown in Table 8.

Table 8 Statistics of full price people getting off bus before 8:40 more than 15 times per month before and after TTJ implementation in south Tai-Ping corridor(unit:people)

TTJ	month	full-price ticket population	growth rate	average monthly growth rate	growth rate of full-price ticket population increased
before	Mar,2009	174			
	Dec,2009	241	38.51%	4.28%	
after	Mar,2011	594	146.47%	9.76%	5.49%

As analyzed in 「original passengers」,「new passengers」 and 「loss passengers」, the result is shown as in Figure 14. It shows that the population of full-price ticket passengers (who used the card more than 15 times during weekdays in March 2009, and once been recorded of getting off the bus before 8:40) is 174 people. And there were 85 people of this population assumed as loss passengers. In December of 2009, 152 people were new passengers. This illustrates that without TTJ being executed, the new commuters (normal and school commuters) increased by 16.9 [152/ 9months] people in average per month. And after executing TTJ, passengers (normal and school commuters) increased by 32.9 people [494/ 15 months] in average per month. This shows that the group of normal and school commuters grew substantially after TTJ was operated.

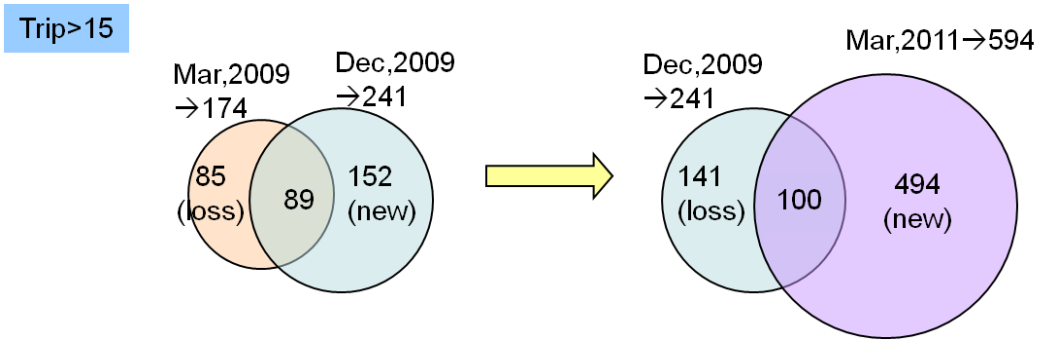

Figure 14 Variation of full price people getting off bus before 8:40 more than 15 times per month before and after TTJ implementation in south Tai-Ping corridor(unit:people)

The Figure 15 illustrates the number of people and trip times of full-price ticket passengers that once got off the bus before 8:40. The figure is based on three different periods of time: in March of 2009, and December of 2009 before TTJ implementation; and in March of 2011 after the TTJ implementation. From the figure we can see that there was an outstanding increase of 15～20 trips (contributed by normal commuters and school commuters) every month after the TTJ was executed. It reveals that the TTJ did actually have increased the commuter population. And the average monthly commute frequency in this road section is about 15～20 times.

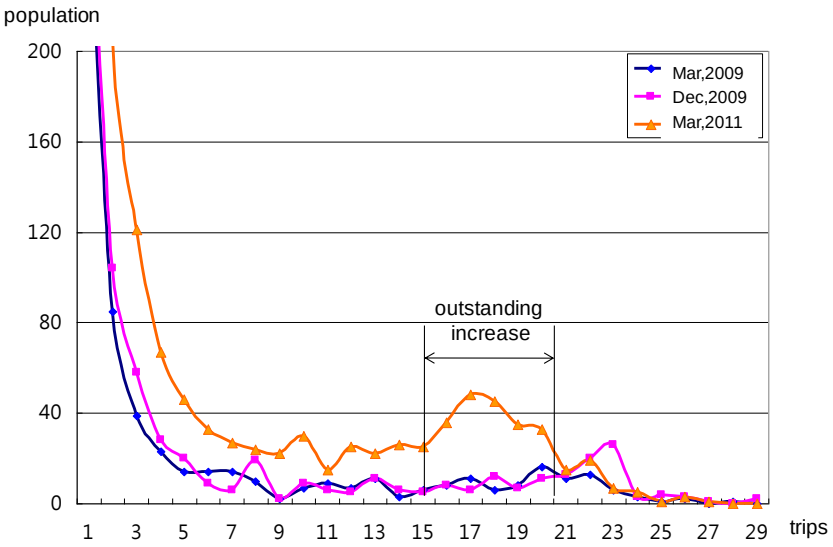

Figure 15 Comparison on the number of passengers getting off the bus before 8:40 between difference times (work day)

4.8 The analysis of school commuters' population of route TTJ-51 in Taiping road section before and after its implementation. (It refers to passenger who got off the bus before 7:20 a.m.)

Students are considered as the main passengers all the time. In this section, we assumed that passengers who got off the bus before 7:20 are students. In this section, it separated trips into two groups: [The monthly frequency of card using is more than 1 time (refers to passengers who once took the bus)], and [The monthly frequency of card using is more than 15 times (refers to passengers who often took the bus)]. In terms of these two groups, we analyzed the change in the number of TTJ users who got off the bus before 7:20 during weekdays for a full- price ticket.

4.8.1 The population growth of full-price ticket passengers who got off the bus before 7:20 more than once

What we studied in this section is the population statistics of full-price ticket passengers who got off the bus before 7:20 more than once in the southern Taiping road section before and after the TTJ implementation (Refer to Table 9). The chart shows that there was a full- price ticket population of 213 people that had been recorded as getting off the bus before 7:20, during weekdays in March of 2009. And there were 259 people of this type of passenger in December of the same year. The population grew by 21.6% [(259-213)/ 213] in nine months. And the average monthly population growth number is 5.1 people [(259-219)/9months]. After the TTJ-51 had been extended to the Taiping road section, the population grew by 121.62% [(574-259)/ 259] in 15 months, and the population grew by 21 people [(574-259) / 15 months] every month in average.

From a further analysis of the [original passengers], [new passengers] and [loss passengers], it shows that the average full-price ticket population growth of new passengers per month is 18.2 people [164 / 9months]. And after the TTJ was executed, the population increased by 31.9% [479/ 15 months] per month in average.

Table 9 Statistics of full price people getting off bus before 7:20 at least once per month before and after TTJ implementation in south Tai-Ping corridor(unit:people)

TTJ	month	full-price ticket population	growth rate	average monthly population growth number
before	Mar,2009	213		
	Dec,2009	259	21.60%	5.1
after	Mar,2011	574	121.62%	21

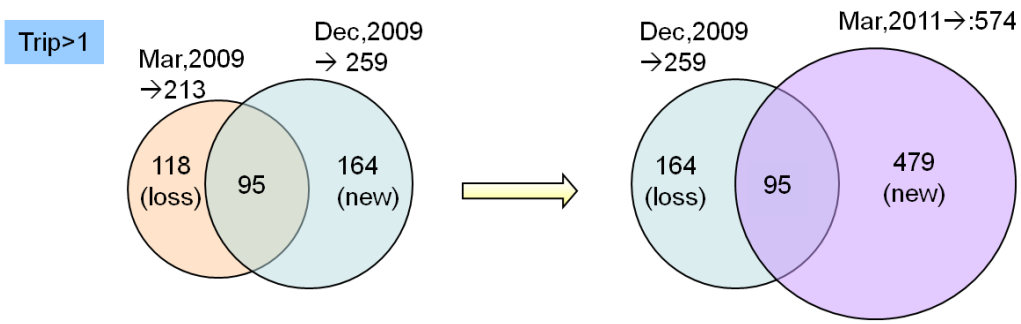

Figure 16 Variation of full price people getting off bus before 7:20 at least once per month before and after TTJ implementation in south Tai-Ping corridor(unit:people)

4.8.2 The population growth of full-price ticket passengers who got off the bus before 7:20 more than once and had used the card more than 15 times every month

In this section, we reviewed on the full-price ticket passengers who got off the bus before 7:20 more than once and had used the card more than 15 times every month (during the weekdays). As you can see from Table 10, the population of this type of passengers is 115 people in March and 154 in December of 2009 before the TTJ was extended to Taiping road section. The population grew by 33.91% [(154-115) /115] in nine months. And the average monthly growth rate is 3.77%.

After route TTJ-51 had been extended to the Taiping road section, the population of

full-price ticket passengers (who got off the bus before 7:20 more than once and had used the card more than 15 times every month) is 380 people. Compared it to the population of 154 people in December 2009, it increased by 146.75% [(380-154)/ 154]. And the average monthly growth rate is 9.78%. This indicates that the population of full-price ticket passengers (who got off the bus before 7:20 more than once and had used the card more than 15 times every month) increased by 6.02% [9.78%-3.77%] after the TTJ had been carried out.

Table 10 Statistics of full price people getting off bus before 7:20 more than 15 times per month before and after TTJ implementation in south Tai-Ping corridor

TTJ	month	full-price ticket population	growth rate	average monthly growth rate	growth rate of full-price ticket population increased
before	Mar,2009	115			
	Dec,2009	154	33.91%	3.77%	
after	Mar,2011	380	146.75%	9.78%	6.02%

In terms of reviewing on the [original passengers],[new passengers] and [loss passengers]. We found out that new passengers grew by 10.3 people [93people/ 9 months] in average per month without TTJ implementation. And after the TTJ had been implemented, the average growth of new passengers is 21.1 people [316/ 15months].

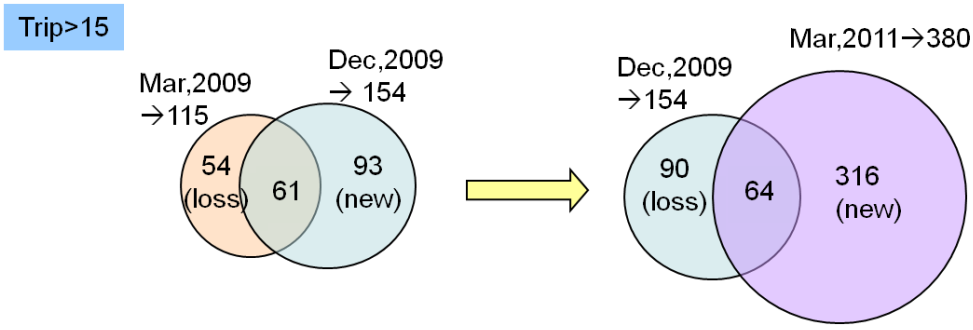

Figure 17 Variation of full price people getting off bus before 7:20 more than 15 times per month before and after TTJ implementation in south Tai-Ping corridor

We studied the full-price ticket population of passengers who had been recorded as getting off the bus before 7:20 during the weekdays (in March 2011) in terms of three periods of time (March and December of 2009 before TTJ was implemented; and March of 2011 after the TTJ was implemented). Figure 18 illustrates the number of trips and people that got off the bus before 7:20 in each month. We can see from the figure, that the population (of passengers who took the bus 15～20 times a month and got off the bus before 7:20) had increased obviously after the TTJ was carried out. It signifies that TTJ did actually help to increase the population of normal commuters and school commuters.

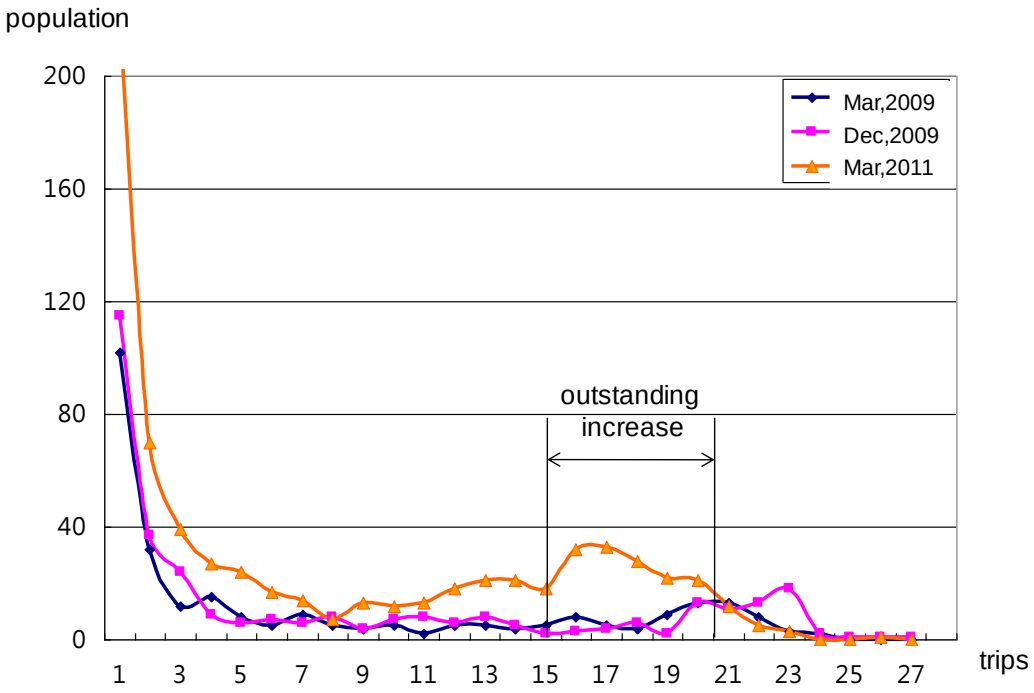

Figure 18 Comparison on the number of full-price passengers getting off bus before 8:40 in different times

4.9 The analysis of frequency of trips of TTJ-51 that contributed by different groups of people in Southern Taiping road section before and after the execution of TTJ

In this research, we reduced the scope of the passenger population gradually. We studied merely on four groups of people: 1. the full- price ticket passengers, 2. the commuters who took the bus more than 15 times per month, 3. the Commuters or school

commuters that once got off the bus before 8:40 a.m. and 4. the school commuters that once got off the bus before 7:20. The frequency of card using and the number of people of these four groups were analyzed as shown in Figure 19～21 before and after the TTJ implementation.

In March of 2009, before the route TTJ-51 had joined up with the Taiping road section operating, the group of passengers whose monthly trips frequency is between 19～23 has more population and trips than the other groups of passengers. (The group of commuters and school commuters who got off the bus before 8:40 a.m. is out of the consideration here.) As shown in the Figure 19, there was no obvious passenger group in the road section before the TTJ-51 was carried out in the southern Taiping road section.

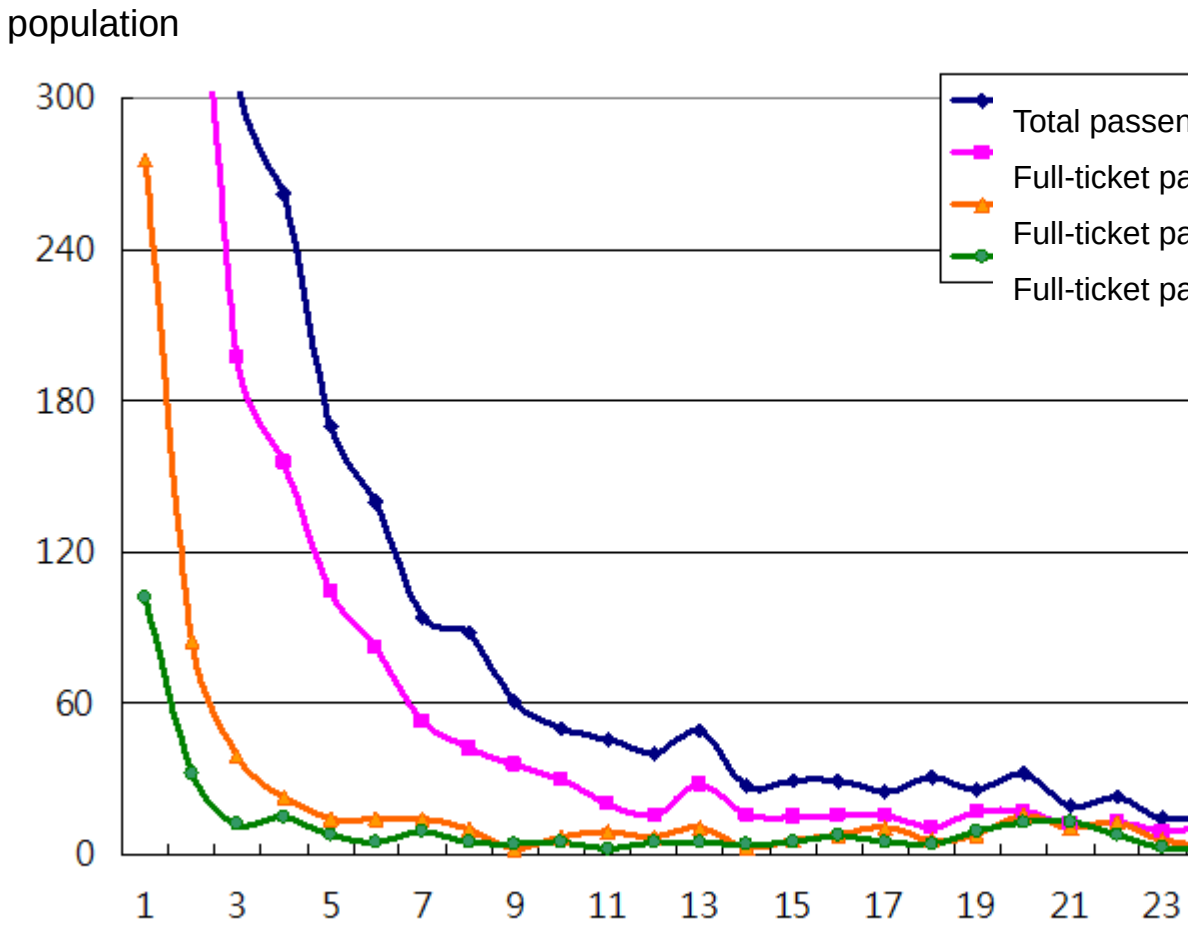

Figure 19 Comparison on different groups for the frequency of card using versus the

number of people on March 2009.

In December of 2009 (before the route TTJ-51 was operated in Southern Taiping road section), the number of trips and people of different groups performed steadily as in March 2009. Since the TTJ-51 had been operated in Southern Taiping road section, the number of people of different groups of passengers had increased. Moreover, the number of commuters and school commuters (who once got off the bus before 8:40) and the passengers (who got off the bus before 7:20 and took the bus for 15-21 times) increased obviously after the route TTJ-51 was operated in Southern Taiping road section in March 2011. It demonstrates that TTJ caused a higher growth rate in commuters and school commuters rather than in general passengers.

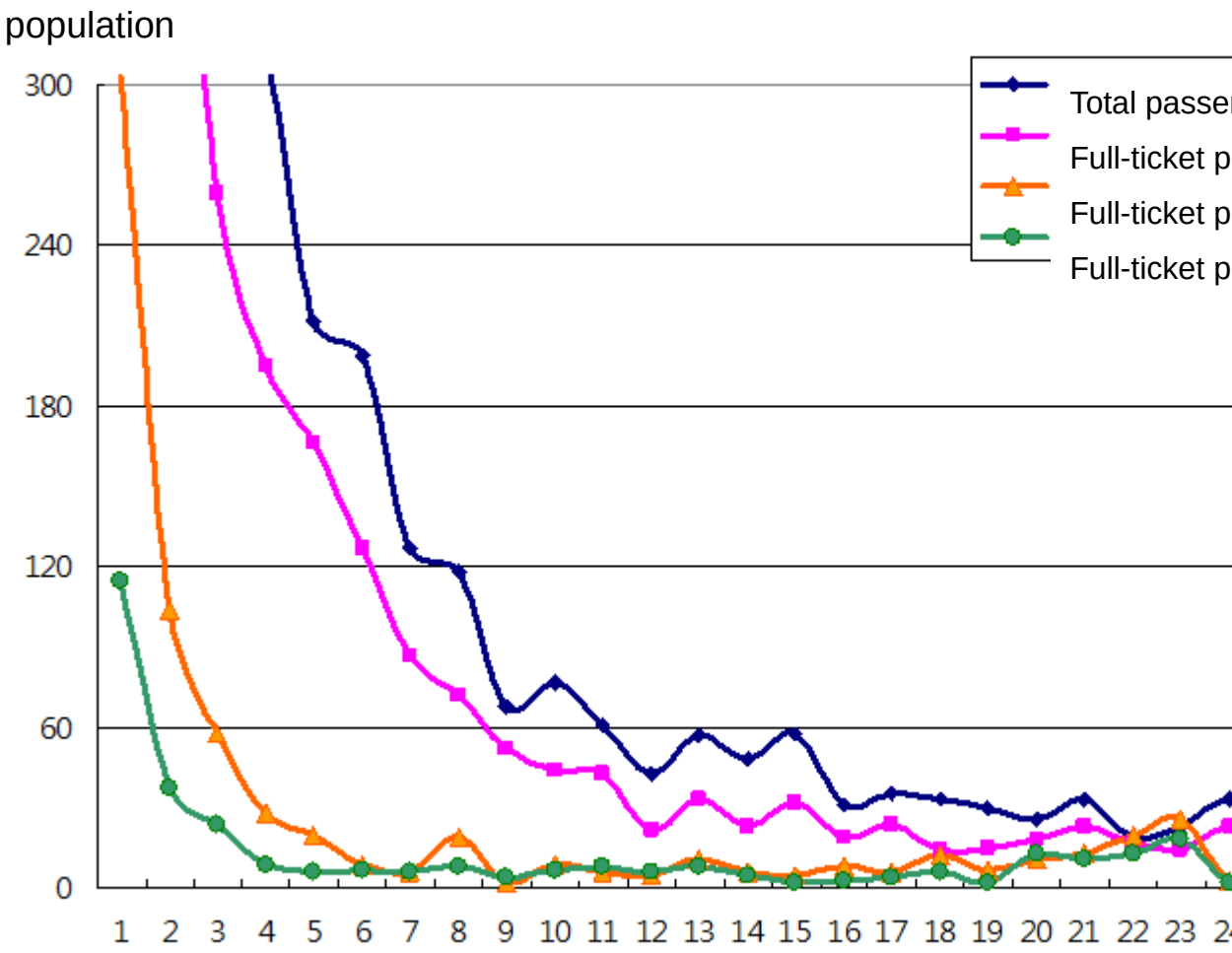

Figure 20 Comparison on different groups for the frequency of card using versus the number of people on Dec. 2009

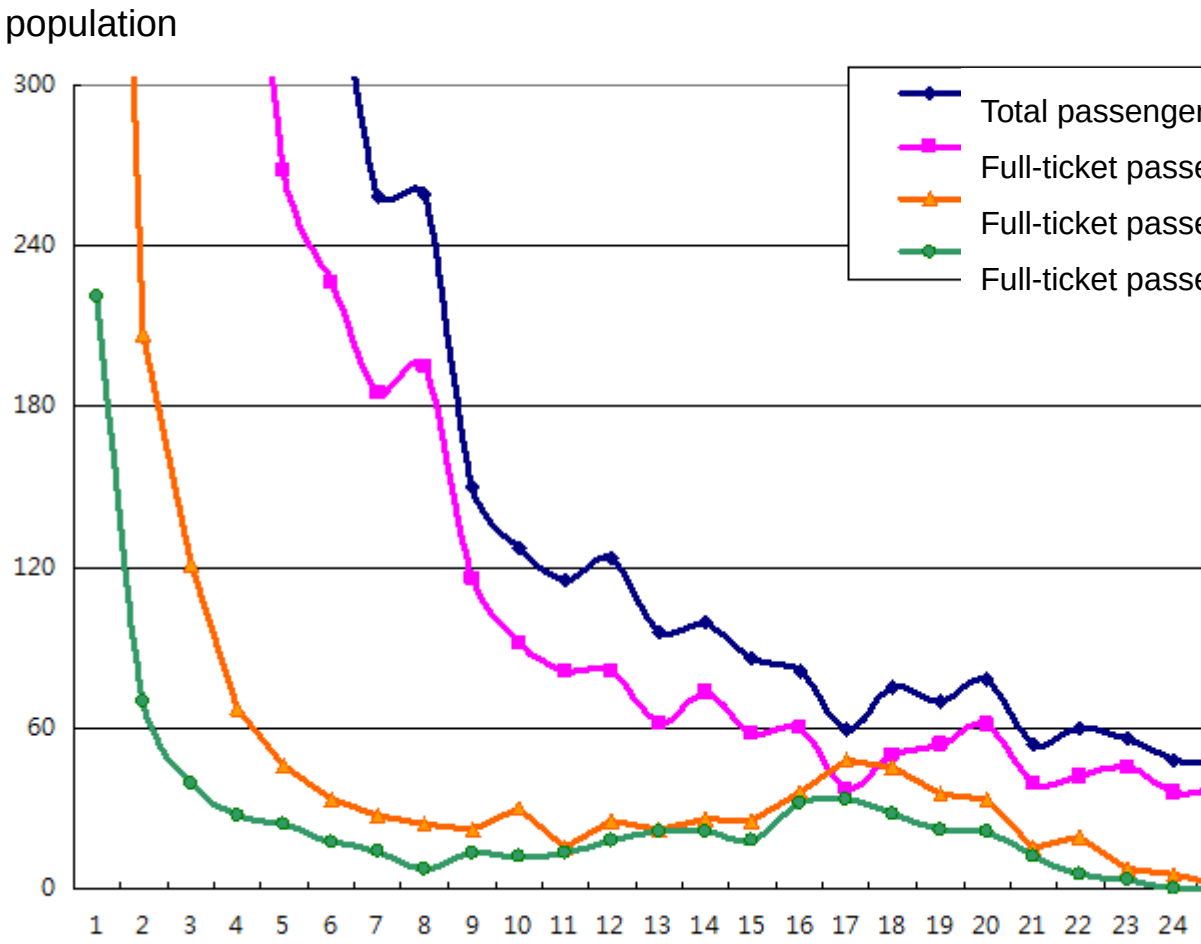

Figure 21 Comparison on different groups for the frequency of card using versus the number of people on March 2011

5. Benefit Evaluation

Traditional Traffic policy is evaluated by indexes such as “Time saving”, “Driving cost saving”, and “Accident cost saving” etc. And B/C ratio is used to assess if the policy works.

Due to domestic economy is closed. The more cost saving for the indexes mentioned previously, the less income the other social economy could make .For example,

diminished accident will cause the income of medical treatment decreased. The decrease of driving cost also caused the maintenance factory make less money. However, the fossil fuel is imported overseas, the net economy benefit should be calculated from the amount of gasoline that was imported.

When it comes to “cost”, 6 routes are created for TTJ. The annual cost is about 180 million NT dollars. One route takes 30 million NT dollars (180 NT/6 routes).The research scope of this paper is fixed to south Tai-Ping corridor, equivalent to half a route. Therefore, the specific route for this research cost 15 million NT (30 million/2).

Refers to section 4.7.2, 500 new commuters are created (494 almost equal to 500), the cost for one commuter is 30 thousand, averagely (150 million/500 people).

To the benefit of gasoline saving, if the 500 people maintain using private transportation tools, the cost is calculated as followed:

The cost for one person per year= [(trips for one person per day) x (the distance per trip) x (days for commuting per year) x (gasoline price per liter / the mileage for that one car could drive with one litter of gasoline)]/ (load factor for private transportation tool)

The parameters predicted as followed:

The trips for one person per day: 2.2

The average distance for one trip: 8 kilometers

The commuting days for one year: 260 days (5days x 52 weeks)

The price of gasoline per liter: 30 NT dollars

The mileage for that one car could drive in the city with one liter of gasoline: 6 kilometers

The load factor for private transportation tool: 1.5 people averagely

According to the assumption above, the gasoline cost for one person on workdays for one year would be:

15.3 thousand/per person= [2.2 trips x 8km x 260 days x (30NTD/6km)/1.5(people/vehicle)]

To sum up, investing 30 thousand dollars to create one commuter who was used to take bus, the B/C ratio will be 1.0 (breaking even) in 2 years. The gasoline saving for the bus user will be the net domestic economy benefit after 2 years.

6. Conclusions and suggestions

6.1 Conclusions

When it comes to a discussion of how to improve the performance of bus volume, the total volume of trips is usually considered as a basis. However, long-term regular commuters and school commuters (especially for those who transferred from private vehicle user to bus user) would actually have contributed more to the bus volume than by those seniors or visitors. In addition, analysis that is made at a small scale is often affected by some particular activities, thus it is inadequate to indicate the real change of public transportation population in this road section. Therefore, by collecting e-ticket data, this research analyzed the population growth of commuters and school commuters before and after the TTJ execution in Taichung City. And results were listed as following:

1. The population of card users had increased from 4,191 people to 8,439 people per month due to the TTJ-51 had joined in with the Southern Taiping road section. It grew by 101%. The population of commuters and school commuters who are also card users (this refers to population of full-price ticket passengers who used the card for more than 15 times per month and once got off the bus before 8:40) increased from 241 people per month to 594 people per month. It grew by 146%, which is a very outstanding rate.

2. After the TTJ was implemented, the group of new bus users (those took the bus more than 15 times per month) increased by 116.57% (refer to the section 4.6.2). This rate is clearly more than the growth rate of 60.75% (refer to the section 4.6.1) those passengers that only took the bus more than once.

3. Under normal circumstance, trips that were generated by bus card users in Taichung city accounted for a 70% of the total trips. And commuters and school commuters often used their cards to take the bus. Therefore, it should be representative to use the card data to stand for the commuters and school commuters in this research.

4. Since the bus has been charging the bus fare in the section of southern Taiping road, the volume had decreased by about 16.10% as a consequence. It's presumed the passengers are very sensitive about price changing.

5. While the TTJ was executed in 2009, the promotion of [free ride in rush hour program] was been carried out as well. But there was no obvious outcome in the growth of volume in this program. Therefore, it's presumed that there is a need to have a good

policy that improves the service as well as its performance. The performance will not be better by just offering the passengers free ride service. Choosing a period of time for free ride service is also an important consideration. However, to offer the free-ride service during the rush hour may not stimulate the commuters to take the bus.

6. After the TTJ was executed, the growth of passenger who took the bus 15～20 times every morning (before 8:40 or 7:20) increased much more than the growth of other groups of passengers. It indicates that the number of commute days that the commuters conducted in this road section is about 15～20 days.

7. The trip number of TTJ-51 passengers who conducted the trips between Yingcai road section and South Taiping road section accounted for 34% of the total trips numbers. The trip number in which the OD points were within the Taiping section accounted for 30% of the total trip numbers. And the trip number in which the OD points were within the Yingcai road section accounted for 36% of the total trips. Therefore, the volume could be increased by 30% by increasing bus service frequency in the southern Taiping road section, but it could be increased by 64% (30%+34%) if the bus service frequency is added and also more routes are developed in accordance with the public demands.

8. During the period of executing free ride policy for route TTJ-51 in December 2010, the total volume in this route was 128,632 people. Since it had been charging in March, the volume dropped to 116,202 people. And the total volume decreased by 9.8% [(128632-116020)/ 128632]. When passengers from the five original bus routes turned into take TTJ due to its free ride, but they stopped taking TTJ when it started to charge bus fare, this may result in a reduction of TTJ bus volume. In addition, when the original TTJ users stopped taking TTJ due to its charging may also result in a reduction of TTJ bus volume.

9. Investing 30 thousand to create one commuter who was used to take bus, the B/C ratio will be 1.0 (breaking even) in 2 years. The gasoline saving for the bus user will be the net domestic economy benefit after 2 years. To the government, it’s really worthy to execute this policy for TTJ.

6.2 Suggestions

1. This research studied the population growth of passengers of TTJ by collecting e-ticket data before and after TTJ implementation. However, data of trips was not able to be collected when it was paid by cash. Thus a particular action or measures should be

carried out to help in collecting the passenger's data under the free ride policy. Such as the policy in 2009 that passengers needed to use the card to get on the bus.

2. The volume in south Taiping road had reduced by 16.10% since the TTJ-51 had been charging the bus fare. It could be reviewed on the reduction of 16.10% in terms of its trip feature (such as ticket type, average monthly trip frequency, trip time, etc.) and take it as a consideration for whether to execute the free ride policy in the future.

3. For all the card data, full-price ticket accounted for 72.79%, senior and disabled registered card accounted for 17.71%, regular card and teacher and student card accounted for 8.38% and half-price ticket accounted for 1.12%. The research studied the trips of full-price ticket on behalf of the trips of commuters and school commuters. In the future, it may include the regular card and teacher and student card into the commuters and school commuters trips for analysis.

4. In this research, it illustrated there was a large proportion of passengers who used the card for just 1～2 times per month. In the future, it could use passenger's card number (which was collected from TTJ member draws) to obtain passengers' contact information, then could conduct questionnaire or telephone interview with the passengers. Through doing interviews with passengers, more information about their trips behavior and characteristics is revealed, which will benefit in making decision for the future policies.

5. From this research, it indicates that there were about 50% of loss passengers every year. In the future, it could analyze what caused these passengers not to continue taking the bus in this section of road. And it could be a future reference when adjusting the bus routes and operating strategies, it would even benefit in studying the migration of passenger population

6. At the time in 2010, passengers did not need to use the card to board TTJ. Although this policy avoided the public complaints, it lost the opportunity of collecting e-ticket data for route adjustment at that time. If there would be a free-ride planning in the future, meanwhile, there would be a need to execute the policy of which passengers need to use the card to get on the TTJ, so that we could collect trips data.

REFERENCES

1.An assessment of service quality for free bus on 2009, thi consultants Inc.,2010.

2.Integrated planning project for Taichung city bus system, thi consultants Inc.,2011.

3.Card data from Fengyuan Bus Transportation Co., Ltd. (2009-2011)

4. Monthly report for Taichung city bus operation, Transportation Bureau of Taichung City Government. (2009-2011)