An Investigation on possible factors influencing the passenger’s choice on mode of transit between BRT and conventional bus services in Guangzhou.

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"Being a dissertation submitted to the faculty of The Built Environment as part of the requirements for the award of the MSc Urban Design and City Planning at University College London: I declare that this dissertation is entirely my own work and that ideas, data and images, as well as direct quotations, drawn from elsewhere are identified and referenced."

Kimber Li
2nd September 2019

Abstract

A new Bus Rapid Transit (BRT) system was adopted in Guangzhou in 2010, which became the first high-capacity and operating flexible BRT system in Asia and even received the 2011 Sustainable Transport Award. As one of Chinese megacities, Guangzhou is undergoing rapid population growth, growth in economy and an increase in private vehicles. This has necessitated improvement in the public transport system towards a better public transport environment. The performance of Guangzhou BRT system and conventional bus service, were investigated in the study.

The aim of the study was to investigate the choice of mode of transit between BRT and conventional bus by public transport users, and to identify any possible influential factors or attributes to the mode chosen by passengers in Guangzhou, China. The study examined the important factors and influence they have on the transit mode choice from three dimensions which were socio-demographic, travel behaviour and 14 service attributes.
Findings were analysed and a conclusion made and recommendation given based on the findings.

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Chapter 1 Introduction

1.1 Study Background

Due to a large number of vehicles on the streets, large cities have progressively confronted issues as a result in traffic jams and thus a waste of time, the urban life quality will be accordingly influenced due to more air pollution and a decrease in urban mobility. Governments have therefore invested in improving public transport systems as an alternative to heavy traffic, which implies a shift of the citizens from private vehicles to public transport, thereby reducing the number of vehicles on the road (Maciel *et al*., 2019). In the increasingly congested metropolitan areas, public transport systems are crucial as they improve mobility and relieve traffic congestion (Ingvardson and Nielsen, 2017.). The BRT system was introduced as a sustainable solution to moderate the expansion of vehicle traffic, as it brings the advantages of a rail transit system – speed, predictability, priority, and comfort – while requiring considerably less capital investment (World Bank, no date.).

Rapid economic growth, urbanisation as well as migration of people to metropolitan areas have created serious challenges in the transportation sector in especially the developing countries. Rail-based systems in many big cities are regarded as a superior transport option, but, its unbearable capital cost has resulted in many of these plans have not been executed yet. In the developing world, BRT has recently become popular urban transit mode as a high-capacity and reliable transit system offering several benefits of a rail-based system but much less capita cost (Sivakumar *et al*., 2006).

1.1.1 BRT in China

Guarda *et al*. (2017) states several crucial reasons for BRT becoming a major transportation mode in China, and they including:

1. An anticipated rapid urbanization .By the end of 2016, China's urbanisation rate reached 57% (World Bank, 2017) and is projected to be at 70% by 2030 (UNDP China, 2013). By the end of 2014, the number of motor vehicles was 154 million and is expected to exceed 200 million by 2020 (EU SME Centre, 2015).

2. As urbanisation progresses, there is a dramatic increase in population density in many cities as well as in private vehicle ownership, mass transit development therefore is the core for serving the rapidly increasing travel demand.
3. Air pollution as a result of vehicle emission. Public transport is a solution for the air pollution menace. BRT is a suitable public transport mode because of its higher capacity compared to conventional bus and much less expensive than rail transit. It can play a significant role in China in contributing to sustainability in the urban transport sector and beyond.

1.1.2 BRT in Guangzhou

In 2010, a new Bus Rapid Transit (BRT) system was introduced in Guangzhou as a sustainable alternative to decrease traffic congestion on dedicated innermost lanes along Zhongshan Avenue – one of the busiest roads in Guangzhou. More than 27,000 passengers are moved per hour towards one single direction by Guangzhou BRT, and it also achieved 805,000 daily boarding, which ranked the third in capacity only to the BRT systems of Bogota and Curitiba (WWF, 2012). It has considerably improved travel times for riders by 29% and passengers save a combined 32 million hours each year on daily commutes. Beyond transportation improvements, Guangzhou BRT system has beneficial effects contributes to the environment. It is projected that CO_2 production will reduce by an average of 86,000 tons annually over the first ten years, and 4 tons of particular matter emissions that result in respiratory illness will be reduced simultaneously.

With regard to both environmental and social benefits achieved by Guangzhou BRT system, it became Asia's first high-capacity and flexible BRT system, and also received the 2011 Sustainable Transport Award at the annual meeting of Transportation Research Board (TRB).

1.2 Public Transport in Guangzhou

Rapid increase in transport demand in many Chinese cities has been a result of rapid urbanisation and population growth. However, public transportation has not been sufficient for expanded demand due to restricted resources and poorly managed facilities.

Hence, urban areas have observed increasing in the use of private vehicles causing traffic congestion, longer travel time and poorer air quality.

Guangzhou, as the capital city of Guangdong Province and located in South China, it is the third largest city in China with a population of 13 million according to the census that was conducted in 2010.

Guangzhou is one of the Chinese cities that have invested heavily in public transport since the year of 2000. City authorities have constructed five fresh underground systems, also as the first Chinese city considering imposing of congestion taxes. The new BRT system was introduced in 2010 in order to mitigate the existing traffic congestion and has become the cornerstone of Guangzhou public transport system.

Guangzhou BRT system entails a 22.5 kilometres long corridor, with fully including direct connecting tunnels between underground and BRT stations at four stations and is the first BRT system worldwide with a bike sharing system simultaneously planned and implemented along the corridor. Moreover, Guangzhou BRT system also features BRT platform bridges linking directly to neighbouring buildings, making the corridor a major example of multi-modal transport integration. The Guangzhou BRT corridor connects Guangzhou's most advanced areas to where potential growth is anticipated, starting from Tianhe District – one of four central core distracts in Guangzhou, where intensive development has been concentrated over the past twenty years, including Tianhe Sports Centre and many high-rise residential developments, and ending in the Huangpu District, where dense and diverse land use is also growing rapidly, with old, ultra-dense, unplanned 'urban villages' like Tangxia (Figure 1&2).

Figure 1 BRT corridor connect Tianhe and Huangpu District

Figure 2 Map of Guangzhou BRT corridor

Figure 3 Two ways of paying - cash/card

Figure 4 Real-time information

Figure 5 Service facility in the station

Few studies have demonstrated a plenty of benefits of Guangzhou BRT system (Cao *et al*., 2015; Hughes and Zhu, 2011.) ranged from various aspects. Yet, those analysis are based on the BRT operation just after the first-year implementation, as Guangzhou was experiencing massive growth of population, economy and private vehicles, the effect of the BRT system should be reviewed regularly to outline any necessary improvements towards a better public transport system in Guangzhou.

1.3 Research Aim and Objectives

The aim of this research was to investigate the transit mode choice between BRT and conventional bus of the existing transport users and to recognise any possible factors or attributes that lead in such a preference, as well as point out any aspects of the services that requires future improvement. This study will critically analyse any reasons result the transit mode choice between BRT and conventional bus journey to accomplish a holistic understanding of an expectational journey by public transport riders.

The research objectives placed together to accomplish the above aim were three points as follows:

- To investigate the transit mode which transport users preferred to take between BRT and conventional bus service in Guangzhou.
- To explore the key factors that affect their transit mode choice between BRT and conventional bus service.
- Identify any aspects of the service that required further improvement for BRT and conventional bus service to enhance the overall service quality and attract more choice rider.

1.4 Research Content

This dissertation has 6 chapters. Chapter 1 presents the dissertation study background and outlines the research aim and objectives. Chapter 2 discusses and summaries the past studies has done on the distinctive features of BRT itself and when compared with other forms of transportation, also any other factors excludes the services attribute that affects the transit mode choice for passengers. Chapter 3 depicts the methodology and analysis method being adopted for the research. Chapter 4 and 5 discuss the key findings of the study. Chapter 6 finally summaries the key findings and the conclusion drawn from this dissertation.

Chapter 2 Literature Review

The aim of the literature review was to indicate any possible factors affecting the transit mode choice between BRT and other forms of transportation, particularly the conventional bus, and to understand the influence of these factors on mode choice preference.

2.1 BRT Characteristics and its Global Trend

In one of the most quoted concepts in the literature, Levinson *et al*. (2003) define BRT as 'flexible, rubber-tired form of rapid transit that combines stations, vehicles, services, running ways and information technologies into an integrated system with a strong identity.' BRT is considered convenient as it ties the speed and reliability of rail service with the operating flexibility and lower cost of conventional bus service (Deng and Nelson, 2011). Accordingly, Diaz and Scheneck (2000) characterised BRT as 'distinct from conventional bus transit in a way it combined technology, the operational plan and the customer interface to create higher quality of services', which distinguishes BRT from the conventional bus system to some extent.

The BRT system has been carefully documented and analysed by a considerable number of prior research, along with its distinctive characteristics, to assist determine the efficient characteristics provided by the BRT. BRT is a bus service operating on exclusive routes and limited stops, the stop spacing is larger than that of conventional buses. Contemporary BRT systems typically integrate the use of intelligent transportation systems (ITS) technologies, for example tracking through Global Position System (GPS).

BRT has been demonstrated to be successful with enormous environmental, social and economic benefits. It has sufficient capacity and also safes on time for the passenger as it is fast, which able to stimulate transit-oriented development (Hidalgo and Graftieaux, 2008; Hensher and Golob, 2008; Deng and Nelson, 2011). Plenty of studies (TRB, 2003; Kim *et al*., 2005; Sivakumar *et al*., 2007; Hoffman, 2008) underlined that BRT can be adapted flexibly to a multitude of urban environments and meet the needs of users in terms of faster speeds, greater service reliability, frequent service, and increased customer convenience. It provides significantly better service than conventional bus due to utilise a combination of progressive technologies, infrastructure, and operational investments. Besides, there are a few review

studies that comparatively evaluated BRT systems across the globe with formal statistical analysis (Baltes, 2003; Hensher and Golob, 2008). Most endorsed the viewpoint that BRT systems provide high-quality services with conventional bus appearing in the right place to address growing public transport patronage saving, enhanced reliability and safety, and improved passenger comfort and convenience.

The successful implementation of the BRT system was recognised in researches conducted in several cities in Asia, Europe and especially Latin America which is the origin of BRT system (Rabinovitch and Hoehn, 1995; Deng and Nelson, 2010, Fjellstrom, 2010; Cervero, 2013), demonstrating its global popularity as a cost-effective alternative for far more costly urban rail investments. BRT has recently become popular urban transit mode in developing countries as its high-capacity and reliable transit system with attractive feature - much less capital cost, which allowing staged development for the system, fast implementation, ultimately sustainable effective and efficient transportation to the cities (Sivakumar *et al*., 2006).

2.2 Comparative Studies between BRT and LRT

Since both Light Rail Transit (LRT) and BRT have been adopted as new transit alternatives by evolving technologies, the performance and achievements of BRT and LRT have been progressively analysed in recent years. BRT emulates essentially the efficiency and amenity features of a modern rail-based transit system but at a fraction of the cost, an LRT system is generally more than four to twenty times as expensive than BRT (Wright and Hook, 2007). Several features that are exhibited in LRT are also found in BRT, resulting in same ridership attraction hence the two should be considered as complementary rather than competitors (Ben-Akiva and Morikawa, 2002; Vukan, 2005). One crucial criticism indicated by Ben-Akiva and Morikawa (2002) was that most of those comparative studies were based on the assumption that rail systems are intrinsically more attractive than the bus system, meaning that riders would prefer rail to bus-based service under the seemingly equivalent systems. Furthermore, Tawfeek and Gouda (2015) points out that passengers always link the BRT to the conventional bus service, since their knowledge towards BRT is affected by the traditional perception of ‘conventional bus’ when compared with LRT, the characteristics, as well as the implementation circumstance of each transit mode, are different. Moreover, rail

versus bus is increasingly criticised as a false dichotomy; the quality of service supplied should be given priority relative to the physical apparatus (Cervero, 2013).

2.3 BRT Vs. Conventional Bus – Bus-based Service Comparison

Although there are plenty of research exploring the choice of riders between LRT and BRT or simply analyse the effect of BRT from various perspectives, a few studies have contrasted the attractiveness between BRT and conventional bus (Cao *et al*., 2015. Currie, 2005), but still with a limited focus only on the quality of service defined as the overall level of attainment of a customer's expectations (Tyrinopoulos and Antoniou, 2008). Both BRT and conventional bus resulted alleviating in environmental pollution and traffic congestion in contemporary metropolises. Transportation made with BRT is more convenient and reliable as opposed to conventional bus as its higher punctuality rate. However, it has also been realised that conventional bus is flexible as it has access to many areas that BRT cannot. It is, therefore, essential to understand the rider attractiveness between BRT and conventional bus service, which able further improvement on both operation efficiency and service level of the urban public transportation system.

2.4 Factors Excluded from Service Attributes

Evidence supports the necessity to recognise the quality attributes of public transport that are expected by the community and to design public transport systems based on these attributes (Redman *et al*., 2013). Quality attributes are categorised as physical (measured directly from the performance of the system) and perceived (users' responses) by Redman *et al*. (2013), and the majority of the previous studies on understanding the benefits of BRT have ignored the impact of the perceived attributes on the overall performance.

It is a reality that apart from transit service attributes, the socio-demographic variables have the most significant effects on travel choice (Taylor *et al*., 1993; Teaff and Turpin, 1996; Ewing and Cervero, 2001). Discrete choice theory suggests that an individual makes a logical decision on travel mode choice after considering the utility of that choice compared to other choices (Ben-Akiva and Lerman, 1985). Studies focused on the social-cognitive theory, whereby the influencing factors determining travel behaviour, which including modal choice,

has been done with emphasis on gender, income, occupation and vehicle ownership as significant factors influencing travel behaviour (Bajracharya and Shrestha, 2017).

Studies have also demonstrated that the gender difference between female and male is in relation to modal choice in travel behaviour, with variety of interpretations (Hanson and Johnston, 1985). There is a necessity to include the socio-demographic factors when assessing BRT attractiveness, rather than merely explored its impact.

2.5 Summary of the Literature Review

The important role of BRT system haven been identified in numerous previous studies along with the fast rate of urbanisation in metropolitan area. Research in the field has brought understanding the significance of BRT system focusing on the design concepts and unique characteristics of BRT. Besides, comparative analysis between BRT and other transit modes have overlooked the impact of conventional bus service as it can run on more roads as well as connecting more places than BRT. A few previous studies have also identified some significant influential attributes that attract public transport choice riders on BRT instead of conventional bus service (Cao *et al.*, 2015; Currie, 2005; Cain, 2009). These studies highlighted the influential attributes for satisfaction with Guangzhou BRT including *ease of use, safety while riding,* and *comfort while waiting*, and further recommended that strategies should be used to enhance BRT's quality of service (Cain, 2009; Cao *et al*., 2015), which presents the performance of transit service from the point of perspective of the passenger and is normally measured through a customer satisfaction survey (TCRP).

Consequently, there is an opportunity that factors other than the quality of service could affect the choice of transit mode, especially for socio-demographic factors, as public transportation is often viewed as a social service for the elderly and poor. Thus, it is may be appropriate to comprehensively investigate any social-demographic factors and service attributes causing preference between BRT and conventional bus, as both are bus mode, with more inclusive viewpoints.

The first objective of the study was to identify whether there was an existing transit mode preference for BRT travel over the conventional bus in Guangzhou, or not. Further comprehensive study will be conducted based on the factors and characteristics possibly

results in this preference. For the transit mode choice, factors such as service attributes, travel behaviours and socio-demographic will be generally considered which will bring about significant impacts. Evidence is required to facilitate the proper understanding of the influence of those factors in the Guangzhou context. By testing those factors in the context of Guangzhou, where rapid urbanisation results increasing travel demand, will also help in concluding important factors in user preference and perception on the two bus-based transit modes.

Understanding the factors influencing riders' mode choice for both bus-based transits was crucial for improving their effectiveness of operation and service level and developing strategies for retaining existing users and attracting new customers to enhance public transport and promote sustainable travel.

Chapter 3 Methodology

3.1 Research Strategy

The study had three interrelated objectives to understand the ridership attraction between BRT and conventional bus service in Guangzhou and thus identify aspects of the service that requires further improvement for both transportation modes.

- To investigate the transit mode which transport users preferred to take between BRT and conventional bus service in Guangzhou.
- To explore the key factors that affect their transit mode choice between BRT and conventional bus service.
- Identify any aspects of the service that require further improvement for BRT and conventional bus service to enhance the overall service quality and attract more choice rider.

This dissertation intends to understand the existing transit mode preference between BRT and conventional bus service in Guangzhou, and influential factors determine this preference. Based on the focus of the preference between BRT and conventional bus, this study incorporates both of quantitative and qualitative research methods, which are rational and feasible to conduct, in order to process a valid and accurate result.

A questionnaire was designed as an informal interview, to collect primary data on individual socio-demographic features, travel behaviour and general idea and preference on BRT or conventional bus service, as well as any BRT or conventional bus attributes influencing the riders' mode choice, to understand their relevance in the context of Guangzhou, to further indicate any possible factors have the influence on riders' mode choice and determining the impact of each factors.

3.2 Data Collection

A representative sample of Guangzhou population was not done with intention to carry out this survey, as it was beyond the scope of the study considering the available resources. It

was an attempt of capturing any possible factors in the sample for the transit node choice between BRT and conventional bus service to have a holistic understanding.

In the level of individualism, survey is considered as the most efficient approach to solicit data. The survey questionnaire was divided into three parts. Part 1, ranging from Q1-Q7, focused on the information relates to participants' journey, to understand the travel behaviour features in detail. Steg (2005) proposed that the users are not be willing to acknowledge the influential factors when questioned directly. The questionnaire that were supposed to be used were evident as from the background of the literature review. Q8 and Q9 in the questionnaire, therefore, adopted questions premeditated by Cain (2009) which asked the respondents to give the rating range from 1 to 5 on each attribute and their overall opinions of both type of transit mode. The ideal goal was to assess the differences in ridership attraction.

Since the literature review also showed a missing gap of analysing the socio-demographic information with transit mode choice, the questionnaire involved detailed individual socio-demographic information collecting through Q10 to Q16. Finally, based on the recommendations have been presented in previous studies in the context of Guangzhou (Salon *et al*., 2014; Cao *et al*., 2015), Q17 was designed to collect any improvement suggestions from participants, aiming at providing more specific ideas to meet the user demand. 18 questions were designed in total and required up to 4 minutes to complete.

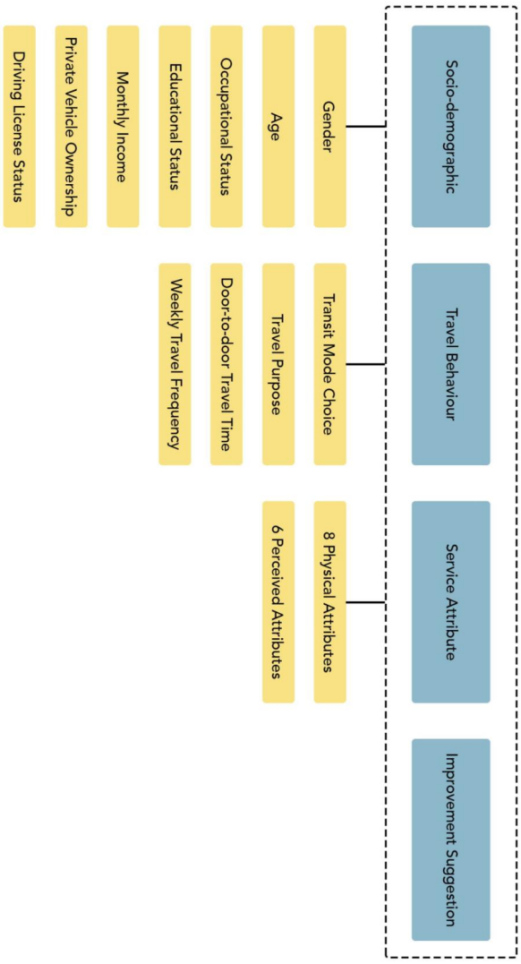


Figure 6 Survey framework

The questionnaire was created via Tencent Questionnaire System and performed in both paper-form and QR-code, participants who were in a hurry scanned the QR-code by mobile

phone and completed the questionnaire online instead of taking the paper-form. The web-based survey format was easier for participants to accept since it allowed them to complete the survey without of the limitation on time and space. 639 valid responses were received.

The data was collected from riders at the BRT stations and bus stops from Tianhe Sports Centre to Huangpu Coach Station (Figure 7) in July 2019, as the corridor is served by both BRT and conventional bus service. Since the study comparing riders' preference of the two types of transit, the same survey will be administered to riders at bus stops in the corridor while collecting data from BRT riders. It was particularly challenging to choose people for the survey due to the flow of the passengers and their willingness to participate in the survey. The survey covered as many social groups as possible, in terms of age and income, and it had been applied to riders during the morning peak time (8 am) to the evening peak time (7:30 pm), as BRT is initially implemented to mitigate traffic congestion.

Figure 7 Location of selected survey stations

Passengers were randomly chosen at the selected stations, and requested to fill out the questionnaire after shortly explaining the survey purpose and obtaining their consent, clarification was sought from the author who was present at the time. Due to the recent development of BRT in many developing countries, general issues like literacy, prompting the necessity of careful design survey, it is also essential explaining the BRT system to all participants clearly to obtain their attitude.

3.3 Analysis Methods

The analysis of the questionnaire data was on the difference in paticipants' transit mode choice from three dimensions: socio-demographic characteristics, travel behaviour and service attributes. The recorded significance and satisfaction levels on service attributes were analysed to identify areas for improvement and the possible reasons for dissatisfaction from each service.

Excel and SPSS 20.0 Statistics were majorly utilised for data collection and analysis. The statistical analysis methods used in this study included reliability test, validity test and descriptive statistic such as the frequency, cross-tab and logistic regression analysis. Excel and SPSS were used in the data summary to observe the characteristics and distribution of collected data with frequency and cross-tab analysis. Logistic regression was mainly for exploring the correlation between socio-demographic, travel behaviour features and travel mode choice. Logistic regression model was built as following:

$$Logit\left(\frac{P_1}{P_2}\right) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \cdots$$

Formula 1

To examine the impacts' difference of socio-demographic and travel behaviour on transit mode choice, the first option of each questions under these two dimensions was selected as reference value. According to the formula 1 above, formula 2 & 3 were generated:

$$Logit\left(\frac{P_{BRT}}{P_{option\,1}}\right) = \beta_{BRT0} + \beta_{BRT1} X_1 + \beta_{BRT2} X_2 + \beta_{BRT3} X_3 + \cdots$$

Formula 2

$$Logit\left(\frac{P_{BUS}}{P_{option\,1}}\right) = \beta_{BUS0} + \beta_{BUS1} X_1 + \beta_{BUS2} X_2 + \beta_{BUS3} X_3 + \cdots$$

Formula 3

X represents variables of personal socio-demo and travel behaviour features. B is the corresponding parameter vectors.

3.4 Ethics Statement

A face-to-face survey was conducted with human participants in this dissertation research. The author clarified the purpose of this research appropriately, including how the output would be disseminated and used. Since the survey was mostly conducted in Chinese, the collected data would be carefully translated into English for further analysis. Participating in the survey was voluntary, and informed consent was discussed with all participants. The whole research would protect both sources and respondents' privacy, minimise the risk of harm, and strive for accuracy and honesty in everything in the dissertation. The data collected from participants was guaranteed to be used for academic purpose only. In general, this study was conducted in the context of a full compliance of research ethnic principles and norms.

3.5 Potential Problems and Limitations

The study adopted a survey to obtain the perspective of people on a set of factors influencing ridership attraction. The sampling was not entirely random, though. For instance:

- Elderly people were far less willing to give time for the survey, and neither were they acquainted with completing questionnaire on the smartphone.
- The author, being a female, refrained from approaching men at the station or stop as she found could be unsuitable for interactions.
- Since the design of Guangzhou BRT corridor is not completely closed, 30 out of 31 BRT service routes would join or leave the BRT corridor from a particular station and continuously run as conventional bus service, the definition of BRT bus thus may confuse some participants.

Chapter 4 Data Summary and Findings

This study aimed at understanding the using of Guangzhou BRT system and conventional bus system, trying to find out any factors influencing the choice of two different modes of public transportation. In this section, SPSS Customise table being used to give full and detailed statistic information to the survey participants concluding the survey that was conducted. At an average duration of 4 minutes for each survey, the collection of 639 samples was done in total (refer Annexure 1), which was sufficient enough to explore the fundamental distribution of sample. The random sampling probability approach was used in collecting the samples data for the survey. Reliability test and validity test were conducted to check for consistency and authenticity of Q8 and Q9 in the questionnaire for further analysis.

4.1 Reliability Test and Validity Test

According to the Table 1, Cronbach's alpha was 0.767 which indicating the questions in this study had good internal consistent.

Cronbach's Alpha	N of Items
0.767	28

Table 1 Reliability Statistics

Table 2 showed that the result of constructive validity test for Q8 and Q9 and the results indicated that KMO=0.843>0.8 and the questionnaire was valid as P value of Bartlett's Test of Sphericity was below 0.05. Further analysis shows that eight factors was extracted and could explain 46.042% of the 28 questions.

Kaiser-Meyer-Olkin Measure of Sampling Adequacy		0.843
Bartlett's Test of Sphericity	Approx. Chi-Square	1845.588
	df	378
	Sig.	0.000

Table 2 KMO and Bartlett's Test

There were 639 respondents in total participated into the survey, according to Table 3, 356 participants chose BRT (55.7%) and 283 (44.3%) chose conventional bus, which shows a preference on choosing BRT in the context of Guangzhou.

Transit Mode	N	Percent
BRT	356	55.7%
Bus	283	44.3%

Table 3 Frequency analysis on transit mode choice

4.2 Individual Socio-demographic Characteristics

Socio-demographic characteristics includes age, gender, occupational status, educational status, monthly income, and private vehicle ownership and status of driving licence. Table 3 summarised these socio-demographic features of participants and their transit mode choice via a cross statistical approach, which provides clear details on travel choice with different socio-demographic characteristics. Overall, female participants (47.1%) is slightly less than male (52.9%) shows in Figure 8, also according to the Table 4, slightly less female chose BRT (46.1%) and bus (48.4%) services than male participants.

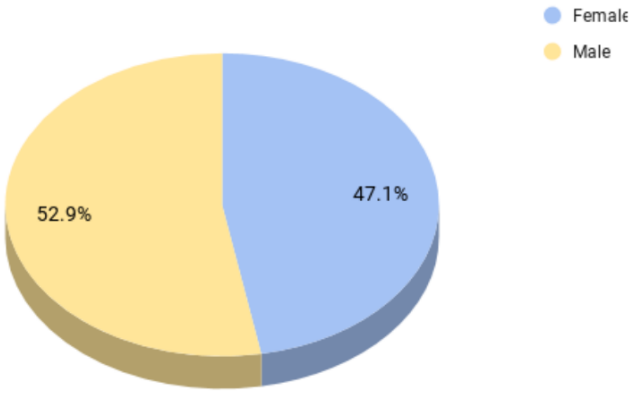


Figure 8 Participant gender difference

Transit Mode	Gender	Frequency	Percent (%)	Transit Mode	Status of driving license	Frequency	Percent (%)
BRT	Female	164	46.1	**BRT**	Yes, I hold one	185	52.0
	Male	192	53.9		No	171	48.0
BUS	Female	137	48.4	**BUS**	Yes, I hold one	138	48.8
	Male	146	51.6		No	145	51.2
Transit Mode	**Age**	**Frequency**	**Percent (%)**				
BRT	10 - 19	43	12.1	**Transit Mode**	**Educational level**	**Frequency**	**Percent (%)**
	20 - 29	153	43.0	**BRT**	Junior High School	4	1.1
	30 - 39	84	23.6		Senior High School	72	20.2
	40 - 49	58	16.3		Higher professional school	115	32.3
	50 - 59	18	5.1		Undergraduate - bachelor degree	128	36.0
	> 60	0	0		Postgraduate - master degree	25	7.0
BUS	10 - 19	38	13.4		Postgraduate - doctoral degree	1	0.3
	20 - 29	124	43.8		Postdoctoral researcher	2	0.6
	30 - 39	58	20.5		Prefer not to say	9	2.5
	40 - 49	47	16.6	**BUS**	Junior High School	2	0.7
	50 - 59	16	5.7		Senior High School	84	29.7
	> 60	0	0		Higher professional school	94	33.2
					Undergraduate - bachelor degree	63	22.3
Transit Mode	**Private vehicle ownership**	**Frequency**	**Percent (%)**		Postgraduate - master degree	19	6.7
BRT	Yes, more than one	80	22.5		Postgraduate - doctoral degree	3	1.1
	Yes, only one	153	43.0		Postdoctoral researcher	5	1.8
	No	123	34.6		Prefer not to say	13	4.6
BUS	Yes, more than one	37	13.1				
	Yes, only one	87	30.7				
	No	159	56.2	**Transit Mode**	**Occupational status**	**Frequency**	**Percent (%)**
				BRT	Student	78	21.9

Transit Mode	Income monthly (RMB[1])	Frequency	Percent (%)				
BRT	0 - 2500	65	18.3		Full-time employee	209	58.7
	2500 - 5000	75	21.1		Part-time employee	15	4.2
	5000 - 7500	122	34.3		Self-employed	34	9.6
	7500 - 10000	52	14.6		Unemployed	1	0.3
	> 10000	25	7.0		Retired	2	0.6
	Prefer not to say	17	4.8		Other	17	4.8
BUS	0 - 2500	65	23.0		Student	71	25.1
	2500 - 5000	80	28.3		Full-time employee	145	51.2
	5000 - 7500	100	35.3	BUS	Part-time employee	16	5.7
	7500 - 10000	11	3.9		Self-employed	37	13.1
	> 10000	10	3.5		Unemployed	2	0.7
	Prefer not to say	17	6.0		Retired	0	0
					Other	12	4.2

Table 4 Frequency analysis on socio-demographics characteristics

All age groups used both BRT and bus service, but mainly the young participants of the age between 20-29 years old to took both BRT (43%) and bus services (43.8%). Over half of both BRT and conventional bus participants were full-time employee as per their occupational status, the percentage was 58.7% for BRT and 51.2% for bus respectively, which is coherent with Table 4 showing that the travel purpose was mainly for commuting travel with BRT (27.8%) and bus (34.9%) service.

Participants were mainly concentrated on low-to-medium income level, only around 5.5% of all participants (25 out of 639) had a monthly income of higher than 10,000 RMB, percentage for BRT rider was 7% and even half less (3.5%) for bus rider. Past study in Guangzhou with a representative sample size of 1473 have also found that conventional bus users generally consisted of lower-income group compared to BRT users (Cao *et al*., 2015). The research finding indicated that lower-income group patronage of BRT had not risen over the year. Over half of participants (65.5%) who prefer BRT currently owning one or more private vehicles, and 52% BRT participants holding a driving licence. It was slightly different situation for those participants who chose conventional bus service as Table 4 shows that bus

[1] The Chinese currency RMB, 1GBP = 8.73RMB

participants without private vehicle account to 56.2%, and 51.2% of bus participants not holding a driving license.

Most participants who preferred BRT service were holders of bachelor's degree (36%), yet for bus riders, most of them (33.2%) graduated from higher professional school. However, an interesting finding existing here that the percentage of participants in senior high school are significant for both transit modes, which accounts 20.2% for BRT and 29.7% for conventional bus, and it is coherent with that student ranks the second highest occupational status among both BRT (21.9%) and conventional bus participants (25.1%).

4.3 Travel Behaviour Features

Travel behaviour characteristics involved the choice of transit mode, travel purposes, door-to-door traveling time and weekly travel frequency. Overall, there were more participants chose BRT (55.7%) than conventional bus service (44.3%) (Figure 9).

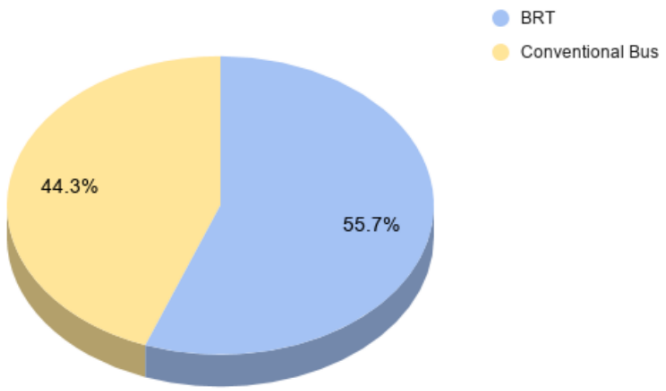


Figure 9 Participants' transit mode choice

Multi-choice format has been used to collect the travel purpose data. A frequency table being produced here. In terms of travel purpose, Table 5 demonstrates that *commuting*, *leisure* and *shopping* were three major travel purposes for BRT riding, occupying 27.8%, 24.1% and

17.6%. Similarly, participants who tend to took bus service primarily for *commuting*, *leisure* and *visiting friend or family*, the percentage is 34.9%, 16.5% and 14.1% respectively.

Transit Mode	Travel Purpose	Responses		Percent of Cases
		N	Percent	
BRT	Commuting	166	27.8%	46.6%
	Education	64	10.7%	18.0%
	Leisure	144	24.1%	40.4%
	Shopping	105	17.6%	29.5%
	Visiting friend or family	91	15.2%	25.6%
	Accompany the child for school	27	4.5%	7.6%
	Total	597	100.0%	167.7%
BUS	Commuting	161	34.9%	56.9%
	Education	55	11.9%	19.4%
	Leisure	76	16.5%	26.9%
	Shopping	59	12.8%	20.8%
	Visiting friend or family	65	14.1%	23.0%
	Accompany the child for school	45	9.8%	15.9%
	Total	461	100.0%	162.9%

Table 5 Frequency analysis on travel purpose

Table 6 presents transit mode choice and door-to-door travel time and weekly travel frequency through a crosstab statistical approach. The average travel time for BRT participants mainly concentrates less than 15 minutes (77.4%) and 15-30 minutes (62.5%) (Figure 10). For participants normally takes conventional bus service, the average traveling time is longer, which takes them 15-30 minutes (64.8%) or even 30-45 minutes (60%). Cross-tab seeks to demonstrate the sample distribution in each variable, showing here that BRT usually costs less traveling time than conventional bus, as its one of the most appealing attributes to generate ridership.

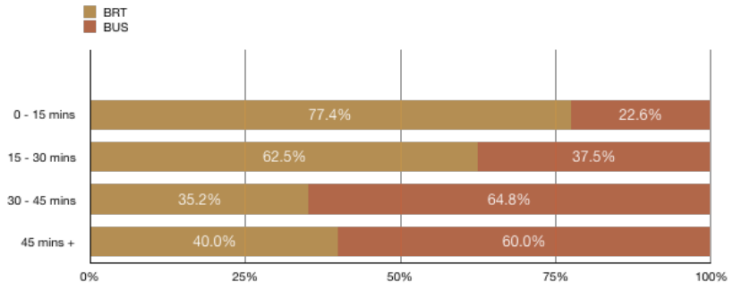


Figure 10 Cross-analysis of transit mode choice and door-to-door travel time

		BRT		BUS	
		N	Percent	N	Percent
Door-to-door travelling time	**0 - 15 mins**	106	77.4%	31	22.6%
	15 - 30 mins	158	62.5%	95	37.5%
	30 - 45 mins	56	35.2%	103	64.8%
	45 mins +	36	40.0%	54	60%
Weekly travel frequency	**< 1 day**	72	52.2%	66	47.8%
	1 - 2 days	178	61.2%	113	38.8%
	3 - 4 days	59	50%	59	50%
	5- 7 days	47	51.1%	45	48.9%

Table 6 Cross-tab analysis of door-to-door travel time and weekly travel frequency

According to Table 6 above, most people chose BRT and conventional bus participants with the weekly frequency of 1-2 days. Table 7 and 8 below shows socio-demographic characteristics and weekly travel frequency via a crosstab statistical approach. Most of participants who were full-time employees mainly choose BRT with the frequency of 1-2 days per week, while for those unemployed and retired participants, had more free time to walk instead of taking automobile, same case as the unemployed and retired participants who chose conventional bus. However, travel frequency based on gender difference showed that more females took BRT with a weekly frequency of 1-2 days than male participants, while female participants chose conventional bus much more frequently compared to male participants by 5-7 days a week.

		Weekly travel frequency			
		< 1 day	**1 - 2 days**	**3 - 4 days**	**5 - 7 days**
Gender	Female	25	91	26	22
	Male	47	87	33	25
Age	10 - 19	7	23	8	5
	20 - 29	42	68	18	25
	30 - 39	10	47	20	7
	40 - 49	7	33	9	9
	50 - 59	6	7	4	1
	> 60	0	0	0	0
Occupational status	Student	18	44	9	7
	Full-time employee	41	98	36	34
	Part-time employee	3	8	3	1
	Self-employed	5	19	7	3
	Unemployed	1	0	0	0
	Retired	0	1	1	0
	Other	4	8	3	2
Educational level	Junior High School	1	3	0	0
	Senior High School	13	35	12	12
	Higher professional school	26	59	16	14
	Undergraduate - bachelor degree	20	65	26	17
	Postgraduate - master degree	9	9	3	4
	Postgraduate - doctoral degree	1	0	0	0
	Postdoctoral researcher	1	1	0	0
	Prefer not to say	1	6	2	0
Income monthly (RMB)	0 - 2500	12	38	8	7
	2500 - 5000	11	43	13	8
	5000 - 7500	24	61	20	17
	7500 - 10000	11	23	8	10
	> 10000	7	8	7	3
	Prefer not to say	7	5	3	2
Private vehicle ownership	Yes, more than one	20	40	13	7

	Yes, only one	40	66	29	18
	No	12	72	17	22
Status of driving license	Yes, I hold one	36	87	39	23
	No	36	91	20	24

Table 7 Cross tab on socio-demographic characteristic and weekly travel frequency (BRT)

	Weekly travel frequency				
		< 1 day	**1 - 2 days**	**3 - 4 days**	**5 - 7 days**
Gender	Female	29	54	29	25
	Male	37	59	30	20
Age	10 - 19	6	14	14	4
	20 - 29	30	46	22	26
	30 - 39	12	30	8	8
	40 - 49	11	18	12	6
	50 - 59	7	5	3	1
	> 60	0	0	0	0
Occupational status	Student	10	31	21	9
	Full-time employee	40	53	23	29
	Part-time employee	4	8	2	2
	Self-employed	9	15	8	5
	Unemployed	0	1	1	0
	Retired	0	1	1	0
	Other	3	5	4	0
Educational level	Junior High School	0	0	2	0
	Senior High School	21	36	18	9
	Higher professional school	24	39	19	12
	Undergraduate - bachelor degree	12	28	13	10
	Postgraduate - master degree	1	6	5	7
	Postgraduate - doctoral degree	0	1	0	2
	Postdoctoral researcher	1	0	1	3
	Prefer not to say	7	3	1	2

Income monthly (RMB)	0 - 2500	10	32	18	5
	2500 - 5000	24	31	13	12
	5000 - 7500	26	39	19	16
	7500 - 10000	2	3	3	3
	> 10000	0	5	3	2
	Prefer not to say	4	3	3	7
Private vehicle ownership	Yes, more than one	6	13	14	4
	Yes, only one	18	40	15	14
	No	42	60	30	27
Status of driving license	Yes, I hold one	39	51	27	21
	No	27	62	32	24

Table 8 Cross tab on socio-demographic characteristic and weekly travel frequency (conventional bus)

4.4 Service Attributes

Table 9 below presents participants' overall idea of the importance and satisfaction with two transit modes and the Likert rating of 14 service attributes through descriptive analysis, the difference between BRT and conventional bus service were significant at a level of 0.01.

Service Attributes	**BRT**		**BUS**	
	Mean±SD	**Ranking**	**Mean±SD**	**Ranking**
Door-to-door travel time	4.43±1.016	3	4.49±0.844	2
Travel cost	3.71±1.210	11	3.61±1.270	11
Frequency of service	3.94±1.182	9	3.92±1.152	8
Comfort while waiting at station/stop	4.03±1.236	6	4.05±1.275	6
Customer service	3.90±1.060	10	3.91±1.144	9
Ease of service use	4.08±0.984	5	3.96±1.066	7
Hours of service	3.38±1.045	12	3.31±1.188	12
Avoid stress/cost of car use	2.91±1.137	14	2.97±1.083	14
Safety while at station/stop	4.45±0.932	2	4.52±0.920	1
Safety while riding the service	4.46±0.886	1	4.43±0.985	3
Other riders	3.24±1.232	13	3.21±1.143	13
Convenience of service	4.19±1.061	4	4.14±1.105	4

Reliability of service	4.01±1.152	7	4.07±1.104	5
Comfort while riding	3.99±0.940	8	3.71±1.118	10

Physical attribute Perceived attribute

Table 9 Descriptive analysis of service attributes importance rating

According to a previous study done by Redman *et al*. (2013), the 14 service attributes being categorised into physical attribute that could be measured directly from the performance of the system, and perceived attribute, which referred to users' response. First, *safety while riding the service, safety while at station or stop and door-to-door travel time* were ranked to be the top three most important attributes influencing people's choice on particular transit mode among both BRT and conventional bus riders (Table 9). This result corroborates with previous findings where safety was one of the most significant factors in all travel modes (Cain, 2009; Wang *et al*, 2015). However, compared to Table 10, which presents the finding from previous study done by Cain (2009), it shows that there were two factors significantly contrast with this study.

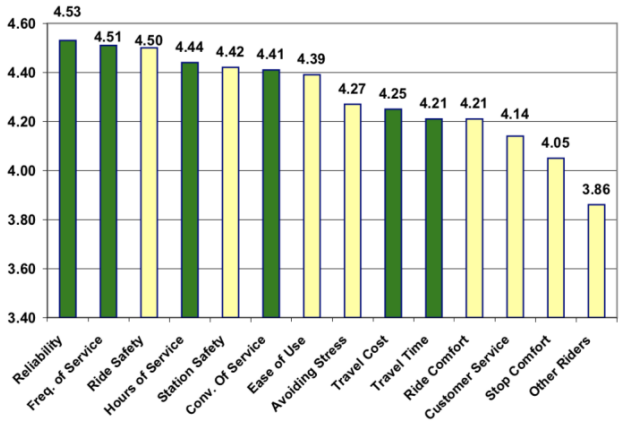


Table 10 Overall importance ranking done by Cain (2009)

Travel time in the western context was not as important as it shows in the case of Guangzhou, the high importance in Guangzhou was dependent on the travel purpose when people choose

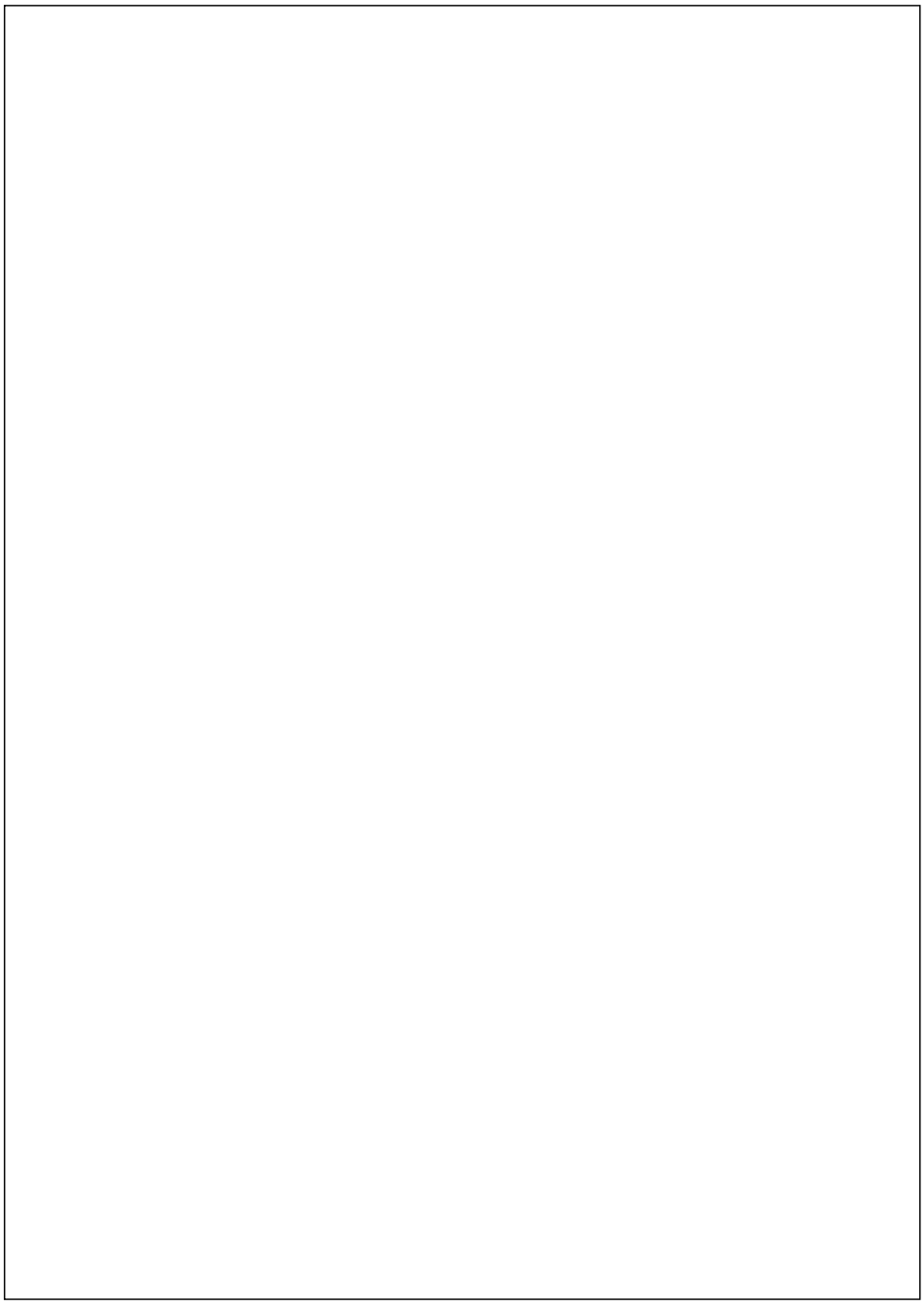
to take automobile, especially for BRT. Majority of the survey participants were full-time employees and studenst, who taking BRT or conventional bus for commuting trip and educational use, they were less flexible with timing compared to other participants. In addition, *hours of service* owns high importance in study done by Cain (2009), while it was not influential in the Guangzhou context, which might due to the Guangzhou BRT corridor connects to the most developed urban district where people has more alternative options any time rather than only choosing between BRT and conventional bus.

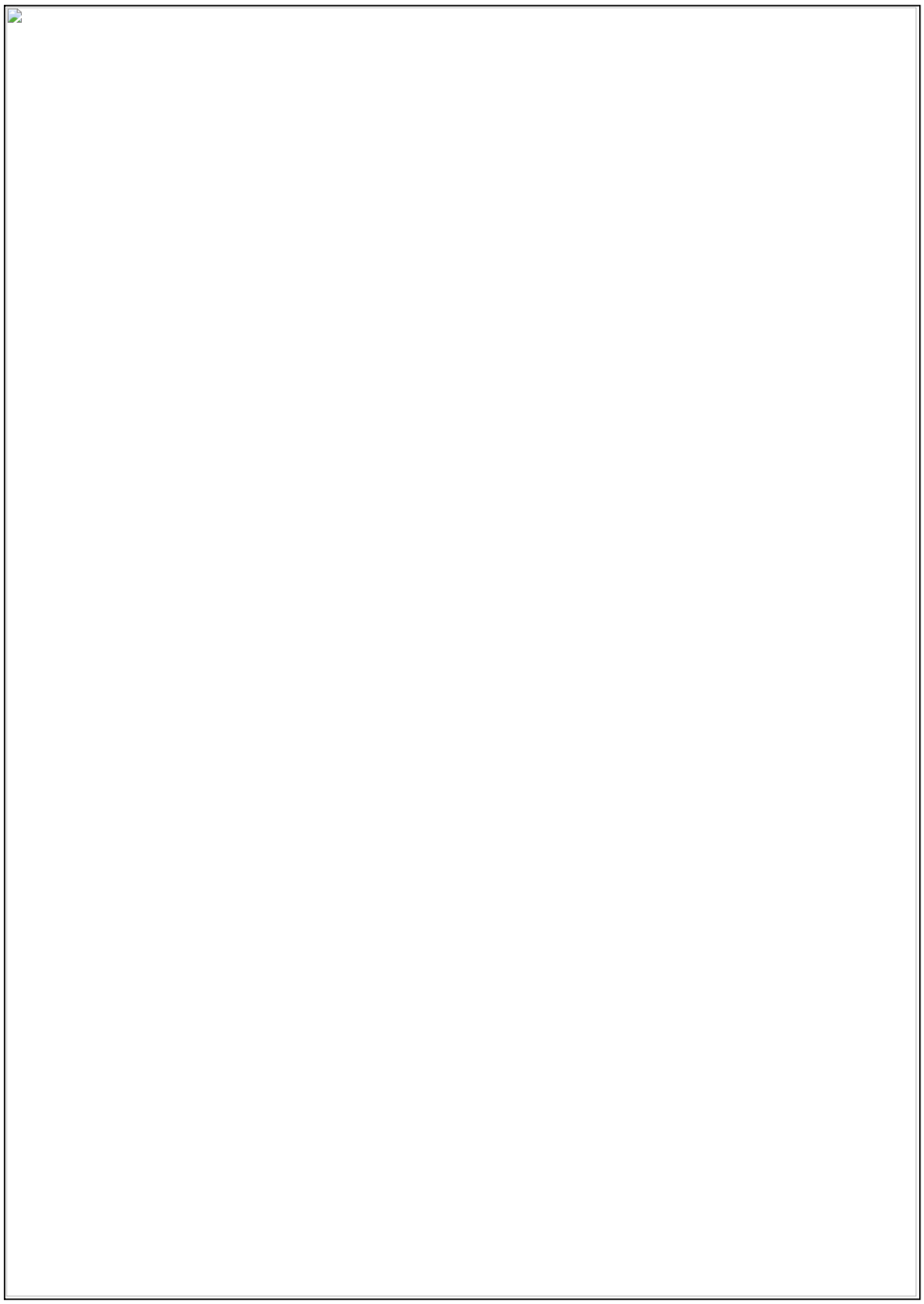
The overall satisfaction rating of conventional bus was lower than BRT service according to Table 11 below. This rating pattern was true for all but two service attributes as exception. In terms of the rating for *travel cost* and *hours of service* for BRT were lower. These are reasonable since BRT covers less areas than conventional bus although they have the same fixed fare, and the BRT service normally run from 6am to 11pm, while conventional bus service covers the time period of 5:30am to 1:40am, noting that there are night bus services operating in certain areas of Guangzhou which almost running 24 hours a day.

Service Attributes	BRT		BUS	
	Mean±SD	Ranking	Mean±SD	Ranking
Door-to-door travel time	4.31±0.806	3	3.79±0.924	5
Travel cost	3.93±0.932	11	4.12±0.991	3
Frequency of service	3.86±0.885	13	3.45±1.11	12
Comfort while waiting at station/stop	4.24±0.779	6	3.11±1.125	14
Customer service	3.98±0.842	10	3.63±1.021	8
Ease of service use	4.35±0.881	2	4.29±0.854	1
Hours of service	3.87±1.045	12	4.24±0.946	2
Avoid stress/cost of car use	3.72±1.009	14	3.49±0.994	10
Safety while at station/stop	4.28±0.796	5	3.71±1.092	6
Safety while riding the service	4.19±0.790	7	3.48±1.233	11
Other riders	4.02±0.822	9	3.23±1.073	13
Convenience of service	4.29±0.867	4	3.82±1.112	4
Reliability of service	4.11±0.826	8	3.62±1.105	9
Comfort while riding	4.38±0.881	1	3.68±1.068	7

Physical attribute Perceived attribute

Table 11 Descriptive analysis of service attributes satisfy rating





Variables			Sig.	Exp. (B)
Socio-demographic	Private vehicle ownership	Yes, more than one = 1	0.000	
		Yes, only one	0.184	1.441
		No	0.000	2.993
	Driving license status	Yes, I hold one = 1	0.000	
		No	0.531	0.875
	Gender	Female = 1	0.000	
		Male	0.382	0.851
	Age	10 - 19 = 1	0.000	
		20 - 29	1.953	0.957
		30 - 39	1.852	0.778
		40 - 49	2.691	1.097
		50 - 59	1.861	0.618
		> 60	0.000	0.000
	Occupational Status	Student = 1	0.764	
		Full-time employee	0.944	1.033
		Part-time employee	0.493	1.516
		Self-employed	0.312	1.710
		Unemployed	0.983	0.971
		Retired	0.999	0.000
		Other	0.814	1.152
	Educational Status	Junior High School = 1	0.032	
		Senior High School	0.322	2.954
		Higher professional school	0.633	1.682
		Undergraduate - bachelor degree	0.867	1.201
		Postgraduate - master degree	0.637	1.709
		Postgraduate - doctoral degree	0.133	12.929
		Postdoctoral researcher	0.410	3.279
		Prefer not to say	0.506	2.209
	Monthly Income	0 - 2500 = 1	0.007	
		2500 - 5000	0.247	0.591
		5000 - 7500	0.046	0.397
		7500 - 10000	0.001	0.143
		> 10000	0.062	0.326

		Prefer not to say	0.398	0.638

Table 13 Logistic analysis of socio-demographic and transit mode choice

Regarding to age group, the youth have higher possibility of choosing both BRT and conventional bus service compared to other age groups. Individuals in this age group were concern more about their financial basis to use other transit mode such as taxi and private vehicle. Also, between BRT and conventional bus, more youth preferred to take BRT as they acknowledge relatively more benefits offered by BRT compared with elder people, in the meanwhile, elder people probably prefer to stick to familiar transit mode and not willing to make changes. It has a substantial inclination to use BRT rather than conventional bus relative to those possessed one or more private vehicles for participants without private vehicle. Besides, its result shows that individual income has deciding effects on participants' travel mode choice as well. When other factors were controlled for, the possibility of choosing BRT as their travel mode rose with increase in income level. It may be due to higher income allowing participants to take less care on the cost performance of their journey, and people have higher ability to bear transportation costs.

However, it was pointed out in the previous study that gender difference deeply influences people's' transit mode choice (Bajracharya and Shrestha, 2017). Hanson and Johnston (1985) argued that women's greater dependence on public transit was partly due to economic factors such as lower average income. Since both BRT and conventional bus are public transit mode, gender is not a notable determinant in transit mode choice in the case of Guangzhou. As regards travel mode choice, personal socio-demographic characteristics generally have significant correlation with it.

5.1.2 Impacts of Travel Behaviour Features

Table 14 shows the logistics regression analysis based on travel behaviour and transit mode choice. Due to the data of travel purpose was collated in the multi-choice format, which thus being eliminated in the model below. Based on the analysis result, it states that travel behaviours have effects on participants' transit mode choice in some case as well.

The correlation between them is less noteworthy and substantial compared to the results of socio-demographics. In this study, both door-to-door travel time and weekly travel frequency were found to have slight impacts on participants' transit mode choice. After controlling for other factors, participants who traveling longer time are prefer BRT more, as they probably perceive that BRT generally provide better service than conventional bus with paying the same price. Regarding to weekly travel frequency, participants who travel 1-2 days per week would like to choose conventional bus than BRT, the possible reason being that participants who travel with such a low frequency did not care about any differences between BRT and conventional bus, as they both being treated as bus-based transit mode and would not make any considerable impacts on participants' journey.

Comfort while waiting at station/stop	Comfort while waiting at station/stop
Reliability of service	**Ease of service use**
Comfort while riding	Frequency of service
Frequency of service	Customer service
Customer service	Comfort while riding
Travel cost	Travel cost
Hours of service	Hours of service
Other riders	Other riders
Avoid stress/cost of car use	Avoid stress/cost of car use

Physical attribute Perceived attribute Attributes rated as important (>4)

Table 15 Service attribute with mean importance above 4 (important)

The common attributes influencing people's transit mode choice are highlighted with pink colour, which were *safety while riding the service, safety while at station or stop, door-to-door travel time, convenience of service, ease of service use, comfort while waiting a station or stop* and *reliability of service*. It is worth to notice that two of the top three most important attributes were rated by both BRT and conventional bus participants are perceived attributes, which were *safety while riding the service* and *safety while at station or stop,* the necessity of involving perceived attributes is demonstrated. Safety being universally acknowledged as an important factor as all previous studies support these findings (Stradling *et al*., 2007; Cain, 2009), previous studies also found that *ease of service use*, *comfort while waiting and riding* and *reliability* were the most important factors for the existing users in the context of Guangzhou (Cao *et al*., 2015).

Participants did not consider *travel cost* to be an important factor influencing their transit mode choice, as the public transportation fare in China is generally cheap due to the subsidy from municipal government. Besides that, majority of the participants in this survey were full-time employees and students (enjoy 50% off discount with travel card) for whom the prices were affordable and thus was not a significant criterion. Additionally, *avoid stress or cost of car use* and *other riders* were also not considered as important factors. There was no sufficient evidence in the previous studies and literatures to investigate those two variations, but perhaps due to the low ownership of private vehicles of general public transportation user.

5.2 Identification of Improvement Required

Majority of participants for BRT and conventional bus service belonged to young age group, probably due to their awareness on the significant role of public transportation in environmental protection and concerns of economic basis. Elderly people, therefore, should be targeted to encourage them to use both BRT and conventional bus, especially for those with private vehicle ownership, in order to achieve modal shift to reduce car dependence and mitigate traffic congestion caused by overuse of private vehicle. Furthermore, door-to-door travel time is found in deciding the transit mode, which requires a high standard to be set and achieving better performance to meet user's demand and attract more choice riders. Also, there is a possible correlation between travel time and reliability of service, as people expects to obtain more accurate travel information including waiting and traveling time.

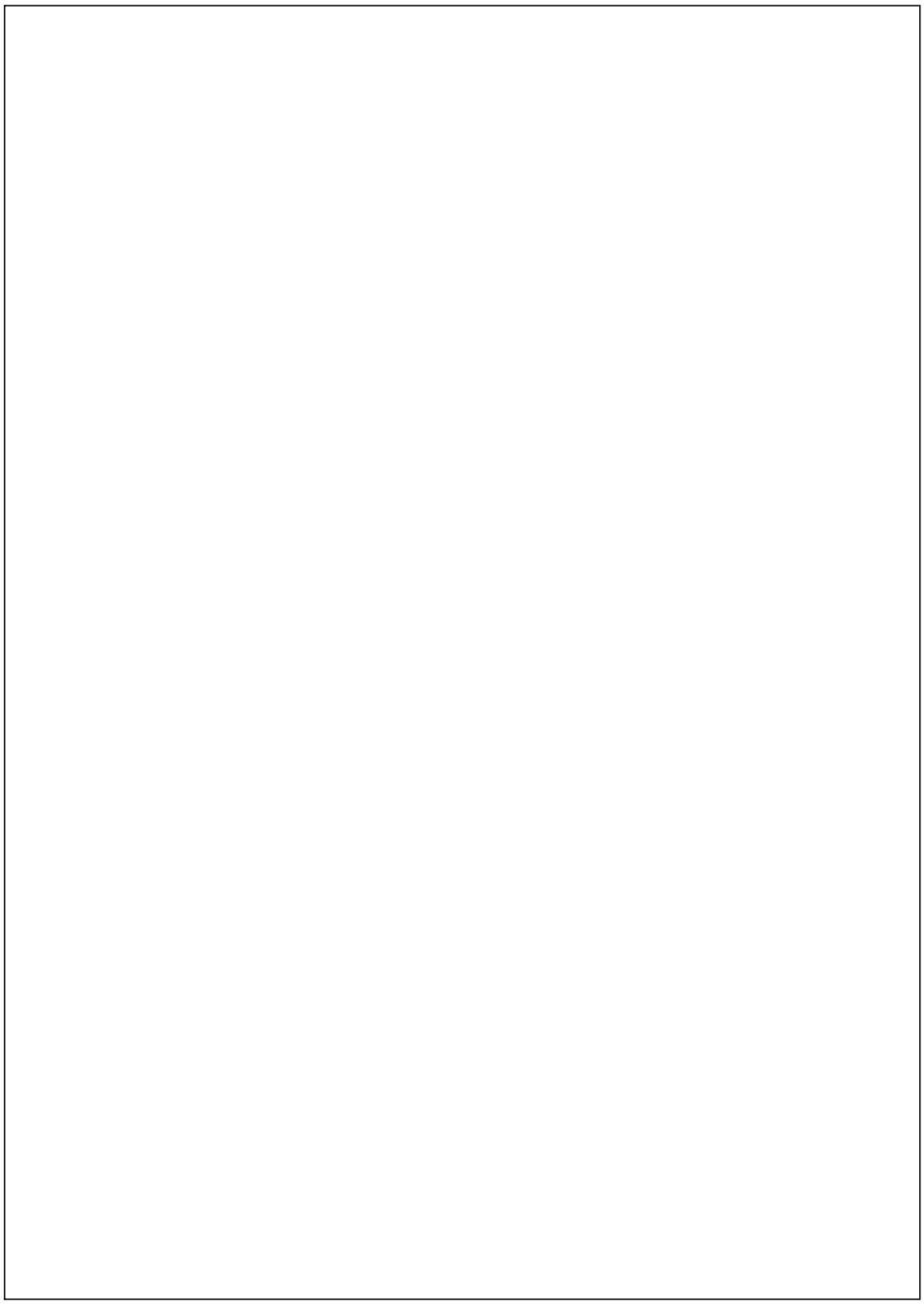
The above section addressed in detail the factors that were vital to the existing BRT and conventional bus users and the level of discontent identified by them. In terms of service attribute, therefore, the transit agencies should prioritise the consideration of those attributes are comparatively more important according to Table 9, and simultaneously relatively less satisfying based on the ranking in Table 11. With median (7.5) being used as the threshold, the *reliability of service* for both BRT and conventional bus service should be improved, and specifically improving *safety while riding the service* and *comfort while waiting at station or stop* for conventional bus.

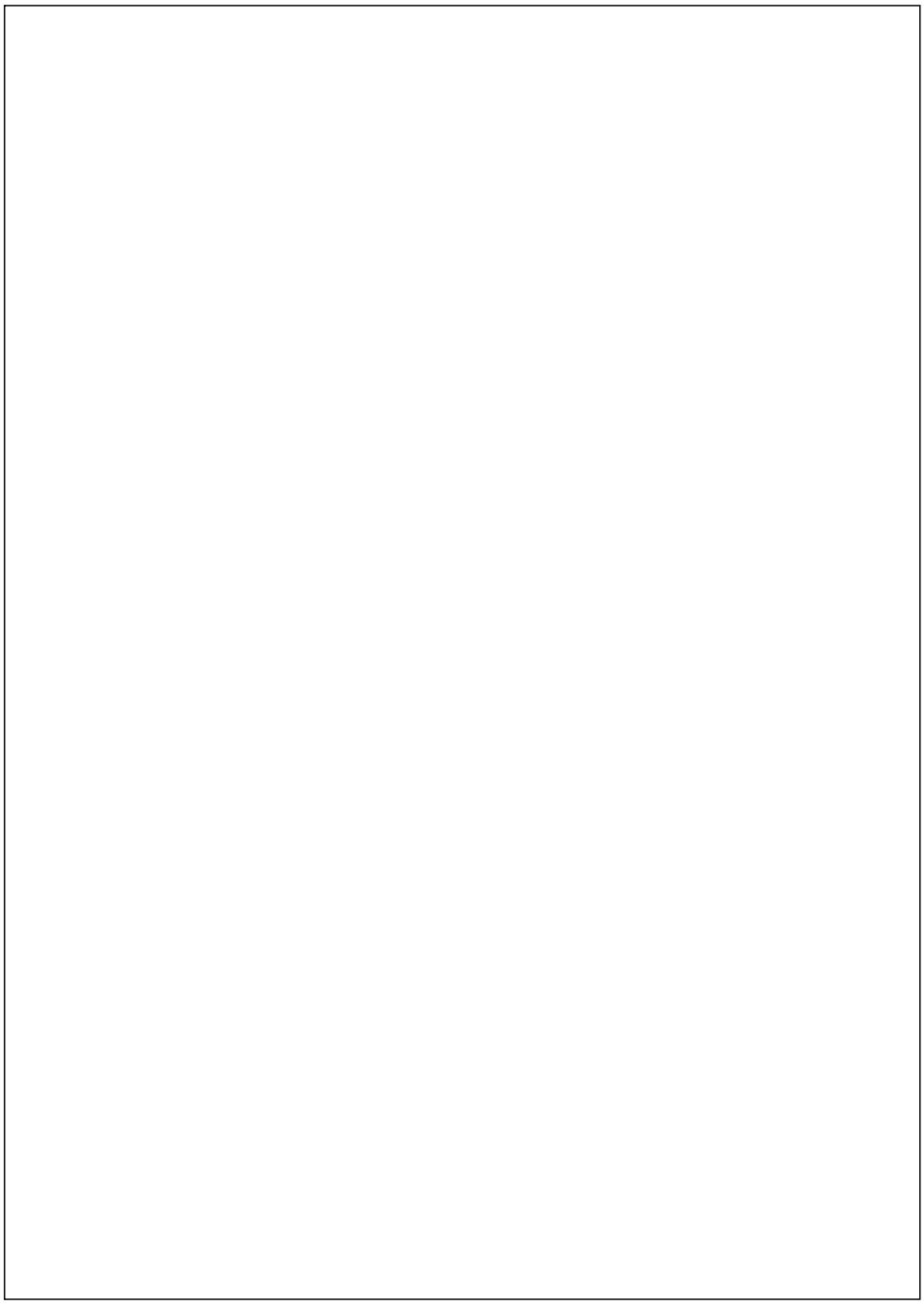
Based on the recommendations have been presented in previous studies in the context of Guangzhou (Cao *et al*., 2015; Salon *et al*., 2014), there was one survey question relating to suggestion on further improvement on BRT and conventional bus service in Guangzhou, and the results being analysed in Table 16 below. It shows that both BRT and conventional bus participants considered *more operating route* should be prioritised in the further service improvement, and the percentage was 24.7% for BRT and 27.4% for conventional bus respectively. BRT users paid least attention to the price adjustment, only 12.5% of participants voted for *cheaper fare*. As mentioned early, the ticket fare of BRT service in Guangzhou is affordable, especially for the second largest group using BRT who were student, with 50% off discount with travel card. *More frequent service* was found the least

important to improve for conventional bus service, as bus is generally more flexible and covers more area in the city rather than focus on one specific BRT corridor.

Transit Mode	Improvement	Responses		Percent of Cases
		N	Percent	
BRT	Cheaper fare	82	12.5%	23.0%
	More operating line	162	24.7%	45.5%
	Longer operating time	135	20.6%	37.9%
	More frequent service	123	18.8%	34.6%
	Combine with more transit mode	153	23.4%	43.0%
Conventional Bus	Cheaper fare	102	17.8%	36.0%
	More operating line	157	27.4%	55.5%
	Longer operating time	101	17.6%	35.7%
	More frequent service	90	15.7%	31.8%
	Combine with more transit mode	123	21.5%	43.5%

Table 16 Frequency analysis on participants' suggestion on further improvement





The second limitation was the definition of BRT service. Unlike other cities, there are 31 BRT routes in Guangzhou currently, and only one route completely using the whole BRT corridor. The rest leaving or joining the BRT corridor somewhere in the middle, which turns into conventional bus service outside of BRT corridor. It is difficult to define them as BRT or conventional bus service. The author talked to staff who working in the Transport Department of Guangzhou and classified those service routes using BRT corridor all as BRT services according to the official definition. However, 30 of those routes partly holding the BRT attributes, which could again induce inaccurate analysis results.

The last limitation relates to travel purpose and the data were collected through multiple choice format, which was unable to do the logistic regression analysis between it with riders' transit mode choice.

6.3 Future Research

This study is an exploratory research on this comparative topic in Chinese context. It is evident that socio-demographic, travel behaviour and service attributes are significant correlated with transit mode choice. In the present discussions on this topic, the role of origin and destination was not addressed, since previous study by Xie (2012) indicated that suburbs in Chinese cities are developed at similar rates as central cities. There is a potential for further study to investigate the BRT and conventional bus attractiveness in both urban central district and suburban area to fill this gap. Also, future study could also give more attention on small-medium-sized cities for a more comprehensive debate in the Chinese context, since the existing studies in China are focusing on mega-cities such as Beijing and Guangzhou, understanding the influential factors of people's transit mode choice between BRT and conventional bus service could provide a better understanding on the necessity of further BRT planning or implementation on other Chinese cities. Besides, there are many researches that focuses on one particular transit mode, but there is limited study on specific group of people such as aging group or the youth. Future research could fill this gap to refine research on this topic. Moreover, this study also highlights the necessity of analysing perceived attributes to identify the areas that require further enhancement, which should be considered in further study on the transport planning academic field.

6.4 Recommendation

The results of this study are noteworthy in relevance to policy implementations to promote sustainable travel in Guangzhou. Socio-demographic characteristics play a significant role in making individual choice on transit mode, while this study demonstrates that its impact was more from age, monthly income and private vehicle ownership than others. The findings propose that future transport approach should consider the heterogeneity of various transit users and differentiated policy could be regarded and implemented to different social-group according to its demographic structure.

Travel behaviour features have relatively smaller impact on transit mode choice between BRT and conventional bus, especially weekly travel frequency was not significant to influence people's choice.

Besides, 8 out of 14 service attributes with mean significance above 4 (important) were rated by participants, 4 of them were physical attributes and another 4 were perceived attributes, which indicates the significance of user's perception in determining the transit mode as same as physical attributes. Results from this study suggests that the transport planner and decision-makers in Guangzhou must consider provision of the top three important attributes - *safety while riding , safety while waiting* and *door-to-door travel time,* with appropriate weighting when designing a new BRT service that are more attractive to the users, subject to an assessment of the relative cost effectiveness of their implementation. Moreover, the difference between significance and satisfaction on service attributes for each transit modes should be acknowledged to develop more attractive sustainable transport solutions within user-centric strategy. Specifically, to improve *reliability of service* for both BRT and conventional bus service, up-to-date timetables and maps could be provided by the relevant agencies, accompanying with implementation of at-stop and on-board real-time information systems, and develop applications to allow access to traveling information through smartphone (Dziekan, 2008). To enhance *safety while riding* for the conventional bus service, the relative agencies or department should train and reinforce driver's behaviours related to safe operation of conventional buses and establish sensible guidelines for run cutting and restrict long platform hours and spreads to prevent fatigue driving (Litman, 2008) Moreover,

comfort while waiting at station or stop can be improved through providing basic amenities such as shelters and benches to meet the riders' demands.

This study just provides insight into the perception of existing users due to the resources and time limitation. It would, therefore, be required to consider perception of non-public transport users, especially private vehicle user, to develop a similar model and form a more holistic approach on this topic. Two models can then be interpreted together to prioritise any policies are able to improve the satisfaction of existing users and attract new riders simultaneously to travel with public transport and attain modal shift towards a more sustainable travel environment.

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Appendix 1 - Questionnaire

BRT/Conventional Bus User Questionnaire

快速/普通公交系统用户调查

您好！这是一份关于广州市快速公交系统以及普通公交系统被使用情况的调查问卷。该问卷非商业用途，所有数据将用于伦敦大学学院硕士研究生毕业论文的研究及完成。对于您的参与作者表示衷心的感谢，希望能占用您宝贵的时间，将您的感受告诉我们，我们非常重视您的宝贵意见以及建议。期待收到您的回复！

Dear participants, truly appreciate your attention to this questionnaire which is a survey investigating the using of Guangzhou BRT system and conventional bus system. It is guaranteed that all the information will be protected with the respect of your privacy, as you will not be individually identifiable, and only be used to support the research of UCL postgraduate dissertation. Thanks so much for your participation and looking forward to your feedback!

1.在BRT以及普通公交车中，您通常更偏向选择哪一种作为您的出行方式？ *

In general, which one do you prefer to take as your transit mode?

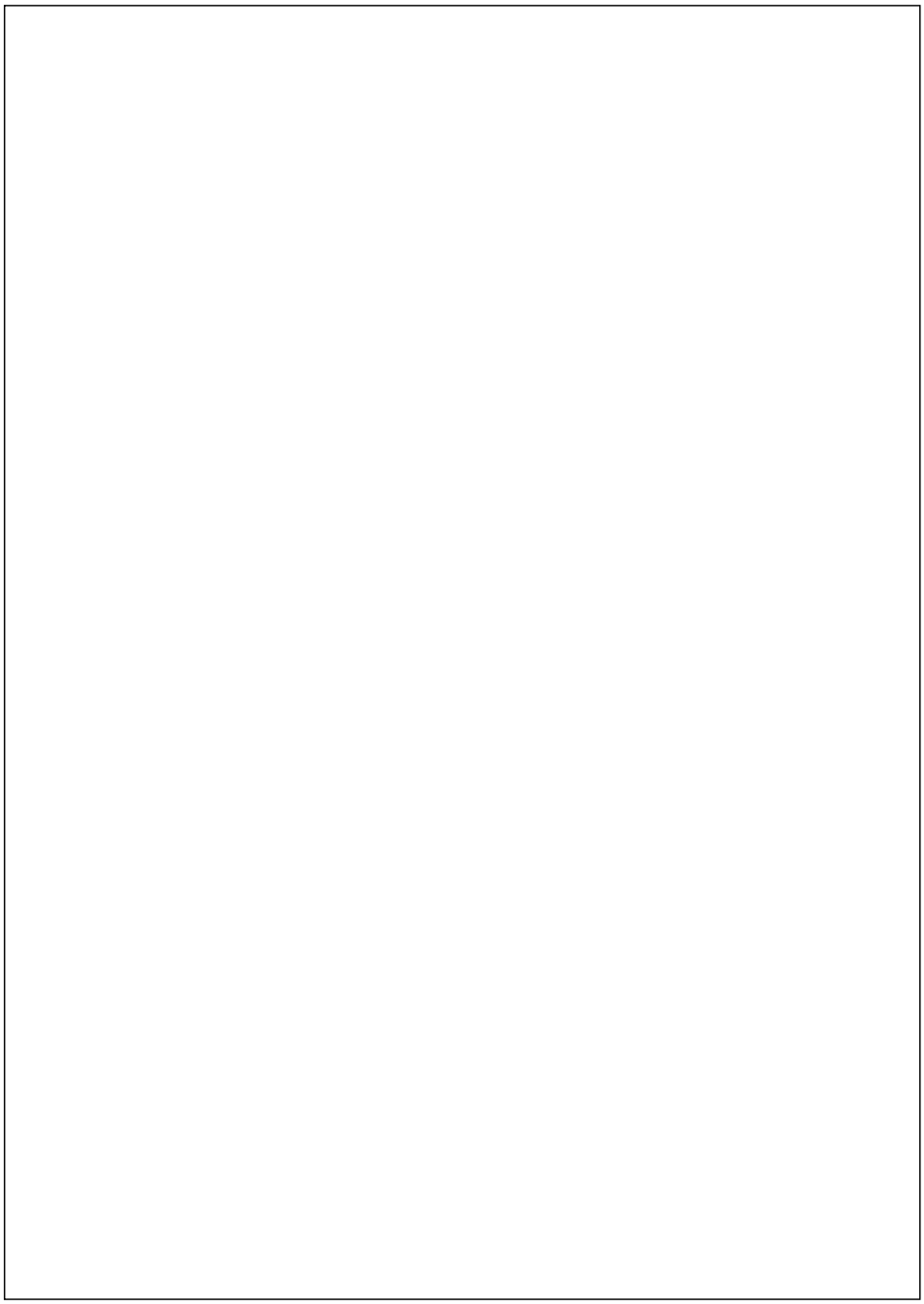
- ◯ 快速公交车 BRT
- ◯ 普通公交车 Bus

2.请简单的为您的选择给出理由。

Please simply state a reason for your choice.

3.您最近一次使用此种公共交通工具（基于您第一题的选择）时，起点为: _____，终点为: _____。（请写下具体的站点名字或街道名字） *

Please state the origin and destinations of your last trip completed with the transit mode chosen in Q1. (pls be specific with the station name or street name)



7.您使用BRT / 普通公车的出行频率为? (基于您第一题的选择) *

Your weekly travel frequency with BRT / conventional bus (according to your answer of Q1)

- ◯ 少于每周一
- ◯ 每周一
- ◯ 每周
- ◯ 每周　　七　5　7

8.通常而言，在决定您是否使用某种交通工具时，以下每一个因素有多重要？（最高5分） *

Generally,how important are each of the following factors in determining whether or not you use this transit?

全程用时 Door-to-door travel time	1 分为非常不重要,5 分为非常重要, 您的评分是 _____ 分
在站候车时的安全（如交通事故及犯罪行为） Safety while at station/stop (safety from accidents and/or crime)	1 分为非常不重要,5 分为非常重要, 您的评分是 _____ 分
搭乘交通工具时的安全（如交通事故及犯罪行为） Safety while riding the service (safety froma accidents and/or crime)	1 分为非常不重要,5 分为非常重要, 您的评分是 _____ 分
出行费用（如车票费用） Travel cost (transit fare)	1 分为非常不重要,5 分为非常重要, 您的评分是 _____ 分
车次频率 Frequency of service (how often service runs)	1 分为非常不重要,5 分为非常重要, 您的评分是 _____ 分
在站候车时的舒适度（如站台设施，天气影响等） Comfort while waiting at station/stop (shelter from weather, amenities, etc.)	1 分为非常不重要,5 分为非常重要, 您的评分是 _____ 分
其他乘客（如安全感/自在感/与他人共享此服务时的兼容感等） Other riders (feeling secure/at ease/compatible with others using the services,etc.)	1 分为非常不重要,5 分为非常重要, 您的评分是 _____ 分
服务方便度 Convenience of service (goes where you need to go/parking availability)	1 分为非常不重要,5 分为非常重要, 您的评分是 _____ 分
客户服务（由司机以及工作人员提供）	1 分为非常不重要,5 分为非常重要, 您的评分是 _____ 分

Customer service (provided by drivers and other transit service staff)		
服务可信度（车次是否按时） Reliability of service (does the service run on time)	1 分为非常不重要,5 分为非常重要, 您	分是 _____ 分
服务时是否 （信 找到路线等） Ease of service use (clear service info, routes esay to figure out, etc.)	1 分为非常不重要,5 分为非常重要, 您	分是 _____ 分
服务运营时间（早末班车时间） Hours of service (how early or late service runs, and/or weekend hours)	1 分为非常不重要,5 分为非常重要, 您	分是 _____ 分
车内舒适度（ 座椅 温度 干净程度等） Comfort while riding (seats available, temperature, smooth ride, cleanliness, etc.)	1 分为非常不重要,5 分为非常重要, 您	分是 _____ 分
避免 汽车 压力及开销（ 交通 停车 事故及罚单等） Avoid stress/cost of car use (traffic, parking, accidents, tickets, etc.)	1 分为非常不重要,5 分为非常重要, 您	分是 _____ 分

9.请为广州BRT / 普通公交车（根据您第一题的选择）的各类服务性质打分 *

Please rate the BRT / conventional bus service (according to your answer of Q1) in Guangzhou in terms fo the different service attributes presented below.

全程用时 Door-to-door travel time	1 分为非常不满意,5 分为非常满意, 您的评分是 _____ 分
在站候车时的安全（如交通事故及犯罪行为） Safety while at station/stop (safety from a accidents and/or crime)	1 分为非常不满意,5 分为非常满意, 您的评分是 _____ 分
搭乘交通工具时的安全（如交通事故及犯罪行为） Safety while riding the service (safety froma accidents and/or crime)	1 分为非常不满意,5 分为非常满意, 您的评分是 _____ 分
出行费用（如车票费用） Travel cost (transit fare)	1 分为非常不满意,5 分为非常满意, 您的评分是 _____ 分
车次频率 Frequency of service (how often service runs)	1 分为非常不满意,5 分为非常满意, 您的评分是 _____ 分
在站候车时的舒适度（如站台设施，天气影响等） Comfort while waiting at station/stop (shelter from weather, amenities, etc.)	1 分为非常不满意,5 分为非常满意, 您的评分是 _____ 分
其他乘客（如安全感/自在感/与他人共享此服务时的兼容感等） Other riders (feeling secure/at ease/compatible with others using the services,etc.)	1 分为非常不满意,5 分为非常满意, 您的评分是 _____ 分
服务方便度 Convenience of service (goes where you need to go/parking availability)	1 分为非常不满意,5 分为非常满意, 您的评分是 _____ 分
	1 分为非常不满意,5 分为非常满意, 您的评分是 _____ 分

客户服务（由司机以及工作人员提供） Customer service (provided by drivers and other transit service staff)	
服务可信度（车次是否按时） Reliability of service (does the service run on time)	1 分为非常不满意,5 分为非常满意, 您的评分是 _____ 分
使用服务时是否便利（如清晰的信息，容易找到路线等） Ease of service use (clear service info, routes esay to figure out, etc.)	1 分为非常不满意,5 分为非常满意, 您的评分是 _____ 分
服务运营时间（早末班车时间） Hours of service (how early or late service runs, and/or weekend hours)	1 分为非常不满意,5 分为非常满意, 您的评分是 _____ 分
车内舒适度（如座椅，温度，干净程度等） Comfort while riding (seats available, temperature, smooth ride, cleanliness, etc.)	1 分为非常不满意,5 分为非常满意, 您的评分是 _____ 分
避免使用汽车的压力及开销（如交通，停车，事故及罚单等） Avoid stress/cost of car use (traffic, parking, accidents, tickets, etc.)	1 分为非常不满意,5 分为非常满意, 您的评分是 _____ 分

如果您告诉我多一些关于您的信息，那将对我们很有帮助。

it would help us a lot if you also provide this additional information about yourself

10.您或您的家庭是否拥有私家车? *

Private vehicle household ownership

- ◯ 是，不止一辆 Yes, more than one
- ◯ 是，拥有一辆 Yes, only one
- ◯ 没有 No

11.您目前是否拥有驾照? *

Status of driving license

- ◯ 是 Yes, I hold one
- ◯ 没有 No

12.您的性别 *

Gender

- ◯ 女性 Female
- ◯ 男性 Male

13.您的年龄 *

Age

- ◯ 10 – 19
- ◯ 20 – 29
- ◯ 30 – 39
- ◯ 40 – 49
- ◯ 50 – 59
- ◯ 60 +

14.您目前的职业状态是? *

Occupational status

- 学生 Student
- 全职 Full-time employee
- 兼职 Part-time employee
- 自雇 Self-employee
- 暂无职业/离职 Unemployed
- 退休人员 Retired
- 其他 Other

15.您的受教育程度 *

Educational level

- 初中 Junior high school
- 高中 Senior high school
- 高等专科 Higher professional school
- 大学本科 Undergraduate – bachelor degree
- 硕士研究生 Postgraduate – master degree
- 博士研究生 Postgraduate – doctoral degree
- 博士后 Postdoctoral researcher
- 不便透露 Prefer not to say

16.您的个人月收入为？ *

Income monthly

- ◯ 0 – 2500 rmb
- ◯ 2500 – 5000 rmb
- ◯ 5000 – 7500 rmb
- ◯ 7500 – 10000 rmb
- ◯ 10000 + rmb
- ◯ 不便透露 Prefer not to say

17.对于现有的广州BRT / 普通公交车系统（根据您第一题的选择），您觉得应该改进或提升的方面有：[多选题] *

Any improvements or suggestions should be implemented on the current Guangzhou BRT / conventional bus system (according to your answer of Q1)

- ☐ 更低的票价 Cheaper fare
- ☐ 更多的运营线路 More BRT operating route
- ☐ 更长的运营时间 Longer operating time
- ☐ 更频繁的班次 More frequent service
- ☐ 与更多的其他交通方式融合 Combine with more transit mode

18.如果于上述问题您有任何更好的建议，请列举。

Please state any other suggestions being not listed for the above question.

对于您的参与作者表示衷心的感谢!
Highly appreciate for your participation!

RISK ASSESSMENT FORM
FIELD / LOCATION WORK

The Approved Code of Practice - Management of Fieldwork should be referred to when completing this form
http://www.ucl.ac.uk/estates/safetynet/guidance/fieldwork/acop.pdf

DEPARTMENT/SECTION BARTLETT SCHOOL OF PLANNING
LOCATION(S) LONDON, BLOOMSBURY
PERSONS COVERED BY THE RISK ASSESSMENT DAI(KIMBER) LI

BRIEF DESCRIPTION OF FIELDWORK SURVEY

EQUIPMENT	Is equipment used?	No	If 'No' move to next hazard If 'Yes' use space below to identify and assess any risks
e.g. clothing, outboard motors.	Examples of risk: inappropriate, failure, insufficient training to use or repair, injury. Is the risk high / medium / low?		

CONTROL MEASURES	Indicate which procedures are in place to control the identified risk
☐	the departmental written Arrangement for equipment is followed
☐	participants have been provided with any necessary equipment appropriate for the work
☐	all equipment has been inspected, before issue, by a competent person
☐	all users have been advised of correct use
☐	special equipment is only issued to persons trained in its use by a competent person
☐	OTHER CONTROL MEASURES: please specify any other control measures you have implemented:

LONE WORKING	Is lone working a possibility?	Yes	If 'No' move to next hazard If 'Yes' use space below to identify and assess any risks
e.g. alone or in isolation lone interviews.	Examples of risk: difficult to summon help. Is the risk high / medium / low?		

GENERALLY WITH LOW RISK

CONTROL MEASURES	Indicate which procedures are in place to control the identified risk
☐	the departmental written Arrangement for lone/out of hours working for field work is followed
☐	lone or isolated working is not allowed
☐	location, route and expected time of return of lone workers is logged daily before work commences
☐	all workers have the means of raising an alarm in the event of an emergency, e.g. phone, flare, whistle
☐	all workers are fully familiar with emergency procedures
☒	OTHER CONTROL MEASURES: please specify any other control measures you have implemented:

ILL HEALTH	The possibility of ill health always represents a safety hazard. Use space below to identify and assess any risks associated with this Hazard.
e.g. accident, illness, personal attack, special personal considerations or vulnerabilities.	Examples of risk: injury, asthma, allergies. Is the risk high / medium / low? LOW RISK

CONTROL MEASURES	Indicate which procedures are in place to control the identified risk
☐	an appropriate number of trained first-aiders and first aid kits are present on the field trip
☐	all participants have had the necessary inoculations/ carry appropriate prophylactics
☐	participants have been advised of the physical demands of the trip and are deemed to be physically suited
☐	participants have been adequate advice on harmful plants, animals and substances they may encounter
☐	participants who require medication have advised the leader of this and carry sufficient medication for their needs
☒	OTHER CONTROL MEASURES: please specify any other control measures you have implemented:

TRANSPORT	Will transport be required	NO		Move to next hazard
		YES	√	Use space below to identify and assess any risks
e.g. hired vehicles	Examples of risk: accidents arising from lack of maintenance, suitability or training Is the risk high / medium / low? GENERALLY LOW RISK			

CONTROL MEASURES	Indicate which procedures are in place to control the identified risk
☒	only public transport will be used
☐	the vehicle will be hired from a reputable supplier
☐	transport must be properly maintained in compliance with relevant national regulations
☐	drivers comply with UCL Policy on Drivers http://www.ucl.ac.uk/hr/docs/college_drivers.php
☐	drivers have been trained and hold the appropriate licence
☐	there will be more than one driver to prevent driver/operator fatigue, and there will be adequate rest periods
☐	sufficient spare parts carried to meet foreseeable emergencies
☐	OTHER CONTROL MEASURES: please specify any other control measures you have implemented:

DEALING WITH THE PUBLIC	Will people be dealing with public	Yes	If 'No' move to next hazard If 'Yes' use space below to identify and assess any risks
e.g. interviews, observing	Examples of risk: personal attack, causing offence, being misinterpreted. Is the risk high / medium / low? GENERALLY LOW RISK		

CONTROL MEASURES	Indicate which procedures are in place to control the identified risk
☒	all participants are trained in interviewing techniques
☐	interviews are contracted out to a third party
☐	advice and support from local groups has been sought
☐	participants do not wear clothes that might cause offence or attract unwanted attention
☒	interviews are conducted at neutral locations or where neither party could be at risk
☐	OTHER CONTROL MEASURES: please specify any other control measures you have implemented:

WORKING ON OR NEAR WATER	Will people work on or near water?	No	If 'No' move to next hazard If 'Yes' use space below to identify and assess any risks
e.g. rivers, marshland, sea.	Examples of risk: drowning, malaria, hepatitis A, parasites. Is the risk high / medium / low?		

CONTROL MEASURES	Indicate which procedures are in place to control the identified risk
☐	lone working on or near water will not be allowed
☐	coastguard information is understood; all work takes place outside those times when tides could prove a threat
☐	all participants are competent swimmers
☐	participants always wear adequate protective equipment, e.g. buoyancy aids, wellingtons
☐	boat is operated by a competent person
☐	all boats are equipped with an alternative means of propulsion e.g. oars
☐	participants have received any appropriate inoculations
☐	OTHER CONTROL MEASURES: please specify any other control measures you have implemented:

MANUAL HANDLING (MH)	Do MH activities take place?	No	If 'No' move to next hazard If 'Yes' use space below to identify and assess any risks
e.g. lifting, carrying, moving large or heavy equipment, physical unsuitability for the task.	Examples of risk: strain, cuts, broken bones. Is the risk high / medium / low?		

CONTROL MEASURES	Indicate which procedures are in place to control the identified risk
☐	the departmental written Arrangement for MH is followed
☐	the supervisor has attended a MH risk assessment course
☐	all tasks are within reasonable limits, persons physically unsuited to the MH task are prohibited from such activities
☐	all persons performing MH tasks are adequately trained
☐	equipment components will be assembled on site
☐	any MH task outside the competence of staff will be done by contractors
☐	OTHER CONTROL MEASURES: please specify any other control measures you have implemented:

SUBSTANCES	Will participants work with substances	No	If 'No' move to next hazard If 'Yes' use space below to identify and assess any risks
e.g. plants, chemical, biohazard, waste	Examples of risk: ill health - poisoning, infection, illness, burns, cuts. Is the risk high / medium / low?		

CONTROL MEASURES **Indicate which procedures are in place to control the identified risk**

- ☐ the departmental written Arrangements for dealing with hazardous substances and waste are followed
- ☐ all participants are given information, training and protective equipment for hazardous substances they may encounter
- ☐ participants who have allergies have advised the leader of this and carry sufficient medication for their needs
- ☐ waste is disposed of in a responsible manner
- ☐ suitable containers are provided for hazardous waste
- ☐ OTHER CONTROL MEASURES: please specify any other control measures you have implemented:

OTHER HAZARDS	Have you identified any other hazards?	No	If 'No' move to next section If 'Yes' use space below to identify and assess any risks
i.e. any other hazards must be noted and assessed here.	Hazard: Risk: is the risk		

CONTROL MEASURES **Give details of control measures in place to control the identified risks**

Have you identified any risks that are not adequately controlled?			
	NO	☒	**Move to Declaration**
	YES	☐	**Use space below to identify the risk and what action was taken**

Is this project subject to the UCL requirements on the ethics of Non-NHS Human Research? No

If yes, please state your Project ID Number

For more information, please refer to: http://ethics.grad.ucl.ac.uk/

DECLARATION The work will be reassessed whenever there is a significant change and at least annually. Those participating in the work have read the assessment.

Select the appropriate statement:

- ☒ I the undersigned have assessed the activity and associated risks and declare that there is no significant residual risk
- ☒ I the undersigned have assessed the activity and associated risks and declare that the risk will be controlled by the method(s) listed above

NAME OF SUPERVISOR PROF STEPHEN MARSHALL

**** SUPERVISOR APPROVAL TO BE CONFIRMED VIA E-MAIL ****