

MODEL FOR EFFECTIVE BUS RAPID TRANSIT RIDERSHIP BASED ON
USERS' PERCEPTION

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Specially dedicated to my

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for their unconditional love and immense support throughout my life.

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ABSTRACT

Users' perception is among the important factors that influence public transport ridership in developed and developing countries. Although there are literatures listing various significant factors that affect ridership, the users' perception about public transport ridership is considerably neglected especially in developing countries like Pakistan. Regardless of the prevailing problems with the Bus Rapid Transit (BRT) in Lahore, the ridership is high and exceed the capacity. Therefore, this study attempts to develop a BRT ridership model based on users' perception in Lahore using factors that are responsible to attract the users. A questionnaire was developed based on the indicators and the conceptual model extracted from the literature. This questionnaire comprises of 57 ridership-related indicators grouped into eight categories. Structural Equation Modelling (SEM) technique is applied to analyse the collected data. The final ridership model is achieved through Confirmatory Factor Analysis (CFA) and Second Order Confirmatory Factor Analysis (SOCFA). The model suggests that technical and technological factors of Lahore Bus Rapid Transit system are the most important factors for BRT ridership in Lahore based on the users' perception. The important technical and technological factors include the availability of information on the web, convenient ticketing system, and updated facilities for stations, bus and vehicle. While, the indicators which are categorised under users' convenience such as parking and pedestrian crossings have the least association with ridership. Even though the proposed model was tested for the BRT in Lahore only, since the indicators and the conceptual model were obtained from the existing literature, the same modelling process can be used for other transit modes in other world cities. This model can help planners develop effective transport planning strategies to improve BRT Lahore by considering the users' perception.

ABSTRAK

Persepsi pengguna adalah antara faktor penting yang mempengaruhi penumpang pengangkutan awam di negara maju dan membangun. Walaupun terdapat kajian lepas yang menyenaraikan pelbagai faktor penting yang mempengaruhi kadar penumpang, persepsi pengguna terhadap penggunaan pengangkutan awam masih diabaikan terutama di negara-negara membangun seperti Pakistan. Walaupun terdapat masalah yang dihadapi oleh *Bus Rapid Transit* (BRT) di Lahore, kadar penumpang adalah tinggi dan melebihi kapasiti. Oleh itu, kajian ini cuba untuk membangunkan Model Penumpang BRT berdasarkan persepsi pengguna di Lahore dengan menggunakan faktor yang berupaya menarik pengguna. Soal selidik telah dibangunkan berdasarkan kepada indikator dan konsep model yang diperolehi dari kajian lepas. Soal selidik ini terdiri daripada 57 petunjuk berasaskan penumpang yang dikelompokkan kepada lapan kategori. Teknik Permodelan Persamaan Struktur (SEM) digunakan untuk menganalisis data yang terkumpul. Model Penumpang terakhir dicapai melalui Analisis Faktor Pengesahan (CFA) dan Analisis Faktor Pengesahan Kedua (SOCFA). Model ini menunjukkan bahawa faktor teknikal dan teknologi sistem BRT Lahore adalah faktor terpenting bagi kadar penumpang BRT di Lahore berdasarkan persepsi pengguna. Faktor teknikal dan teknologi yang penting termasuk kebolehdapatan maklumat di laman sesawang, sistem tiket yang mudah, dan kemudahan terkini untuk stesen, bas dan kenderaan. Sebaliknya, faktor yang dikategorikan di bawah kemudahan pengguna seperti tempat letak kereta dan lintasan pejalan kaki mempunyai perkaitan yang terendah dengan penumpang. Walaupun model yang dicadangkan telah diuji untuk BRT di Lahore sahaja kerana faktor dan model konseptual diperolehi daripada kajian lalu yang sedia ada, proses pemodelan yang sama boleh digunakan untuk mod transit lain di bandar-bandar lain di dunia. Model ini boleh membantu para perancang membangunkan strategi perancangan pengangkutan yang berkesan untuk menambahbaik BRT Lahore dengan mengambil kira persepsi penumpang.

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LIST OF ABBREVIATIONS

BRT	-	Bus Rapid Transit
PT	-	Public Transport
SEM	-	Structural Equation Modelling
ANOVA	-	Analysis of Variance
CFI	-	Comparative Fit Index
GFI	-	Goodness of Fit Index
RMSEA	-	Root mean square estimate appro
ML	-	Maximum Likelihood
KMO	-	Kaiser-Meyer-Olkin Measure
CFA	-	Confirmatory Factor Analysis
SOCFA	-	Second Order Confirmatory Factor Analysis

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CHAPTER 1

INTRODUCTION

1.1 Background

The importance of an efficient and attractive transport system can be judged by its plausible impact on sustainable urban development. Transportation contributes to improved economic activities by ensuring an efficient mobility of people to access their workplaces and other services safely and in a timely manner. Over the recent years, the urbanization of the developing countries has increased drastically (Rafiq et al., 2016). Due to this alarmingly high population growth rate, the urban infrastructure around the housing as well as the commercial areas is being developed in such a way to incorporate more privately-owned vehicles. This growing motorisation level is leading to several alarming issues, for instance, the problems of pollution, congestion (Beirão & Cabral, 2007), high consumption and prices of fuel (Hensher, 1998; Sheinbaum-Pardo & Chávez-Baeza, 2011), road accidents (Kingham et al., 2001) and an increased cost (Hagman, 2003; Beirão & Cabral, 2007) arise due to excessive usage of private mode of transportation. Therefore, shifting people to the public transport is essential, although, it is a tough task to attract people towards public transport. Various studies related to shifting passengers from private to public transport are being done.

There is a comprehensive amount of literature available analyzing the various aspects of public transportation system. One of the important aspects is the public transport accessibility. An accessible public transport is an effective transit service which involves crucial transit system characteristics such as a convenient infrastructure, sufficient stations, feasible proximity of stations and provision of feeder bus service. Affordability is another crucial factor for effective public transport that is related to the income level of users, comparative cost and fare price. Similarly, transit-related safety, comfort and reliability are critical issues in transport planning research.

Improving such factors (accessibility, affordability, safety, comfort and reliability) in a transport service, makes it more attractive for the commuters leading to a shift from other transport modes to a more effective one. In this way, the number of passengers on that particular transport service increases. The number of passengers riding on a particular transport service is ridership. Increase in ridership of public transport improves the financial stability, socio-economic wellbeing and environmental sustainability of a country. However, public transport ridership is still substantially under-researched in developing countries putting commuters' welfare at stake.

Because of the scarcity of resources, users as well as providers make choices on specific grounds such as fares, quality and accessibility. Public transport system should be reliable, affordable, accessible, safe, fast and comfortable with minimal environmental impact to improve the number of passengers. There is a need to study the phenomenon of public transport ridership keeping in view the perceived quality to provide a feasible service. The perception of users about the transport service is crucial to evaluate the factors that attract them to a particular transport service. There is a body of literature on the service quality, satisfaction level of the passengers and travel behavior, however, the identification of effective factors of ridership based on users' perception has been under-studied especially in the developing countries.

This research aims to investigate the significant factors of public transport ridership based on users' perception. A good public transport contributes significantly to a high economic and social performance. Pricing factors have been frequently analyzed influencing ridership, however, service quantity and service quality factors are other important groups of ridership indicators (Taylor & Fink, 2003). Various studies have been done in the developed countries in this regard. However, in addition to the consideration of considerably neglected users' perception in the developing countries, this study also focuses on the determination of public transport ridership indicators. Keeping in view various factors of the ridership in public transport system, this study evaluates key variables that affect ridership based on users' perception.

Pakistan is a developing country with poor management and economic facilities. Currently, the public transport system of Pakistan needs to be paid attention

due to the reason that the quality of the public transport contributes to economic development. In a populous city like Lahore, thousands of people travel daily for work, education and recreational purpose. However, public transport of Lahore lacks the ability to provide a convenient, effective and attractive service. The providers do not focus on designing the facilities according to the nature of the commuters. Monzón et al. (2013) mentions that the effectiveness of public transportation is affected by the creation of this lack of internal coordination causing a continuous decline in the ridership levels. In order to increase the ridership level, the service provided by the providers must match the expectations of the users. Improved transport ridership leads to a sustainable urban development. Because of the poorly planned public transportation system, commuters use private vehicles, creating several economic and environmental issues such as congestion, travel cost, an increased travel time, pollution and excessive fuel consumption. The increase in travel costs, environmental pollution, and travel time affect the productivity of the commuters significantly (Harriet et al., 2013).

Lahore is the second largest city of Pakistan with the neglected public transport sector. Considering that only 16% of the total trips of the the commuters in the city are made by using public transport (BRTdata, 2019), therefore, this sector needs to be paid attention. It is evident that, public transport users of Lahore are facing several issues affecting their productivity. Most of the transport systems implemented in Lahore are merely for profit, neglecting the users' needs. As mentioned by Rana & Bhatti (2018), millions of commuters in Lahore use worn-out buses, vans and rickshaws to fulfil their travel needs. However, surprisingly public transport of Lahore has not yet been adequately addressed in the literature.

After the implementation of Pakistan's first Bus Rapid Transit (BRT) system in 2013, public transport modes used in Lahore are mainly the BRT, vans, taxis and rickshaws (Rana & Bhatti, 2018). BRT Lahore is a 27 Km corridor taking masses through important attractions of the city (Figure 1.1; 1.4). However, Rathore & Ali (2015) mentioned that BRT Lahore is only a "Basic BRT" with lower boarding capacity, least safety measures and poor service planning. BRT Lahore is the first ever modern form of the transit system in the country. Although being operational for six

years, the system still fails to provide the required level of service. One of the notable issues is the provision of insufficient and uncomfortable transportation service to the users. The daily ridership of BRT is high enough to exceed the capacity and a considerable number of users do not find seat to make their trip safe and comfortable (Ahmed & Azeem, 2015; Rathore & Ali, 2015; Figure 1.2). Interestingly, they still prefer it over other public transport services for the same route. Passengers' safety is also at stake due to the oversight of crucial quality factors. For instance, on February 25, 2019, an accident near Youhanabad station killed 22-year old female University student and injured 25 (The Express Tribune, 2019; Figure 1.3). Another accident on February 18, 2013, caused one death near Gulabdevi Intersection while several other accidents causing several injuries are reported (Ahmed & Azeem, 2015). Moreover, the productivity of BRT Lahore is 12 persons/hour; that is the minimum acceptable standard for productivity (Ahmed & Azeem, 2015). In the current research, BRT Lahore has been taken as a study area to find the significant factors that are responsible to attract passengers towards it despite of various deficiencies.



Figure 1.1 Bus Rapid Transit Lahore



Source: Haider, 2014

Figure 1.2 Jam packed bus during peak hours



Source: Express Tribune, 2019

Figure 1.3 BRT Lahore Collision, February 2019



Figure 1.4 BRT Lahore

It is evident from the review of literature that there are some considerably neglected context variables in public transport studies of the developing countries such as environmental impact, technological improvements and pedestrian facilities. However, such factors have an undeniable impact on the ridership of public transport. It is required to address these factors in order to find the most important factors of public transport ridership in the developing countries. For instance, transport planning includes the importance of pedestrian facilities, but their impact on public transport ridership has been under-researched. Provision of pedestrian facilities (such as walkways, cycling paths) make public transport accessible for the users and improves the ridership. Considering users' perception of such factors can help improve the ridership modelling. Lack of such vital factors in the previous studies in developing countries has created a gap in the research.

In the developed countries, many studies have been done in the context of the public transport ridership, however, only a few studies are present in the literature related to the developing countries. Therefore, there are unrealistic and impractical policies in the developing countries. For instance, the policies designed to promote car use as well as automobile-oriented space in developed world, for convenient door-to-door transportation, is economically and socially impractical in developing countries (Vasconcellos, 1997). Additionally, the customer satisfaction level is essential to assess their perception about the public transport system (Casas & Delmelle, 2017). Satisfied customers intend to use the particular transport service more (Li, 2018). Some literature related to the factors such as safety, security, comfort, coverage, and cleanliness can be found in the developing countries. However, little effort has been made to investigate the sufficient number of variables altogether, including the latent and observed variables. Although, a body of literature can be found related to the passenger satisfaction level to analyse the service quality, however, the perception of the passengers towards public transport ridership has been studied insufficiently. Perception of users is essential while planning an attractive and good quality public transport system. However, various ridership studies lack users' perception. For instance, Kohn (2000); Taylor & Fink, (2003); Vuchic (2005) have examined ridership factors neglected users' perception by review of literature and considering data from transport providers. The commuter has the power to decide the fate of the provided service. Unsatisfied users will not prefer using that transport service, leading to a decline in the ridership and, an economic, social and financial loss. This leads to the need for identification of important ridership factors that attract users towards BRT Lahore. Such a ridership model can be helpful to improve the system itself and can be applied in other public transport systems to improve their ridership along with ensuring a comfortable service.

1.2 Problem Statement

The developing countries face several social, economic and political challenges frequently. Due to which it is impossible to make future decisions in the developing countries based on the theories established in the developed countries. Various

transport planning policies have been established in the developed countries, however, there is a lack of effective policies in the developing countries to improve their transport system. For instance, the cycle promoting policies, to limit the number of private vehicles, are effective in developed countries, however, in the developing countries, cycling is less applicable due to social issues as well as the lack of adequate infrastructure. Public transport ridership is an important concern that leads to the improvement of environmental and socio-economic welfare of the society. However, the ridership research has not yet been brought to developing countries sufficiently. For instance, Hadiuzzman et al. (2017) evaluated 22 factors that affect public transport ridership in Dhaka, Bangladesh and Tabassum et al. (2017) analysed the impact of accessibility on public transport ridership in Lahore, Pakistan. Analysing public transport ridership is very important to find effective solutions to the prevailing societal and developmental issues in the developing countries, however, it is neglected considerably. Current research intends to fill this gap by providing a deeper understanding of important ridership factors from the users' perception.

Several factors in an urban setting affect the ridership of a public transport system. However, perceived service quality determines the effectiveness of the transit service which attracts more users. Under the ridership studies, it is vital to consider the users' perception, since customers are the sole judges of the service quality (Berry et al., 1990). To find the significant factors that are responsible for improving the ridership, the perception of users is required to be studied. A body of literature is found on the ridership of the public transport through users' perception in the developed countries, but minimal studies have been done in the developing countries. For instance, in the developed countries; in Spain, De Ona et al. (2013) considered users' satisfaction survey of bus users and found that out of service, personnel and comfort, the service is the most important factor for the users. Similarly, Cirillo et al. (2011) found that in Italy, reliability is the most important public transport characteristic through users' perception. Moreover, it was found that safety has a positive impact on public transport ridership in Melbourne (Delbosc & Currie, 2012). On the other hand, very limited studies based on users' perception in the developing countries can be found.

In the public transport research of the developing countries, some context variables have been considerably neglected such as environmental impact (Taylor & Fink, 2003; Javid et al., 2015; Tabassum et al., 2017; Ngoc et al., 2017; Wong et al., 2017), technological improvements (Lai & Chen, 2011; Tabassum et al., 2017; Wong et al., 2017) and infrastructure (Redman et. al, 2013; Imam, 2014; Hadiuzzman et al., 2017). It is required to address such factors in order to analyse the public transport ridership in the developing countries. Factors such as technological improvements, environmental impact and pedestrian facilities have been neglected in the previous studies on the ridership. However, it is evident that such factors have an undeniable impact on the usage of the public transport. Lack of such important factors in the previous studies creates a gap in the research. By including these variables, a comprehensive ridership model can be proposed that includes essential factors based on users' perception.

1.3 Research Objectives

Research objectives of the study are

- 1) To identify the public transport ridership factors based on the users' perception.
- 2) To find the effect of socio-demographic factors on the ridership factors.
- 3) To find the most important factors that affect the public transport ridership based on the users' perception in Lahore.
- 4) To develop a model for public transport ridership based on the users' perception in Lahore.

1.4 Research Questions

Research questions of the study are as follows:

- 1) What are the factors of the public transport that improve the ridership based on the users' perception?
- 2) What is the effect of socio-demographic factors on the public transport ridership factors?
- 3) What are the most important factors that affect public transport ridership based on users' perception in Lahore?
- 4) What kind of model can explain the public transport ridership based on the users' perception in Lahore?

1.5 Scope and Limitation of the study

The study area of this research to test the proposed model is the public transport system of a metropolitan city of Pakistan, Lahore, the capital of the Punjab province. Lahore is a populous city with a population of 11,126,285 (Pakistan Bureau of Statistics, 2017). Congestion is a significant problem of Lahore because of a massive number of privately owned vehicles on the narrow roads especially during the peak hours, causing frequent delays. According to JICA (2012), the private motorised vehicle growth rate has increased to 17% per year between 2004 and 2008 in Lahore. Moreover, road accidents ratio is 15 per 1000 people per year in Pakistan (Ghaffar et al., 2004). Lahore has inefficient and insufficient transport planning strategies, causing congestion (JICA, 2012). Being a big city, where every day thousands of people travel for education and work purposes, Lahore needs a well-planned and easily accessible public transport system.

Pakistan's first Bus Rapid Transit system is operational in Lahore since February 2013, that runs from Gajju Mata to Shahdara within the city. There are 63 single articulated buses carrying masses over a 27 kilometres corridor. Lahore

Development Authority (LDA) constructed the Metro Bus system in Lahore by seeking help from Turkish experts to create a copy of Metro Bus of Istanbul and is managed by Punjab Metrobus Authority. BRT Lahore has only achieved “Basic BRT” standard (Rathore & Ali, 2015), although, the infrastructure is embellish by the comfortable platform seating area, escalators on various platforms, hi-tech ticketing sensors, ground level bus entrance, separate seating for men and women, overhead and underground roads and enough lighting produced by generators during dark hours.

A 5-point Likert scale questionnaire is designed to find out the most important ridership factors from the users’ perception. The statements in the questionnaire reflect the factors that are identified from the existing literature. Also, the questionnaire includes the socio-demographic profile of the users. Data is collected from the users of Bus Rapid Transit Lahore to find out the factors that are responsible for choosing their preferred public transport mode.

The factors were identified from the various ridership studies from different countries. Therefore, the proposed model contains sufficient factors that were found to be important in different geographical locations. This model can also be applied in other public transport systems as well. However, in this research, this model is limited to the user’s perception of Lahore city only. People’s perception and behaviours may vary in different urban areas. However, due to the limitation of time and resources, only one study area has been taken into consideration. The model, if implemented in other urban areas, can produce overall outcomes. Moreover, this study is limited to BRT users’ perception only. However, the research can be extended further using spatial, financial and statistical data related to the public transport system.

1.6 Research Assumptions

In this study, it is assumed that there will be no significant changes during the data collection period. There will be no policy change and no design change of the existing road network. It is assumed that no change in the public transport routes will

occur during the data collection. There will be no change in the existing operational systems of the public transport.

1.7 Expected Contribution

This research adds to the knowledge of public transport ridership. Improving the ridership is an essential concern for public transport planners these days. This study intends to develop a model for effective ridership factors for BRT through the user's perception. This research can be used to improve public transport system that fulfils the needs of the users successfully. This study will be helpful for the planners and decision makers to make informed decisions, keeping in view the demand side of the transport markets. More demand for public transport increases the ridership, hence recovering cost and increasing the revenue. Considering the users' perceptions, this research can effectively contribute to provide a high-quality public transport to the commuters in Lahore, Pakistan. This will assist in generating more socio-economic benefits to the users. An effective public transport helps to create employment, save resources and control pollution.

1.8 Significance of the research

In the literature, ridership has been under studied by the researchers. While, studies that investigate transit service quality, travel behaviour, users' satisfaction, travel demand and loyalty factors can be extensively found. This research primarily evaluates the effective factors that affect the ridership of a public transport system by combining the previous studies related to the service quality, travel behaviour, users' satisfaction, travel demand and loyalty. Moreover, previous researches neglected several important factors such as pedestrian facilities, technological improvements, environmental impact etc. However, such factors are essential to analyse ridership due to their direct relation with the users. This research intends to include the previously neglected factors. Likewise, the combined effect of different aspects of the ridership

(environmental, financial and technical factors etc.) has been neglected. This research provides an enhanced understanding of the significant factors affecting the public transport ridership in Lahore, Pakistan, by including eight latent factors as well as fifty-seven observed items. Existing transport planning literature lacks such a comprehensive ridership model.

1.9 Research Design

Variables that affect public transport ridership are identified through the literature review. A conceptual model for the public transport ridership, based on the literature review was developed in the first step. Next, a ridership questionnaire was designed based on the variables in the conceptual model. Data was collected from the users of public transport (BRT users in Lahore). The Population of people using the BRT in Lahore is more than 200 thousand. The sample size for this study has been calculated through the Krejci-Morgan Table as well as sample size calculation formula. The socio-demographic section of the questionnaire was analysed through the descriptive statistics as well as inferential statistics including t-test and ANOVA test. The ridership factors have been analysed with Structural Equation Modelling technique. Structural Equation Modelling technique, a collection of various techniques that deals with linear structural relationships among latent variables (Nachtigall et al., 2003), is used in this study to explain the effect of several latent variables that are related to the public transport ridership. AMOS software provides an easy user-interface to configure path diagrams, model fit, and estimate parameters (Nachtigall et al., 2003). The Confirmatory Factor Analysis process achieves the acceptable values of fit indices during the analysis process. A model is proposed that explains the effective public transport ridership factors. The results of the proposed model will help to suggest improvements from the users' perspective. Therefore, the results can be used to suggest some improvements to make public transport more attractive to the commuters. Figure 1.5 shows the flow chart of the said research design.

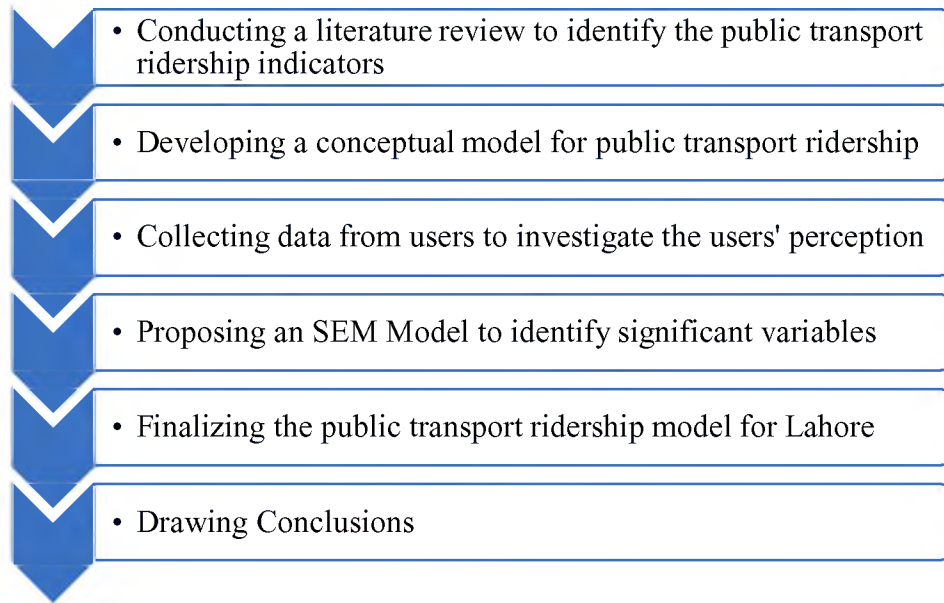


Figure: 1.5 Research design

1.10 Organization of the Thesis

Chapter 1 is an introductory chapter which presents an overview of the research. It focuses on the research background, problem statement, objectives of the research, the scope, research design, research assumptions, limitations, contribution and significance of the study. Chapter 2 focused on literature review. The first part of the review process focuses on identifying indicators of public transport ridership. It includes the concept, theories and benefits of an effective public transport system. The second part deals with the development of a conceptual model with the help of variables collected from the literature whereas the third part identifies the suitable methodology, sampling, data collection method and software to be used. Moreover, the scope of the study has also been explained. Chapter 3, presents the methodology applied in the study, the types of data required for the study, method and instrument of collecting the data, sampling, data analysis and software used. Chapter 4 reports the findings of this study. As a result of the analysis, the factors that are most significant from the users' perception are mentioned. Their relationship with public transport ridership is described. Moreover, the frequency of the respondents under various demographical differences have been mentioned. Chapter 5 presents the final results

of the study. It discusses and summarises the study based on the findings. Furthermore, recommendations and suggestions are made for future studies have been given.

1.11 Chapter Summary

This chapter gives a conceptual background of the research. An introduction to the aim, objectives and research questions has been given. The concept and the background of the public transport ridership are explained. An increased use of the private vehicles leads to many issues such as congestion, pollution and travel delay. Therefore, in this industrialised era, commuters need an effective public transport system. The performance and the quality of a transport service makes it more attractive. Thus, to make it attractive, planners need to make effective strategies accordingly. The more the ridership, the more is the growth of public transport. Moreover, a description of the scope of the study is given. Users of BRT Lahore are taken as the respondents for the study. The research design includes the data collection through the ridership questionnaire from the users of BRT. Analysis of the data collected from 409 respondents has been done using Structural Equation Modelling technique in AMOS. The findings suggest the significant variables of the ridership from the users' point of view.

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