

INDIVIDUAL CONGESTION COSTS FOR PRIVATE MOTORIZED VEHICLE  
USERS (A CASE STUDY OF MALL ROAD CORRIDOR AND CIRCULAR  
ROAD CORRIDOR, LAHORE)

IMRAN NAWAZ

A project report submitted in partial fulfilment of the  
requirements for the award of the degree of  
Master of Science (Urban & Regional Planning)

Department of Urban & Regional Planning  
Faculty of Built Environment and Surveying  
Universiti Teknologi Malaysia

JANUARY 2019

## **DEDICATION**

This thesis is dedicated to my beloved parents, who have been a source of inspiration and gave us strength when I thought of giving up. They taught me that the best kind of knowledge to have is that which is learned for its own sake. It is also dedicated to my friends, teachers who shared their words of advice and encouragement to finish this study.

## ACKNOWLEDGEMENT

In preparing this thesis, I was in contact with many people, researchers, academicians, and practitioners. They have contributed towards my understanding and thoughts. In particular, I wish to express my sincere appreciation to my main thesis supervisor, Professor Dr. Mehdi Moeinaddini, for encouragement, guidance, critics and friendship. Without his continued support and interest, this thesis would not have been the same as presented here. The door to Dr. Mehdi Moeinaddini office was always open whenever I ran into a trouble spot or had a question about my research or writing.

I would also like to thank the respondents who were involved in the validation survey for this research project. Without their participation and positive input, the validation survey could not have been successfully conducted. I would also like to thank Universiti Teknologi Malaysia (UTM) Librarians, who deserve special thanks for their assistance in supplying the relevant literatures.

Finally, I must express my very profound gratitude to my parents and to my postgraduate students especially Tufail Ahmed for providing me with unfailing support and continuous encouragement throughout my study and through the process of researching and writing this thesis. This accomplishment would not have been possible without them. Unfortunately, it is not possible to list all of them in this limited space. Thank you

## ABSTRACT

Traffic congestion has severe effects on the economy, human well-being, safety and environment and almost all countries of the world either developing or developed are somehow affected by its adverse impacts. Lahore as a Metropolitan City faced numerous problems because of traffic congestion which puts direct effect on number of economic activities. Numerous studies have been performed in the past to estimate the congestion costs. However this study mainly focuses on the estimation of individual costs due to traffic congestion and the effects of socio-demographic factors on individual congestion costs of private motorized vehicle users. In this study proposed individual traffic congestion cost equation to estimate the costs whereas some statistical test i.e. ANOVA and T-test have been used to identify the effects of socio-demographic factors on individual congestion costs. This study is totally based on the primary data which was collected through filling of questionnaire from the respondents. The sample size for this study was 282 with confidence level 95% and sampling error 6%. The results of the study revealed that the individual congestion costs of the respondents lies between 22 Rs per day to 793 Rs per day. ANOVA and T-test suggests that that all the socio-demographic factors are effective in estimating the individual congestion costs. This research also revealed that the respondents who owned a car have more individual congestion costs as compared to the one who owned a motorbike. The expected contribution of this study will help the private motorized users to anticipate their cost so that they can effectively manage their vehicle expenses. Moreover it will also encourage people to change their travel behaviour to use transport effectively in their daily activities.

## ABSTRAK

Kesesakan lalu lintas memberi kesan yang teruk terhadap ekonomi, kesejahteraan manusia, keselamatan dan persekitaran dan hampir setaip pelusuk negara di dunia sama ada negara membangun atau negara maju turut terjejas oleh kesan yang tidak baik akibat kesesakan lalu lintas. Di Bandar Lahore atau lebih dikenali sebagai Kota Metropolitan menghadapi masalah kesesakan lalu lintas yang teruk telah memberi kesan secara langsung kepada jumlah aktiviti harian ekonomi. Banyak kajian telah dilakukan pada masa lalu untuk menganggarkan kos kesesakan. Walau bagaimanapun kajian ini terutamanya menumpukan pada anggaran kos individu disebabkan oleh kesesakan lalu lintas dan kesan faktor sosio-demografi terhadap kos kesesakan individu pengguna kenderaan bermotor swasta. Dalam kajian ini, cadangan persamaan kos kesesakan lalu lintas individu untuk menganggarkan kos manakala beberapa ujian statistik iaitu ANOVA dan ujian T telah digunakan untuk mengenal pasti kesan faktor sosio-demografi terhadap kos kesesakan individu. Kajian ini adalah berdasarkan data utama yang dikumpulkan melalui pengisian soal selidik dari responden. Dalam kajian ini, bilangan sampel untuk adalah 282 dengan tahap keyakinan 95% dan ralat persampelan 6%. Hasil kajian menunjukkan bahawa kos kesesakan individu responden terletak antara 22 Rs sehari hingga 793 Rs per hari. ANOVA dan T-ujian mencadangkan bahawa semua faktor sosio-demografi adalah berkesan dalam menganggarkan kos kesesakan individu. Kajian ini juga mendedahkan bahawa responden yang memiliki kereta mempunyai kos kesesakan individu yang lebih tinggi dibandingkan dengan yang memiliki motosikal. Akhir kata, sumbangan yang diharapkan dari kajian ini akan membantu pengguna bermotor swasta untuk menjangka kos mereka supaya mereka dapat menguruskan perbelanjaan kenderaan mereka dengan berkesan. Selain itu ia juga akan menggalakkan orang ramai untuk menukar tingkah laku perjalanan mereka untuk menggunakan pengangkutan dengan lebih berkesan dalam aktiviti harian mereka

## TABLE OF CONTENTS

	<b>TITLE</b>	<b>PAGE</b>
	<b>DECLARATION</b>	<b>ii</b>
	<b>DEDICATION</b>	<b>iii</b>
	<b>ACKNOWLEDGEMENT</b>	<b>iv</b>
	<b>ABSTRACT</b>	<b>v</b>
	<b>ABSTRAK</b>	<b>vi</b>
	<b>TABLE OF CONTENTS</b>	<b>vii</b>
	<b>LIST OF TABLES</b>	<b>x</b>
	<b>LIST OF FIGURES</b>	<b>xi</b>
	<b>LIST OF ABBREVIATIONS</b>	<b>xii</b>
	<b>LIST OF SYMBOLS</b>	<b>xiii</b>
	<b>LIST OF APPENDICES</b>	<b>xiv</b>
<b>CHAPTER 1</b>	<b>INTRODUCTION</b>	<b>1</b>
1.1	Introduction	1
1.2	Problem Background	2
1.3	Problem Statement	4
1.4	Research Objectives	5
1.5	Research Questions	5
1.6	Theoretical Framework	5
1.7	Scope of Research	6
1.8	Research Assumption	8
1.9	Limitations of Research	9
1.10	Expected Contribution	9
1.11	Significance of Research	9
1.12	Research Design	10
1.13	Chapter Outlines	11
1.14	Chapter Summary	12

<b>CHAPTER 2</b>	<b>LITERATURE REVIEW</b>	<b>13</b>
2.1	Introduction	13
2.2	Traffic Congestion	13
2.3	Previous Works	16
2.4	Important Indicators for Individual Cost	24
2.5	Analysis Methods in Traffic Cost Related Studies	27
2.6	Chapter Summary	30
<b>CHAPTER 3</b>	<b>RESEARCH METHODOLOGY</b>	<b>31</b>
3.1	Introduction	31
3.2	Identification of Traffic Congestion costs using literature review	32
3.3	Proposed Cost Estimated Method	33
3.4	Collecting Data	34
	3.4.1 Questionnaire Design	34
	3.4.2 Sampling and Sample size	34
3.5	Data Analysis	36
	3.5.1 Descriptive Analysis	36
	3.5.2 Estimating the individual congestion costs	37
	3.5.3 Effects of socio-economic factors on congestion costs	38
3.6	Study Area	39
3.7	Chapter Summary	40
<b>CHAPTER 4</b>	<b>ANALYSIS AND RESULTS</b>	<b>42</b>
4.1	Introduction	42
4.2	Socio-demographic Analysis	43
	4.2.1 Gender	43
	4.2.2 Age Limits	44
	4.2.3 Income Level	45
	4.2.4 Marital Status	46
	4.2.5 Vehicle Type	47
	4.2.6 Job Type	48
4.3	Individual Cost Calculations	49

4.4	Effects of Socio-demographic factors on individual costs	52
4.4.1	Effects of gender on individual costs	52
4.4.2	Effects of age limits on individual costs	56
4.4.3	Effects of income level on individual costs	61
4.4.4	Effects of marital status on individual costs	66
4.4.5	Effects of vehicle type on individual costs	69
4.4.6	Effects of job type on individual costs	73
4.5	Chapter Summary	78
<b>CHAPTER 5</b>	<b>CONCLUSION AND RECOMMENDATIONS</b>	<b>79</b>
5.1	Conclusions	79
5.1.1	Objective 1	79
5.1.2	Objective 2	80
5.1.3	Objective 3	81
5.1.4	Objective 4	82
5.2	Recommendations for further studies	83
<b>REFERENCES</b>		<b>85</b>

## LIST OF TABLES

<b>TABLE NO.</b>	<b>TITLE</b>	<b>PAGE</b>
Table 2.1	Traffic Congestion definitions (Aftabuzzaman, 2004)	16
Table 2.2	Individual Traffic Congestion Indicators	26
Table 4.1	Gender	43
Table 4.2	Age Limits	44
Table 4.3	Income Level	45
Table 4.4	Marital Status	46
Table 4.5	Vehicle Type	47
Table 4.6	Job Type	48
Table 4.7	Coefficient of individual cost indicators	50
Table 4.8	Individual traffic congestion costs	51
Table 4.9	Gender group statistics	54
Table 4.10	Gender independent sample T-test	55
Table 4.11	ANOVA test for age limits	58
Table 4.12	Descriptive statistics of age limits for individual costs	59
Table 4.13	Post hoc Tukey method for age limits	60
Table 4.14	ANOVA test for income level	64
Table 4.15	Descriptive statistics for income level on individual costs	64
Table 4.16	Post hoc Tukey method for income level	65
Table 4.17	Group statistics of marital status	68
Table 4.18	Independent sample T-test for marital status	69
Table 4.19	Group statistics of vehicle type	71
Table 4.20	Independent sample T-test for vehicle type	72
Table 4.21	ANOVA test for job type	75
Table 4.22	Descriptive statistics of job type for individual costs	76
Table 4.23	Post hoc Tukey method for job type	77

## LIST OF FIGURES

<b>FIGURE NO.</b>	<b>TITLE</b>	<b>PAGE</b>
Figure 1.1	Conceptual framework of Individual Traffic Congestion Cost	6
Figure 1.2	Traffic congestion in study area	7
Figure 1.3	Traffic jam points map	8
Figure 1.4	Operational Framework of Research	11
Figure 2.1	Income and Vehicles, Twenty-two countries, 2000 (Downs, 2003, p.275)	14
Figure 3.1	Research and Design Flow Chart	32
Figure 3.2	Study Area Map	40
Figure 4.1	Gender Proportion	43
Figure 4.2	Age Limits Proportion	44
Figure 4.3	Income Level Proportion	45
Figure 4.4	Marital Status Proportion	46
Figure 4.5	Vehicle Type Proportion	47
Figure 4.6	Job Type Proportion	48
Figure 4.7	Coefficient of individual cost indicators	50
Figure 4.8	Individual traffic congestion costs	52

## **LIST OF ABBREVIATIONS**

ITCC	-	Individual Traffic Congestion Cost
GNP	-	Gross National Product
VOC	-	Vehicle Operating Cost
USD	-	United State Dollar
PM	-	Particulate Matter
SPSS	-	Statistical Package of Social Science
ERM	-	Eastern Regional Transport Model
NTA	-	National Transport Authority
WTP	-	Willingness to Pay
SM	-	Strategy Method
PKR	-	Pakistan Rupee

## LIST OF SYMBOLS

$X^2$	-	Chi Square
$n$	-	Sample size
$N$	-	Population Size
$e$	-	Sampling error
$p$	-	Proportion of population

## LIST OF APPENDICES

<b>APPENDIX</b>	<b>TITLE</b>	<b>PAGE</b>
Appendix A	Questionnaire	89

# CHAPTER 1

## INTRODUCTION

### 1.1 Introduction

From the last three decades, rapid urbanization and growth brought hazardous issues in the world mainly to the developing countries. Many issues come in the way like traffic congestion, lack of funds for basic services, affordable housing and declining infrastructure (UN, 2015) which can be termed as public issues. Traffic congestion is causing drastic negative impacts mainly in urban areas due to increase in vehicle occupancy and inefficient public transport. The traffic congestion tends to delay, hinder and counterproductive for numerous economic activities in the city (Ali, Adnan, Noman, and Baqueri, 2014). It also hurt routine life of people; individual time delays, and additional cost of business activities from the workforce, supplier and customer markets (G Weisbrod, Vary, and Treyz, 2003).

The studies on traffic congestion related problems are examined under various areas, for example, environmental conditions and well-being. Conversely economic loss due to traffic congestion is also investigated in number of ways. Jonathan Levy and others in 2010 studied and described the negative impacts of traffic congestion on public health and determined how these impacts compare in magnitude to the economic cost (Levy, Buonocore, and Von Stackelberg, 2010). The study conducted by Australian Government, Department of Transport and Regional Service, estimated congestion cost of about USD 10 Billion which mainly include operating cost, private time cost and business time cost for all Australian cities (BTRE, 2007). In context of Pakistan, Faiq and others in 2012 studied and investigate the factors like encroachment on road, less parking facilities etc. of traffic jams in Karachi and determine its impact on performance of economy (Matin, Herani, & Warraich, 2012). Similarly another study which was conducted by Mir Shabbar Ali and others in 2014 estimated the traffic congestion cost on major arterial

in Karachi indicates that nearly 9000 USD were lost daily due to traffic congestion (Ali et al. 2014). The cost comprises travel time and fuel consumption. The methodology was based on collected data through tracking system and through socio-economic surveys.

The mega city like Lahore is also facing similar traffic jam problems, and there is no such efforts have been made to estimate the economic losses due to these congestions on major roads which are affecting social life as well as their business life. As during peak hours mostly people stuck in traffic congestion lost their precious time and money which indirectly reduced their productivity for work and make them stressful throughout the day. In addition, there are limited studies that estimate individual congestion costs for private motorized users. So, this research was designed to identify the factors that affect productivity for motorized user due to traffic congestion. Lahore a metropolitan city with a lot of traffic problems is chosen as a case study for this research.

## **1.2 Problem Background**

The residents of Lahore witness that the density of traffic has substantially increase since last decade and it is common now to stuck in heavy traffic jams even if commuter wants to cover a small distance. The reason behind the increase of traffic congestion in Lahore is mainly because of increase in car ownership and inward migration of people to avail diverse opportunities. The dominance of private car usage within city is likely to increase further as a result of rise in household income with occurrence of traffic congestion and high consumption of fuel (Harriet, Poku, and Emmanuel, 2013).

Traffic congestion has severe effects on the economy, human well-being, safety and environment. Almost all countries of the world either developing or developed are somehow affected by its adverse impacts (Golob & Regan, 2000). Lahore is a Metropolitan City which faced numerous problems because of traffic congestion and it puts direct effect on number of economic activities (Ali et al.

2014). The major portion of economy is linked with those workers who spend time for business activities and when congestion happened the workers in metropolitan areas delay in response which put adverse impacts on their economic activities (Matin et al, 2012), like most of the people in Lahore are working class so due to these congestion they cannot reach their work on time which result in economic loss in term of salary deduction for them. The productivity level reduces and interrupts due to traffic congestion which is a symbol of economic depression (Weisbrod, et al. 2017). Similarly, for the companies who are running online delivery business also received a lot of loss due to these congestion as they cannot deliver their items on time. Moreover, the people who are running their business will not get on time towards their destination faced economic consequences. This congestion also reduces the work efficiency as people stuck for so long which make them more frustrated and stressful. In addition, motorized users who stuck for so long in traffic consume more fuel and due to slow movement of vehicle and continuous foot on engine put pressure on engine which also increase the maintenance cost of vehicle.

Although the experts are working to reduce traffic flow in Lahore by introducing Mass Transit System and other public transport services, the congestion happens often everywhere and put economic pressure on working class. Throughout the world number of studies performed to resolve these issues like McKinnon in 2016 focuses on logistical problems due to the traffic congestion (Mckinnon, 2016). Another study in Bangladesh was conducted to estimate the congestion cost which include environmental, vehicle operating cost, social cost and travel time (Khan and Rashedul Islam, 2013). Beside this, one study was performed in Lahore regarding the economic loss due to traffic congestion and its impact on environment and other things which mainly includes time wasted, average earning of driver and fuel wastage (Hassan, 2017). Most of the studies that were performed in Lahore regarding traffic jams are related to environmental impacts like air quality monitoring of PM<sub>2.5</sub> and PM<sub>10</sub> in oldest market of Lahore (Moneeza Abbas, Ramsha Javed, Zunaira Javed, 2011) and others but no one calculated the individual congestion costs for private motorized users.

All the above mentioned studies helped in dealing the economic issues but these methods cannot be successful to estimate costs for individual motorized traffic

users due to traffic congestion as all the studies related with the overall traffic congestion costs of the area and the effects on drivers and income and there is a need to study the costs that workers or people who are doing business spent during traffic congestion and the factors that are affecting individual motorized vehicle users due to these congestion. Also previous models calculated the cost of one or two factors for overall area but no one calculated the cost for individual motorized users especially their productivity time.

### **1.3 Problem Statement**

Lahore is a hub of activities with diverse culture and economic activities. With the increase in population and vehicle ownership, the blockage on roads can be seen everywhere particularly on major roads during peak hours which not only disturb the social life of the residents but also affect their economic activities in term of productivity. For example, traffic congestion increase the travel time which causes time delay and loss working hour's results in productivity reduction (Matin et al, 2012). Similarly, this congestion made people more stressful which not only affect their health but also reduce work efficiency. Moreover, the vehicles stuck in traffic jams also consumed more fuel and it also exerts pressure on engine which will increase maintenance cost. These problems are the major factors which are affecting the individual users. However, the existing methods only calculate the congestion cost of overall area in term of time delay and fuel consumption and fewer studies calculate the cost that are related to individual private motorized vehicle users. This calculation is important to measure because due to this the people have better understanding about their cost and encourage them to change their travel behaviour.

## **1.4 Research Objectives**

The objectives of the research are:

1. To identify the indicators related to the direct congestion costs for individuals who use private motorized vehicles.
2. To weight the congestion costs for individuals who use private motorized vehicles.
3. To estimate the congestion costs for individuals who use private motorized vehicles.
4. To identify the effects of socio-demographic factors on the individuals congestion costs for private motorized vehicle users.

## **1.5 Research Questions**

1. What are the indicators related to congestion costs that can affect individual private motorized vehicles?
2. How important is the traffic congestion related cost for individual private motorized vehicles?
3. How the individual traffic congestion costs for private motorized vehicles can be estimated?
4. How can the socio-demographic factors affect the individual congestion costs for private motorized vehicles?

## **1.6 Theoretical Framework**

The theoretical framework is represented in Figure 1.1. The cause of traffic congestion is the increase in car ownership which affects the daily commuters who owns a vehicle. It basically affect individual in four major ways i.e. productivity reduction in terms of less working hours, increase stress level being stuck in congestion for so long, consumption of extra fuel and increase vehicle maintenance

cost. Individual traffic congestion cost equation will help to estimate the cost for individual's vehicle users so that they can forecast their expenses. It will also be incorporated in transportation policy making. Furthermore, this model can also be used in developing software's for cost management.

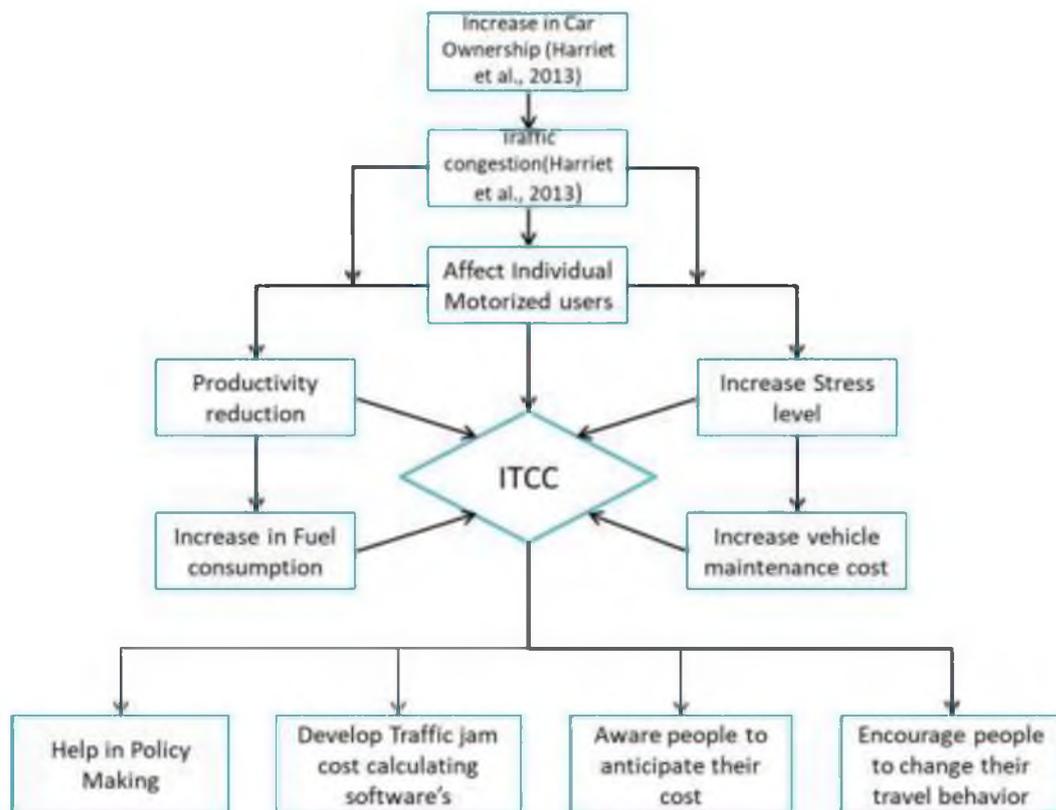


Figure 1.1 Conceptual framework of Individual Traffic Congestion Cost

## 1.7 Scope of Research

For this research, two corridors were selected as a case study. The traffic congestion occurred normally and affects individuals severely in these corridors. The selected corridors are:

- Mall Road Corridor from Canal Junction to Secretariat (5.1 km) (Figure 1.2)
- Circular Road Corridor from Data Darbar to Dehli Gate (2.8 km) (Figure 1.3)

Both these corridors were the main linkage to most of the commercial and business activities in the city. Mall road passes from the centre of the heart and during peak hours in the morning and in the evening the heavy traffic congestion can be seen there. Similarly circular road is surrounded by business activities and major markets of whole city present there which generate a lot of traffic on circular road and also due to no specific parking, blockage occurred most of the time disturbing the business activities of the locals. In that regard four factors are identified in this research that will affect private motorized vehicles during traffic congestion i.e. productivity time loss due to traffic delays, consumption of extra fuel during stuck in traffic jam, maintenance cost because of slow movement of vehicle and continuous foot on the break exerting pressure on engine and the last is stress generated due to nuisance and environmental pollution which decreases the efficiency while work. These are the factors that will be discussed in this study by taking these corridors as a case study.



Circular Road



Mall Road

Figure 1.2 Traffic congestion in study area



Figure 1.3 Traffic jam points map

Figure 1.3 showed two target area of this research. The mall road corridor had six attraction point starting from canal intersection and ends at civil secretariat. This path is 5.1 km long and the major traffic can be seen there during peak hours. This corridor is surrounded by different business activities along with some private and some government buildings. Similarly the other corridor also had six business points starting from bhatti chowk and ends at ek moriya pull. It is 2.8 km long corridor with hubs of commercial and business activities. The major traffic generated here during peak hours.

## 1.8 Research Assumption

It is assumed that the average costs for private users represent real costs during traffic congestion. It is also assumed that the interviewer will answer the question in an honest and candid manner as the main data will be collected by interviewing individual motorized users. The proposed model will represent normal weather conditions and it is assumed that the weather conditions will not change during the research.

### **1.9 Limitations of Research**

The data which was collected during survey is limited to normal weather conditions so this research cannot represent an extreme weather conditions. Similarly, this research is limited due to time constraints and had included very limited size of sample for whole city to probe in this research therefore study in depth is required. Lastly, the data which was collected during survey was totally based on the views and experience of the respondents.

### **1.10 Expected Contribution**

The expected finding of this research is to aware the individual motorized users to anticipate their cost so that they can effectively manage their vehicle expenses. These findings can also be used in developing software's which can estimate the traffic congestion cost for individuals. Moreover, the factors which identified in this research will be able to help in future for making policies regarding traffic congestion. Lastly it will also encourage people to change their travel behaviour so that they can effectively use alternative transport for their daily activities.

### **1.11 Significance of Research**

Past researches mainly focus on the overall estimation cost of like time delay and fuel consumption cost and they didn't focus on individual costs for private motorized vehicles. This study will help to identify the factors that will affect due to traffic congestion and estimate the cost that the individual spent on these factors due to blockage of roads. The factors like stress cost and maintenance cost along with productivity cost and fuel cost will help to educate people to use alternative travel options and reducing their individual costs during congestion. Beside this, the individual traffic congestion cost equation will also help the experts while proposing any future projects.

## 1.12 Research Design

This research mainly includes four main steps to estimate the individual traffic congestion costs for private motorized vehicles.

1. The first step is the identification of traffic congestion costs which will affect the individuals who use private motorized vehicles. These costs can be identified using literature review that includes past studies and existing problems of case study.
2. After identification of these congestion costs the next step is to propose the cost estimated method that can be used to estimate the individual traffic congestion costs for private motorized vehicle users.
3. The third step is to weight the traffic congestion related costs for individual motorized users. This step will be done by collecting data after designing questionnaire which will include different questions related to congestion costs. While collecting data ask people to prioritize the factors and use people perception to find the weights by applying descriptive analysis.
4. The last step is the analysing collected data which has two parts. Firstly the cost for individual private vehicle users is calculated through some mathematical methods. Secondly the identification of the effects of socio-demographic factors on individual congestion costs for private motorized vehicle users by using ANOVA and T-test

The sampling method that is used in this study is purposive sampling which is the most pure form of probability sampling and more scientific results could be used to represent the target population. The method used to determine the sample size for this research is Krejcie and Morgan (1970). The sample size for this research is around 282 after taking confidence level 95% with 6% sampling error.

In order to collect data from case study questionnaire is designed which mainly includes information about socio-economic and demographic background of the respondents. Similarly, it also includes the questions that are related to the factors that will affect individual costs due to traffic jam. The respondents were the people

who are doing business in the target area. They are mainly private employed or businessman having private vehicle who stuck in traffic congestion. The operational framework of research is explained in Figure 1.4 as follows:

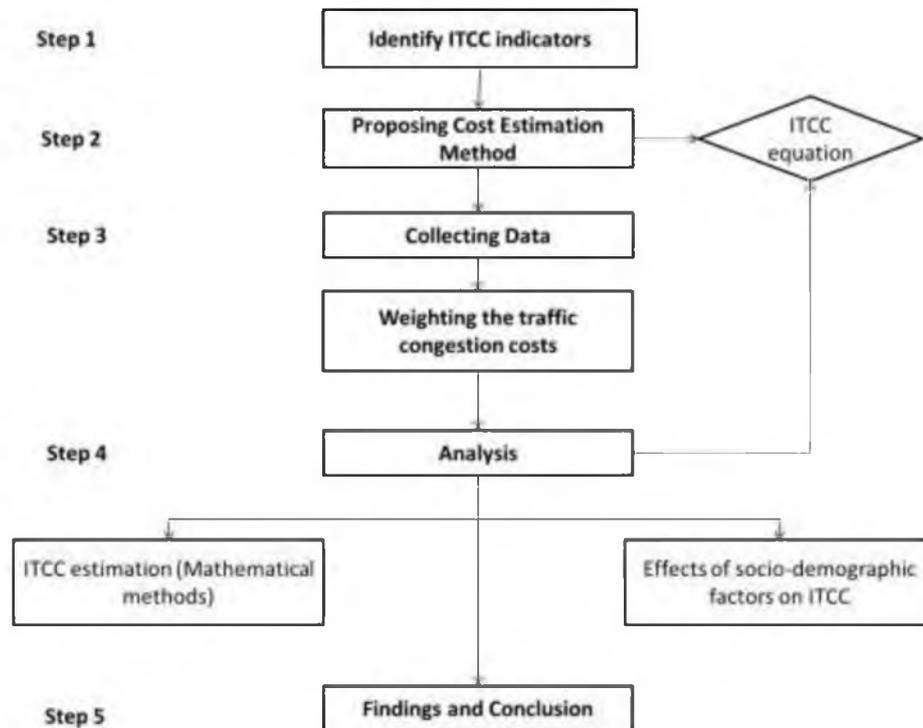


Figure 1.4 Operational Framework of Research

### 1.13 Chapter Outlines

The first chapter is the introduction of the research which contains different sections i.e. background of problems, research objectives and questions, scope of research, significance of research, expected contribution and a brief introduction of methodology. The second chapter is the Literature Review in which previous works have been carried out along with the identification of individual congestion costs indicators and methods that have been used in the past. The third chapter is the research design in which the complete methodology of the research is studied. The fourth chapter is the analysis of collected data and conclusion and findings is the last chapter of this research.

## **1.14 Chapter Summary**

This chapter basically introduces the research area and outlines the background and rationale for the present study. It briefly reviews the individual congestion costs and the studies that have done in the past. This chapter briefly overviews the design process that is adopted by this research. It also explains the limitations and expected contribution of this research. This chapter subsequently describes the aims of the present study and provides the overview of each chapter.

## REFERENCES

- Aftabuzzaman. (2004). Measuring Traffic Congestion- A Critical Review 30 th Australasian Transport Research Forum 30 th Australasian Transport Research Forum, 1–16.
- Ali, M. S., Adnan, M., Noman, S. M., & Baqueri, S. F. A. (2014). Estimation of traffic congestion cost - A case study of a major arterial in Karachi. *Procedia Engineering*, 77, 37–44. <https://doi.org/10.1016/j.proeng.2014.07.030>
- Arnott, R., Small, K., Arnott, R., & Small, K. (1994). The Economics of Traffic Congestion maximize an individual driver's Rush-hour driving strategies that convenience may contribute to overall congestion, 82(5), 446–455.
- Beland, L., & Brent, D. A. (2018). Traffic and crime ☆. *Journal of Public Economics*, 160(March), 96–116. <https://doi.org/10.1016/j.jpubeco.2018.03.002>
- BTRE. (2007). Estimating urban traffic and congestion cost trends for Australian cities.
- Bureau of Transport and Regional Economics. (2007). Estimating urban traffic and congestion cost trends for Australian cities.
- Colbeck, I., Nasir, Z. A., Ahmad, S., & Ali, Z. (2011). Exposure to PM10, PM2.5, PM1 and Carbon Monoxide on Roads in Lahore, Pakistan. *Aerosol and Air Quality Research*, 11, 689–695.
- Davis, N., Joseph, H. R., Raina, G., & Jagannathan, K. (2015). Congestion costs incurred on Indian Roads : A case study for New Delhi.
- Downs, A. (2003) Still Stuck in Traffic : Coping with Peak-Hour Traffic Congestion. Washington, DC: Brookings Institution Press.
- Downs, A. (2004) Still stuck in traffic: coping with peak-hour traffic congestion. Washington, D.C.: The Brookings Institution.
- ECMT. (2004). MANAGING TRAFFIC CONGESTION MANAGING TRAFFIC CONGESTION. OECD.
- EFEU. (2017). THE COSTS OF CONGESTION, An Analysis of the Greater Dublin Area. Dublin: Irish Government Economic & Evaluation Service.
- Faiq Matin, G. M. H. and U. A. W. (2012). Factors Affecting Traffic Jam in Karachi and its Impact on Performance of Economy Faiq Matin 1 , Gobind M. Herani 2

- and Usman Ali Warraich 3. *KASBIT Business Journal*, 32, 25–32.
- Gee, G. C., & Takeuchi, D. T. (2004). Traffic stress , vehicular burden and well-being : A multilevel analysis, 59, 405–414. <https://doi.org/10.1016/j.socscimed.2003.10.027>
- Golob, T. F., & Regan, A. C. (2000). Freight industry attitudes towards policies to reduce congestion. *Transportation Research Part E: Logistics and Transportation Review*, 36(1), 55–77. [https://doi.org/10.1016/S1366-5545\(99\)00017-4](https://doi.org/10.1016/S1366-5545(99)00017-4)
- Hassan, A. (2017, 11 06). Every Kilometre of Traffic Congestion Costs Millions to the Economy. Retrieved 11 20, 2018, from [www.propakistani.pk](http://www.propakistani.pk): <https://propakistani.pk/2017/11/06/aitzaz-traffic-congestion-costing-millions-economy/>
- Harriet, T., Poku, K., & Emmanuel, A. K. (2013). An Assessment of Traffic Congestion and Its Effect on Productivity in Urban Ghana. *International Journal of Business and Social Science*, 4(3), 225–234. Retrieved from [http://www.ijbssnet.com/journals/Vol\\_4\\_No\\_3\\_March\\_2013/25.pdf](http://www.ijbssnet.com/journals/Vol_4_No_3_March_2013/25.pdf)
- Jacobs, F. (2017). U.S. is most congested country in the world. New York: Global Fleet.
- Khan, T., & Rashedul Islam. (2013). Estimating Costs of Traffic Congestion in Dhaka City. *International Journal of Engineering Science and Innovative Technology (IJESIT)*, 2(3), 281–289.
- Kockelman. K. (2004) Traffic congestion, in K. Myer (ed.), *Handbook of transportation engineering*, New York: McGraw-Hill.
- Krejcie, R. V, & Morgan, D. W. (1970). DETERMINING SAMPLE SIZE FOR RESEARCH, 38, 607–610.
- Levy, J. I., Buonocore, J. J., & Von Stackelberg, K. (2010). Evaluation of the public health impacts of traffic congestion: A health risk assessment. *Environmental Health: A Global Access Science Source*, 9(1), 65. <https://doi.org/10.1186/1476-069X-9-65>
- Masood, M. T. K. (2011). Transportation Problems in Developing Countries Pakistan :, 6(11), 256–266. <https://doi.org/10.5539/ijbm.v6n11p256>
- Mccartt, A. T., Shabanova, V. I., & Leaf, W. A. (2003). Driving experience , crashes and traffic citations of teenage beginning drivers, 35, 311–320.
- Mckinnon, A. (2016). Logistical Operations The Effect of Traffic Congestion on the

- Efficiency of Logistical Operations, 5567(April).  
<https://doi.org/10.1080/13675569908901576>
- Moneeza Abbas, Ramsha Javed, Zunaira Javed, T. M. and F. N. (2011). Air Quality Monitoring of PM2.5 and PM10 at Heavy Traffic sites of Asian's Oldest Market: Anarkali Bazaar, Lahore. *Int. J. Econ. Environ. Geol.*, 2004(3), 444–447. <https://doi.org/10.1017/S003060531000181X>
- National Transport Authority. (2016). *Regional Modeling System*.
- P B Goodwin. (1997). Solving Congestion, INAUGURAL LECTURE FOR THE PROFESSORSHIP OF TRANSPORT POLICY UNIVERSITY COLLEGE LONDON.
- Pakistan Bureau of Statistics. Retrieved May 10, 2018, from [www.pbscensus.gov.pk](http://www.pbscensus.gov.pk):  
<http://www.pbscensus.gov.pk/>
- Parkinson, B., & Parkinson, B. (2001). Anger on and off the road, 507–526.
- Pishue, B. (2017, 09 27). America's Worst Cities for Traffic – 25 Worst Traffic Hotspots. Retrieved 11 20, 2018, from <http://www.inrix.com>:  
<http://inrix.com/blog/2017/09/us-hotspots/>
- Rosen, A. (2013, July 8). What Really Causes Traffic Congestion? New York City, New Yoek, United States of America.
- Rothenberg, M.J. (1985) Urban congestion in the United States-what does the future hold, *ITE Journal*, 55(7), 22-39.
- SCHNEIDER, B. (2018, 02 07). Traffic's Mind-Boggling Economic Toll. Retrieved 11 20, 2018, from <https://www.citylab.com>:  
<https://www.citylab.com/transportation/2018/02/traffics-mind-boggling-economic-toll/552488/>
- Susan Grant-Muller, J. L. (2007). Costs Of Congestion: Literature Based Review Of Methodologies And Analytical Approaches.
- UN. (2015). sustainable development. Retrieved December 13, 2017, from <http://www.un.org>: <http://www.un.org/sustainabledevelopment/cities/>
- Victoria Transport Policy Institute (VTPI) (2005) Congestion reduction strategies: identifying and evaluating strategies to reduce congestion, in: *Online TDM Encyclopaedia*, Victoria, British Columbia, Canada: Victoria Transport Policy Institute.
- Weisbrod, G., Vary, D., & Treyz, G. (2003). Measuring economic costs of urban traffic congestion to business. *Transportation Finance, Economics and*

Economic Development 2003: Planning and Administration, 98–106.  
<https://doi.org/10.3141/1839-10>

Weisbrod, G., Vary, D., & Treyz, G. (2017). Measuring the Economic Costs of Urban Traffic Congestion to Business. *Moratuwa Engineering Research Conference (MERCon)*, 141–146.