

Original Article

Analysis on the Road Traffic Congestion in Colombo Metropolitan Area

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Abstract

The main focus of this study is aimed at understanding the factors causing traffic congestion in Colombo Metropolitan Area. Therefore, the study was carried out to address major research questions as, what factors affecting the current vehicle traffic flow, followed by what are the impacts of traffic congestion and what is the opportunity cost of time and fuel wastage cost of congestion. The main objective of the research was to identify the factors affecting the current vehicle traffic flow in Colombo, while the specific objectives of the research are to identify the impacts of traffic congestion, to estimate the opportunity cost of time and fuel wastage cost and to identify whether the commuters are satisfied with the strategies implemented by the government to mitigate traffic congestion. Accordingly, from the survey conducted for the commuters, the researcher identified factors such as **“Growth of population and vehicles”**, **“Unforeseen circumstances”**, **“Events and incidents”** has an individual effect on the current vehicle traffic flow. In addition to that the researcher identified the main impacts of traffic congestion as **“Time”**, **“Fuel”**, **“Earnings”** and **“Productivity”**. And also the researcher identified that majority of the commuters are satisfied with the Bus Priority Lane and Park and Ride, while majority of the commuters neither satisfied nor dissatisfied with the Ferry Service

as a strategy implemented to mitigate traffic congestion.

Keywords: *Traffic Congestion, Vehicle Traffic Flow, Opportunity Cost, Fuel Wastage*

Introduction

Traffic congestion remains a significant problem in most cities around the world, especially in developing countries, resulting in huge delays, increased fuel wastage and monetary losses. Due to inadequately planned road networks, the common outcome in several developing countries is the existence of small critical areas which are common hotspots for congestion. Inadequate traffic management around such hotspots is likely to result in extended traffic congestion. (Jain, Sharma, & Subramanian, 2012)

However, traffic congestion is much more a result of the basic mobility problem, which is that several people want to move at the same time every day. For example, the efficient functioning of the whole society system requires people to go to work, go to school, and even walk around at the same time and interact with each other.

A. Significance of the Research

The study identifies the factors causing traffic congestion in Colombo Metropolitan Area and its impact. This study will increase the awareness of motorists and the public about the importance of knowing the impact of traffic congestion. This is of significance to the transport planners of the Colombo city in assisting their future transport projects within the city and for the government and regulated authorities to implement policies. For future researchers, this research will serve as a basis and a source of perspective leading to their exploration for the improvements of this study. They can also come up with questions that did not answered by this study. And also they can use this to expand the scope of the study to investigate about the country's traffic congestion.

B. Research Problem and Objectives

Transport demand has increased significantly over the last few decades, especially in the Colombo Metropolitan Area. As demand for traffic increased, traffic congestion increased resulting in many negative consequences. This causes economic losses, travel time costs and increased operating costs for vehicles, such as fuel consumption. Taking into consideration that it has a negative impact on economic and environmental aspect of the society, it is crucial for social well-being to address this issue

Although many actions were taken to mitigate traffic congestion in the city of Colombo, most of them have not been successful. This suggests that this problem is growing exponentially and should be addressed persistently in order to avoid the negative consequences

Main Research Objective

- 1) To identify the factors causing traffic congestion in Colombo Metropolitan Area.

Specific Research Objectives

- 1) To identify the relationship between factors causing traffic congestion and the current vehicle traffic flow.
- 2) To identify the impacts of traffic congestion on selected demographic variables.
- 3) To calculate the opportunity cost of time and fuel wastage cost of traffic congestion.
- 4) To identify whether the commuters are satisfied with the strategies implemented
- 5) By the government to mitigate the traffic congestion.

Literature Review

According to the European Conference of Ministers of Transport (ECMT), there is no specific definition of traffic congestion and it can be defined in different ways (Managing urban traffic congestion, 2007). The most common definition of congestion in the state of traffic flow is when travel demand exceeds the capacity of the road. (Aftabuzzaman, 2007). From the viewpoint of delay travel time, congestion occurs when the usual flow of traffic is interrupted by a high density of vehicles resulting in excess travel time.

Table 1: Factors causing traffic congestion

Factor	Reference
Excessive Number Of Vehicles	(Report on the Study of Road Traffic Congestion in Hong Kong, 2014)
Population Growth	(Raheem, Olawoore, Olagunju, & Adeokun, 2015)
Inefficient Public Transport Services	(Harriet, Nkrumah, & Anin, 2013)
Inefficient Road Traffic Management	(Jain, Sharma, & Subramanian, 2012) (Nadeeshan & Mudunkotuwa, 2018)
Poor Roadway Condition	(Reddy & Tilak, 2016)
Unforeseen Circumstances	(Schwietering & Feldges, 2016)
Illegal parking	(Mahmud , Gope, & Chowdhury, 2012)
Improper planning of city and urban development	(Mahmud , Gope, & Chowdhury, 2012)
Economic Development and Urbanization	(Reddy & Tilak, 2016)
Higher purchasing power of public	(Mahmud , Gope, & Chowdhury, 2012)
Improper lane management	(Mahmud , Gope, & Chowdhury, 2012)

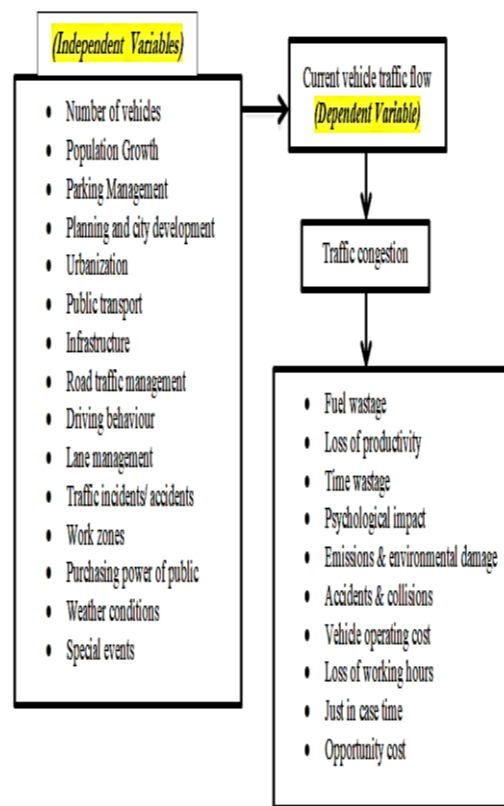
The impacts of traffic congestion could be classified into four main groups of environmental, economic, social and health. The nature, extent and severity of the consequences differs between one city to another, depending among many other things, on city size, road capacity and street layout, land use spatial distribution, travel patterns and public and private modes of transport. (Mahmud , Gope, & Chowdhury, 2012)

Research Methodology

A. Research Design

The research design falls in to the category of casual research where the main objective is to verify the extent and nature of cause-and-effect relationship between variables.

Figure 1: Conceptual Framework



B. Sample and Sampling Technique

Among the entire population of Colombo, data from more than 250 commuters were collected within the Colombo Metropolitan Area on the basis that each commuter encountered traffic congestion in Colombo. The researcher has used convenience sampling technique as the sampling method for this study.

C. Data Collection

A questionnaire was prepared to collect the primary data required for the study.

D. Data Analysis

The statistical tool being used in this research is SPSS version 16.0. Analysis of the data consists of Descriptive Analysis, Factor Analysis, Correlation Analysis, Regression Analysis and Chi Square Test.

Results and Discussion

A. Identification of the factors causing traffic congestion

The Cronbach’s Alpha is a widely spread convenient statistical technique or tool to measure the internal consistency (reliability) of a psychometric test. If the value of Cronbach’s Alpha is higher than 0.7, it is in an acceptable level.

Table 2: Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.835	.840	15

The reliability of the overall data set exceeding the Cronbach’s Alpha value of 0.7 and ultimately resulting 0.835, allowing the conclusion that reliability of the data set is at its acceptable level. The calculated KMO statistic value is 0.847 suggests that there is a proportion of variance in the data set that might be caused by underlying factors. Since the statistic is more than 0.6 indicated that a factor analysis will be useful with the data set (Gamachchige & Mudunkotuwa, 2017)

To identify factors, Rotated Component Matrix has been drawn using Varimax Method. 15 Factors were reduced to 4 factors.

- Factor 1 - Infrastructure and Development
- Factor 2 - Growth of population and vehicles
- Factor 3 – Unforeseen circumstances
- Factor 4 – Events and incidents

B. Correlation Analysis

The association between the current vehicle traffic flow and the identified four factors are tested by using the Pearson Correlation Analysis.

The hypothesis used in Correlation Analysis is as follows;

H0: There is no association between current vehicle traffic flow and ith factor

H1: There is an association between current vehicle traffic flow and ith factor

(ith factor = Infrastructure and Development, Growth of population and vehicles, Unforeseen circumstances, Events and incidents)

According to the Correlation Analysis, Probability values for the factors, “Growth of population and vehicles” and “Unforeseen circumstances” are 0.003 and 0.005 respectively. Hence it is significant (p<0.05), null hypothesis can be rejected. Therefore it can be concluded that, there is an association between the current vehicle traffic flow and the factors “Growth of population and vehicles” and “Unforeseen circumstances.”

C. Model Development for Current vehicle traffic flow

To development of the model, Regression Analysis has been carried out.

Table 3: Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.269 ^a	.072	.058	.403	2.136

According to the Model Summary, multiple correlation or the joint association is given by R. That is 0.269. This indicates that, independent variables are having a weak association jointly with dependent variable, current vehicle traffic flow. Proportion of the dependent variable covered by regression model is explained by R square. If the R square value is equal or more than 0.6, the particular model is nicely fitted. The R square value is 0.072. But still the model is valid as the probability of F test statistics is 0.000 and significant ($P \leq 0.05$) as per the Regression ANOVA. It indicates that, the model is jointly significant.

Following equation is constructed by illustrating the effect of independent components on the current vehicle traffic flow.

$$Y = 2.349 + 0.154X_1 + 0.139X_2 - 0.181X_3$$

- Y = Current vehicle traffic flow
- X₁ = Growth of population and vehicles
- X₂ = Unforeseen circumstances
- X₃ = Events and incidents

Table 4: Coefficient Matrix

Model	Unstandardized Coefficients		Standardized Coefficients	T	Sig.	Collinearity Statistics	
	B	Std. Error	Beta			Tolerance	VIF
1 (Constant)	2.349	.331		7.094	.000		
Infrastructure and Development	-.027	.079	-.027	-.347	.729	.554	1.805
Growth of population and vehicles	.154	.056	.178	2.725	.007	.813	1.229
Unforeseen circumstances	.139	.051	.193	2.695	.007	.679	1.474
Events and incidents	-.181	.076	-.164	-2.386	.018	.737	1.357

The hypothesis used in Regression Analysis is as follows;

H₀: There is no individual effect of *i*th factor on Current vehicle traffic flow

H₁: There is an individual effect of *i*th factor on Current vehicle traffic flow

(*i*th factor = Infrastructure and Development, Growth of population and vehicles, Unforeseen circumstances, Events and incidents)

According to the Coefficient Matrix, probability values for the factors, “Growth of population and vehicles”, “Unforeseen circumstances”, “Events and incidents” are 0.007, 0.007 and 0.018 respectively. Hence it is significant ($p < 0.05$) and null hypothesis can be rejected. Therefore, it can be concluded that “Growth of population and vehicles”, “Unforeseen circumstances” and “Events and incidents” have an individual effect on the current vehicle traffic flow.

D. Relationship between the impacts of traffic congestion and selected demographic variables

In order to check the relationship between the impacts of traffic congestion with some selected demographic variables, a chi-square test was conducted using the responses obtained for various items such as fuel wastage, loss of productivity, time wastage, etc.

The hypothesis used in chi-square test is as follows:

H0: i^{th} impact is not depend on j^{th} variable

H1: i^{th} impact is depend on j^{th} variable

(i = Fuel wastage, Loss of productivity, Time wastage, Psychological impact, Emissions and environmental damage, Accidents and collisions, Vehicle operating cost, Loss of working hours, Opportunity cost)

(j = Occupation, Mode of travel)

Relationship between the impacts and occupation

P values of Loss of productivity and Just in case time are respectively 0.020, 0.027, which are

less than 0.05 and significant. Therefore H0 is rejected, which suggests that impact of loss of productivity and the impact of just in case time depends on the occupation.

Relationship between the impacts and mode of travel

P value of Fuel wastage is 0.046, which is less than 0.05 and significant. Therefore H0 is rejected, which suggests that impact of fuel wastage depend on Mode of travel.

E. Cost Calculation of Traffic Congestion

By using the data collected from the sample population, the opportunity cost and the fuel wastage cost of traffic congestion has been calculated.

Opportunity cost of time means the commuters’ foregone value of the time that spent on road due to traffic congestion. The Total Average Opportunity Cost per day of the sample population can be calculated as Rs. 148,750. The Total Average cost of fuel wastage per day of the sample population can be calculated as Rs. 83,400.

F. Commuter’s satisfaction on the current strategies implemented by the government to mitigate traffic congestion in Colombo

When the respondents were asked to respond whether they are satisfied or dissatisfied with the strategies implemented to mitigate the traffic congestion, following distribution of responses were obtained.

Figure 2: Satisfaction on BPL

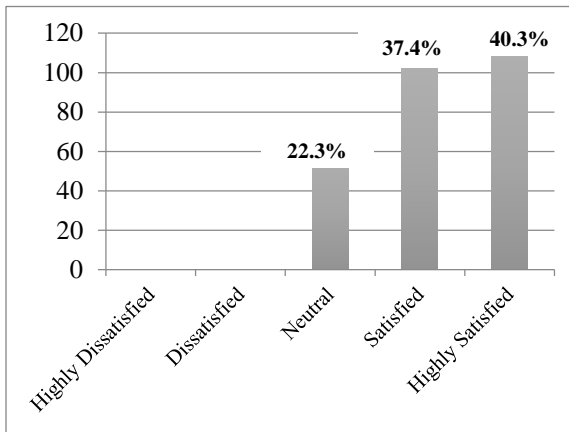


Figure 3: Satisfaction on Park and Ride

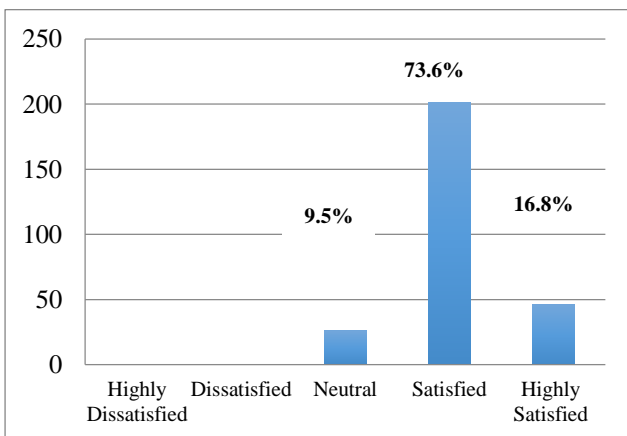
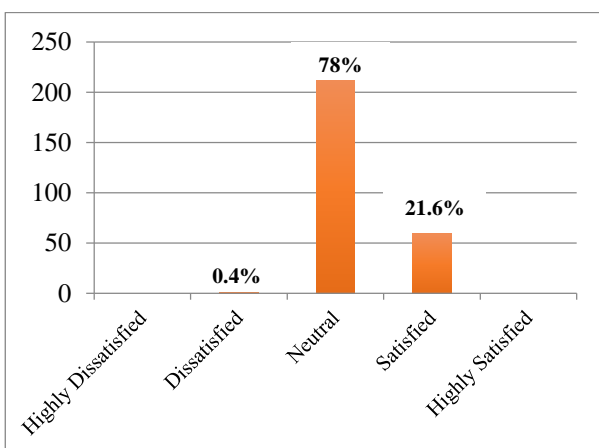


Figure 4: Satisfaction on Ferry Service



Conclusion

The primary objective of this research is to identify the factors causing road traffic congestion in Colombo Metropolitan Area. Factors were identified through factor analysis. There are 15 factors in this research study and they are reduced to 4 components by factor analysis. Through the Correlation Analysis it was confirmed that there is an association between the current vehicle traffic flow and the factors “Growth of population and vehicles”, “Unforeseen circumstances” while there is no enough evidence from the sample responses to identify the association between “Infrastructure and Development” and “Events and incidents” with the current vehicle traffic flow. Through the Regression Analysis it was found that “Growth of population and vehicles”, “Unforeseen circumstances”, “Events and incidents” have an individual effect on the current vehicle traffic flow, while the “Infrastructure and Development” does not have an individual effect on the current vehicle traffic flow.

Through the Chi Square Test, the relationship between the impact of traffic congestion and some demographic variables has been identified. It was found that only the impact of loss of productivity and the impact of just in case time depends on the occupation. Other impacts do not depend on the occupation. Only the impact of fuel wastage is depending on the mode of travel while all other impacts do not depend on mode of travel.

According to the cost calculation of traffic congestion, each person who travels to Colombo has to bear an unproductive cost due to this traffic congestion.

Apart from the ferry service majority of the respondents are satisfied with the BPL and Park and Ride that has been implemented by the

government with the aim of mitigating traffic congestion in Colombo.

Recommendations

In order to mitigate the traffic congestion in Colombo the researcher would recommend the following remedies.

- In order to discourage the use of private vehicles, government intervention is highly recommended to improve the quality of public transport so that many people will use public transport.
- BPL and City Bus Service must be further implemented to other routes, addition to the routes in which those strategies are already implemented.
- Traffic management and road network plans should be updated on a periodic basis as required.
- The construction and repair of road works should be carried out during the night, otherwise they should be avoided during peak hours.

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