Loss of Manpower due to Road Traffic Congestion in Sri Lanka: A Study in Kandy City

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ABSTRACT

Traffic congestion is widely viewed as a growing problem in many urban areas in Sri Lanka as the overall volume of vehicular traffic continues to grow faster than the overall capacity of the transportation system. Road traffic congestion directly reduces productivity level and demonstrates a loss of resources. Specially, it creates a huge loss of manpower as most people have to spend their productive time on the road. The main purpose of this research is to estimate the total loss of manpower due to road traffic congestion in Kandy city in Sri Lanka. Data collected covering 220 commuters and monitoring records for one month of the main corridors entering to the Kandy city in 2017 are used for the analysis. Results show that on average the loss of manpower due to traffic congestion is 27 % of their working number of hours per month and 97 percent of commuters perceived that their productivity in the workplace are seriously affected by the traffic congestion related issues in the study area. The overall findings of this research will help implement policies to mitigate traffic congestion that is increasingly posing a major impediment to efficient mobility of people and freight, urban environmental protection, and sustainable development.

KEYWORDS: Kandy; Manpower; Road transport; Traffic congestion

Introduction

Total vehicle population in Sri Lanka has dramatically increased with a compound annual growth rate of 10 % between 2012-2016 (Jayasooriya and Bandara, 2017). According to vehicle registration records in Sri Lanka, in peak hours, more than 3 million automobiles use road infrastructure all over the country. Of these 50 % of automobiles are inbound to Colombo and Kandy while most of them are privately owned automobiles (Lakruwan and Weerasinghe, 2013). The growth of vehicles per 1000 people from 2008 to 2015 was raised 171 to 305 (Department of Motor Traffic, 2016). This growing trend in vehicle population provides important implications on Sri Lankan society, economy and the environment. A larger portion of vehicles in Sri Lanka is driven in major cities and much of the issues related to the transport sector in Sri Lanka are associated with urban environment. The traffic congestion on streets in major cities is getting worse each day as people shift from unorganized, outdated, and overcrowded public transport modes to use their private vehicles. Low travel speed due to the traffic congestion results in high emissions to the environment, loss of productivity and production, deteriorating the health capital and increasing the other costs components such as adaptation (for example living closer place to the city). All these have resulted in a massive environmental, financial, health and man-hour loss, waste of fuel, wear and tear of vehicles (Jayasooriya and Bandara, 2017).

In an international comparison it is found that, fuel usage for transport as a percentage of total fuel consumption is the highest in Sri Lanka (International Energy Agency, 2013). For examples, India (7%), Thailand (16%), and Malaysia (19%) have higher fuel usage for transportation while Sri Lankan usage is about 21% (Athukorala, 2013). Interestingly, this percentage has doubled within past three years. Recent studies shows that in many cities in Sri Lanka average traffic speed continue to slow down (Jayasooriya and Bandara, 2017). Furthermore, though expressways provide travel up to 100kmph speed, when inbound/outbound from urban regions to access expressways, within Colombo Metropolitan, users spend more than one hour to travel 10 km during peak hours while Kandy average speed has reduced to 5 km per hour during a peak period. Acceleration and deceleration may lead to increase in operating costs in terms of fuel, tyres and brakes.

Given this background, this research attempts to estimate total loss of manpower due to road traffic congestion using data from Kandy district in Sri Lanka. Specific objectives are to (1) estimate the annual cost of manpower loss; (2) assess the willingness to pay (WTP) if road traffic congestion related time loss reduces to half from current level; (3) identify the determinants of WTP for reducing urban traffic congestion. The study will apply different analytical methods to measure manpower loss and empirically estimates these costs for different groups of commuters separately. The most important aspect of this study is that it provides a measure of the real monetary value of the cost of congestion related manpower loss. In specific, the results of this study will help to understand the magnitudes of the unnecessary economic and social cost due to vehicle congestion in urban areas in Sri Lanka. A study of this nature helps show the aggregate monetary cost to the society because of not having a proper road system in the country. In general, the findings of this research will contribute to pay immediate attention for this issue (which is a hidden costs) while achieving environmental improvement in the urban atmosphere. Furthermore, the results of the study will provide an opportunity to show the importance of investing more on road sector that reduce the congestion while generating regional as well as global benefits in the future.

Literature Review

A number of studies have already been undertaken to investigate the various aspects of urban traffic congestion and its impact on individual, businesses and the economy as a whole (Shefer, 1994; Johnston and Ceerla, 1996; Schwela et al., 1997; Smith and Lewis, 2003; Weisbrod et al., 2003; Goodwin, 2004; Graham, 2006; Zarkadoula et al., 2007; Sankaran and Wood, 2007; Barth and Boriboonsomsin, 2008; Hartgen and Fields, 2009; Song and Miller, 2012; Xu et al., 2013; Zhang et al., 2014; Baqueria et al., 2016). In general, all these studies have repeatedly identified road traffic congestion as one of the major factor for emissions in the world and it creates different type of cost components to the individuals as well as the society.

Shefer (1994) investigated the private cost and social cost of traffic congestion. This study identifies the gap between private and social cost of vehicle travel and resulting negative externalities such as air pollution, noise pollution and productivity loss. Johnston and Ceerla (1996) investigated the effects of new high-occupancy vehicle (HOV) lanes on travel and emissions in US. In this study past modelling efforts in this field have been reviewed and travel demand simulation were used to demonstrate the new HOV lanes and their emission. Schwela et al. (1997) investigated the relationship between motor vehicle related air pollution and its impact on public health. According to this study, air pollution related to motor vehicles can have serious adverse health effects on the population. De Vlieger et al. (2000) studies the environmental effects of driving behaviour and congestion by considering passenger cars. According to this study, an intense traffic congestion can increase fuel consumption by 20 – 45 percent. Weisbrod et al. (2003) examined how urban traffic congestion imposes economic costs using data from Chicago and Philadelphia. Similar studies have been carried out on the same area by Small (1999) and Vliege et al. (2000). Goodwin (2004) attempted to identify the total cost of congestion with the marginal costs by analysing the variations, which makes the journey time unpredictable. Accordingly, practical measures need to be introduced to provide good alternatives for freight and passenger movements, which reduce the intensity of use of scarce road space in congested conditions.

Graham (2006) investigates the link between returns to urban density, productivity, and road traffic congestion. The results of this study show that road traffic congestion plays an important role in explaining diminishing returns. According to Faiz et al. (1996), the emission levels depend heavily on traffic-flow characteristics, such as average flow speed, the frequency, and intensity of vehicle acceleration and deceleration, the number of stops, and vehicle operating mode. Chen et al. (2007) carried out a study on nine heavy-duty diesel vehicles and reported that low speed with frequent acceleration and deceleration, particularly in congested conditions, are the main factors that aggravate vehicle emissions. Barth and Boriboonsomsin (2008) also found that traffic congestion induced transportation plays a significant role in carbon dioxide (CO2) emissions. Eliasson (2008) evaluated environmental effects of the pilot test of congestion charging in Stockholm and found that possible emissions reduction by changing the scenario was reduced 2 - 3 percent. Hartgen and Fields (2009) examines the impact of congestion on accessibility to key employment centres and destinations within an urban region while Shukla and Alam (2010) studied the relationship of traffic and emissions in a dynamic urban traffic condition in Delhi. They found high emissions during accelerations.

Sweet (2011) identified three categories of economic cost of traffic congestion. They include first-order impacts (to transport system and users), second-order impacts (to business or resident locations), and the fiscal outcomes of public sector policies into their analysis.

Maparu and Pandit (2010) found the delay in minutes on the different corridors of Kolkata to range from 20 minutes to about 60 minutes indicating a considerable congestion on the roads of Kolkata. Harriet et al. (2013) inspects the traffic congestion situation in the Kumasi metropolis and how it affects worker efficiency. The research found that mobility in Kumasi Metropolis is affected by traffic congestion and as a result, peak hours have negatively affected worker productivity. Xu et al. (2013) developed a methodology to identify the congestion patterns from the accumulated massive historical dataset. Their results show that the method can effectively identify and summarize the congestion pattern with efficient computation and reduced storage cost. Song et al. (2015) developed the delay correction model (DCM) to predict emissions from buses traversing intersections based on traffic variables that is commonly used to describe intersection performance. In this study, the DCM is applied using intersection delay, number of stops and intersection type as inputs, from which a delay correction factor (DCF) can be estimated. According to Chakrabartty and Gupta (2015) traffic congestion leads to increase in operating cost of vehicles, delay the journey, increase the pollution and stress. They also attempt to measure the external cost of congestion on the roads of Kolkata. The result obtained indicates that there is a considerable monetary loss due to traffic congestion.

Most of the researches on traffic congestion (May and Marsden, 2007; Harriet et al 2013; Weisbrod et al, 2003; Lewis 2008 and Downie, 2008) argue that congestion impairs us from moving freely and that it disrupts business activities in cities and reduces productivity. Weisbod et al. (2003) conclude that congestion leads to reduced productivity through reduced worker access to job and shopper access to stores because of excessive delay in traffic. Rodríguez et al. (2016) studies influence of driving patterns on vehicle emissions using data from Latin American cities. Further, it identifies the possible fuel consumption savings of between 35 and 85 million gallons per year and total potential economic benefits of up to 1400 million dollars per year. Baqueria et al. (2016) focuses on value of time (VOT) estimation for work trips in an extremely congested network in Karachi city. They conducted a stated preference survey at various industries location in the study area. In this study, a choice set of four alternative modes based on the currently used mode was presented to each individual. The results revealed a strong impact of travel time and travel cost on the disutility of travel.

The review of previous literature shows that research on economic costs related to traffic congestion are numerous and number of researchers have used different techniques and methodologies to measure economic cost of congestion. However, it is clear that most of these studies have tended to simply value, a particular aspect of congestion such as the environment cost, emission etc., rather than analyzing loss of time as well as productivity of it, which can be the biggest component of the cost of traffic congestion. Therefore, these studies have only provided limited information on the cost of traffic congestion. Accordingly, it is obvious that more conceptual and empirical work is needed to develop a better understanding of the real cost of urban traffic congestion in developing countries. This study will partly attempt to fill this void in the literature.

Methodology

In general, travel demand and supply are used to analyze traffic conditions and resulting externalities. The fundamental economic problem related to the congestion is that road users consider the costs that they bear themselves (such as fuel costs and travel time). However, they do not consider the value of additional delay that they impose on others when using a congested road facility (Coto-Millán and Inglada, 2007). Economic theory refer to the latter costs as external costs as they are not borne by the person whose use of the road creates them (De Palma et al. 2011). If the demand for transport is not constant over a time, (it mainly has 'peak travel' and 'off peak travel') and transport infrastructure has a finite capacity in the short run when the demand for the limited capacity rises the congestion occurs. This means that peaking causes traffic congestion. This occur when the number of motorists attempting to use a section of roadway at the same time exceeds the road's capacity. This will add the additional cost components such as excess fuel usage, extra pollution, extra time, etc. for other commuters.

This research mainly employs descriptive statistics of simple averages to analyze the field data. In order to measure the manpower loss of traffic congestion, data collected from 220 daily commuters are used. Surveys data were mainly obtained from two socio-economic surveys. First, survey was conducted covering people[1] who are coming to city area from various places for employment/ business in almost every day. We designed this survey covering public transport users, people who use their own vehicles and people who do the job as drivers. From this survey, data related to the commuters' travel distance, travel time, working hours, willingness to pay values for save the time (if the speed doubles), etc. were collected. Data related to the value of time of daily commuters, value of time for specific transport mode, travel delay in time units, travel distances, average peak & off-peak travel speeds and average fuel consumption were also collected from this survey.

Second survey is the monitoring survey of the selected corridors. In this survey, we collected data by monitoring vehicles as well as monitoring structural characteristics of the road in order to identify the type of vehicles, real driving speed in peak and off peak period, structural characteristics that can be seen along the road corridors for each 200 meters. Structural characteristics of the road were mainly collected to identify the possible reasons for the traffic congestions. In addition to the survey data, secondary data were also collected and used to identify the vehicle types, fuel consumption pattern, engine capacity, and price of different type of fuels. Secondary data were obtained from Department of Transport & Logistics, Kandy City Development Project Office, Department of Census and Statistics, and Ministry of Transport in Sri Lanka. Specific variables that are important in this study includes, travel distance, usual travel time for one direction journey, working hours, mode of transport, fuel type (petrol/ diesel/ hybrid), fuel consumption quantity of the vehicle (km/l), WTP values for avoiding traffic congestion, if the speed is doubled. We also investigated the determinants of the WTP for reducing delay to half from the current level.

[1] In the survey, we mainly concentrated the employed people in the Kandy city area.

In order to identify determinants of WTP for reducing traffic congestion variables such as income, opportunity cost of traffic congestion, travel delay in time units, loss hours and some of the socio-economic variables need to be investigated. In addition to that, variables such as vehicle operation cost, fuel cost, and consumption quantity and fuel price can be important. However, initial run of the model found that some of these variables are either correlated with other variables or highly insignificant. Therefore, those variables were dropped from the final model. We used regression model to identify the factors affecting WTP for reducing delay to a half from the current level. Basic model used in the analysis is given below.

$$Y_i = \beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + \beta_3 X_{3i} + \beta_4 X_{4i} + \beta_5 X_{5i} + \beta_6 X_{6i} + \beta_7 X_{7i} + \beta_8 X_{8i} + \beta_9 X_{9i} + U_i \quad [1]$$

Where β_j is the coefficient value of each variable (j = 1, 2…9) and i represents respondent or commuter (i = 1, 2,…., 220). U stands for the error term. Definitions of each variable is given in the Table 1.

Table 1: Definition of each variable

Sign	Variable	Definition
Y	WTP	WTP for reducing delay from the current level to half (Rs/ Per month)
X_1	INCOME	Income of the respondent (Rs/ Per month)
X_2	LOSS HOURS	Number of hours loss due to traffic congestion per month
X_3	TRAVEL EXPENDITURE	Transport expenditure of the respondents per month
X_4	DISTANCE	Distance from residence place to working station (Km)
X_5	FAMILY SIZE	Size of the family (number)
X_6	EDUCATION	Education level of the respondent (number)
X_7	AGE	Age of the respondent (number of year)
X_8	GENDER	Dummy variable: 1 if Male, 0 Otherwise
X_9	OWN VEHICLE	Dummy variable: 1 if respondent travel by own vehicle, 0 Otherwise

Note: WTP was taken for a given week and converted to monthly figure

Primary data were collected relating to each variable in the regression model. A structured questionnaire on traffic congestion and loss of time was used to obtain data on socio-economic characteristics of respondents, daily travel cost, number of hours lost in each day and associated other factors. The questionnaire provides adequate quantitative and qualitative data for the assessment of the loss of labour due to road traffic congestion in the study area.

At the end of the questionnaire, we ask a contingent valuation question to understand their WTP if we implement a policy to reduce daily traffic delay to a half from the current level.

Results and Discussion

Kandy is one of the major cities in Sri Lanka located in the central province. It is the second-largest city of the island and the capital of Central Province of the country. Its geographic location has made it a major transportation hub in the island while it being the gateway to the Central Highlands of the country, the city can be reached by major motorways in every direction of the island. About 0.18 million population reside within Kandy Maniple Council (KMC) area and more than 50,000 of vehicles move daily within the area (Jayasooriya and Bandara, 2017). Kandy town is in a low-lying area and its condition is similar to a bottom of a basin surrounded by mountains. Kandy traffic problems have made severe impact on people by causing inconvenience and it has affected them socially and economically. At present, the Government of Sri Lanka has undertaken a series of expressway and road development projects that will link every part of the country including the North and the East whose road infrastructure must catch up with the rest of the country. However, still government has not taken any steps to overcome the issues related to the traffic congestion in Kandy city. With this background, we first look at the descriptive statics of the survey data gathered for this study.

Table 2: Descriptive statistics of the sample respondents

Variable	Average	Maximum	Minimum
WTP (Rs/per month)	1,560.00	5,000.00	0.00
Income(Rs/per month)	68,200.00	175,000.00	245,00.00
Loss Hours (number/per month)	54.30	164.00	22.00
Travel Expenditure(Rs/per month)	3,200.00	12,450.00	1,400.00
Distance (Km)	12.64	35.00	4.25
Family Size (number)	4.00	7.00	1.00
Education (number)	10.00	16.00	8.00
Age (number)	48.00	64.00	18.00
Own vehicle users	24 %		
Male	78 %		
Public sector workers	12 %		
Private sector workers (except drivers)	74 %		
Drivers	8 %		
Self employed	6 %		

Characteristics of individuals responding to the survey are given in Table 2. Average WTP for a given month is Rs. 1,560 while maximum is Rs. 5,000. The mean monthly income of the respondents is Rs. 68,200. It is observed a higher variation of the monthly income of the respondents as we have a quite heterogeneous group in our sample. Average age of the respondents is 48 years with a minimum of 18 and a maximum of 64 years. Male respondents accounted for 78 per cent and females is 22 per cent. Employment is the main income source of the sample with 82 per cent employed either the private sector or as drivers (private or public sector). Most respondents have obtained elementary and secondary education (43 per cent and 92 per cent respectively).

In many urban areas, there are increasing concerns about how the growth of traffic congestion may adversely affect the area's economy (business sales and income). At the most basic level, increasing congestion can be associated with the type of vehicles that use the road as some trips on the road system related to some vehicles such as truck and bus will entail longer travel times for riders and higher vehicle operating costs for vehicle operators. The added time and expense for drivers and passengers are the key components of the total congestion costs. Therefore, it is important to identify the type of vehicles that arrive to the city in a particular day. Table 3 reports the average number of vehicles arriving to the city in a given working day.

Table 3: Average number of vehicles arriving to the city in a given working day

Vehicle Type	Peak Hour Number (Per hour)	Off-Peak Hour Number (Per hour)	Total (%)
Bus	297	132	6.37
Lorry	194	70	3.91
Truck	21	8	0.43
Bowser	32	6	0.57
Car	1194	428	24.10
Cabs	69	31	1.48
Jeep	218	52	4.00
Wagon	148	56	3.03
Van	414	93	7.54
Ambulance	9	2	0.17
Three wheel	1053	413	21.78
Motor cycle	1331	444	26.36
Others	14	5	0.27

Note: Peak hours are between 6.00am- 9.00am, 1.00pm -2.00pm and 4.00pm - 6.00pm. Others are used as off-peak hours

During business days in Kandy city, traffic congestion reaches great intensity at predictable times of the day due to the large number of vehicles using the road at the same time. This phenomenon is called peak hour, although the period of high traffic intensity often exceeds one hour. In some places of the city traffic volume is consistently, extremely large during peak hours.

Exceptionally, traffic upstream of a vehicular collision or an obstruction, such as construction, accidents, may also be constrained, resulting in a traffic jam. We estimated the total number of vehicles under each category, arriving to the city during the weekdays. Then we calculated the hourly arrivals number of vehicles in peak and off peak hours, which is recorded in Table 3. In terms of vehicles arriving in Kandy city on a given working day, 26 % are motor cycles, which is the highest with a number of 1331, during peak hours and 444 during off peak hours, followed by cars with an average arrival rate of 24 % with 1194 of cars during peak hours and 428 during off peak hours. The third highest number of vehicle type that enters the city is three wheelers with a rate of 22 % with 1053 during peak hours and 413 during off peak hours. Every other vehicle type (lorry, truck, bowser, cabs, jeep, wago, ambulance, and others) take less than 15% with an average number of 8% of vans and 6 % of buses entering the city.

People often work and live in different parts of the city in any country. Places of work, school, and shops are often located away from housing areas, resulting in the need for people to commute to city in every day. According to the monitoring survey, approximately 0.3 million people including schoolchildren commute between Kandy city and residential areas daily. People may need to move about within the city to obtain goods and services, for instance to purchase goods or attend classes in a different part of the city. All these journeys are involved extra time loss and sometimes delays, which may result in late arrival for employment, meetings, and education, resulting in lost business, disciplinary action or other personal losses. In this context, we estimated the loss of time for different vehicle users per day due to traffic congestion and identified value of it based on the wage rate. These estimations are given in Table 4.

Table 4: Estimated time loss and its opportunity costs

Category	Time Loss (minutes)	Average Wage rate (per hour)	Loss per day (Rs.)
Owned vehicle user except three wheels and motorcycles	204	992	3373
Public or Private Bus User	95	234	371
Drivers	272	275	1247
Three wheel users	45	325	244
Motorcycle user	36	197	118

Note: These values are estimated using sample averages. Hourly wage rate is estimated for each category using their monthly salary or profits

Concerning the number of minutes lost due to traffic congestion, it is the drivers who are affected the most with a loss of 275 minutes per day, followed by vehicle owners who use their vehicles (204 minutes), public or private bus users (95), three wheeler users (45), and motorcycle users (36). In terms of lost wage rate per hour, vehicle owners who use their vehicles encounter a loss of Rs. 992.00 per hour with a loss of Rs. 3,373.00 per day. Public and private bus users bear a cost of Rs.234.00 per hour with a loss of Rs. 371.00 per day. Despite the most number of hours are lost by the drivers, the average wage rate lost per hour by them are Rs. 275.00 with Rs. 1242.00 per day. Looking at the sample, the average loss for three wheeler users is Rs. 244.00 per day. The average wage for motorcycle users is Rs. 197.00 per hour and their value of the loss time is Rs. 118.00 per day. Using this information as well as the estimated number of commuters arriving city in each day, we estimated total value of the loss time per day in the city area. These estimations are given in Table 5.

According to the data given in Table 5, the highest number of people uses public or private buses as their means of commuting which is 150,000 bearing a loss of Rs. 55.575 million amounting to 25 % of the losses per day. The vehicle owners who use their own vehicles are the ones who are burdened with the highest lost in monetary terms, which is Rs. 141.66 million with a 64 % and a number of 42,000 commuters bear this loss. These are business owners or persons working at top-level position such as managers, doctors, lecturers etc., and the value of their time is higher than the other groups. A number of 16,000 drivers lose Rs. 19.946 million with a 9 % of the total loss. A number of 12000 three wheeler users lose Rs. 2.925 million with 1% and 6500 motor cycle users lose a total of Rs. 0.768 million which is 0.35 % of the total loss. It becomes clear that the total loss of the manpower due to the traffic congestion is approximately Rs. 220 million per day which is more than five billion loss per month.

Table 5: Estimated time loss per day for all commuters

Category	Values of the time loss per day (Rs.)	Number of commuters	Total Loss (Rs.)	% of total
Owned Vehicle User except three wheels and Motorcycles	12,580	42,000	141,657,600	64.14
Public or Private Bus User	2,565	150,000	55,575,000	25.16
Drivers	1,700	16,000	19,946,667	9.03
Three wheel users	468	12,000	2,925,000	1.32
Motorcycle user	252	6,500	768,300	0.35
Total		226,500	220,872,567	100.00

Note: Our estimated number of commuters arriving to the city in each day are based on monitoring survey

There is a large volume of published studies analyzing the willingness to pay (WTP) in different areas. In general, WTP is used by the environmental economists to value the goods that are non-traded and without property rights such as air, water, forests, wildlife, and other environmental services where there is no market (Athukorala, 2013).

In the field of transport economics, WTP has been used to value transportation related goods such as emissions of pollutions to the air, the emission of noise, improvement in transportation and improvement in road surface (Fosgerau and Bjorner, 2006; Asensio and Matas, 2008; Takada and Fujiu, 2010). In the context of traffic congestion, it creates a negative externality since it entails a loss of travel time for the commuters due to slower speeds, longer trip times, and increased queuing while imposing delays on others. It is evident that traffic congestion incurs a massive financial and man-hour loss for the people who travel daily to the city area in Kandy. Therefore, we ask contingent valuation question from people in order to understand their valuation of the delayed time. After explaining all the background information to the respondent, we asked, "If government is taking necessary action to reduce the traffic congestion related delay to a half from current scenario, how much would you be willing to contribute per month?" The results of the WTP to reduce a delay to a half from current level is given in Table 6.

According to Table 6, people's average willingness to pay to reduce the traffic delay by half varies from one type of vehicle user to another. Vehicle owners using their own vehicles, who express their willingness to pay the most, are ready to pay Rs. 3200.00 per month to reduce the traffic delay by half succeeded by drivers, public or private bus users, three wheeler users, and motorcycle users who are willing to pay Rs.1220.00, Rs. 724.00, Rs. 640.00 and Rs. 185.00 per month respectively. It is evident that drivers WTP is relatively higher when comparing with other three categories. Majority of the drivers are bus or van drivers and their daily income mainly depends on how many commuters they could serve within a given hour. This is one of the reasons for having higher WTP for them. In the informal discussion with respondent found that some commuters believed it is the sole responsibility of government to provide better services in order to meet all relevant quality, safety and regulatory requirements and standards in the transport sector. The mean WTP of all road users' in the sample is approximately Rs. 2000 per month. Most of the respondents were willing to pay for eradication traffic congestion by developing more road infrastructure in the study area.

As the final step of the analysis, we estimated the determinants of WTP using OLS regression. We ran two models by controlling several socio-economic variables and the results are reported in Table 7. The results show that household income, loss number of hours and travel expenditure are statistically significant in both models. These results indicate there was a significant positive relationship between willingness to pay and household income, when household income increases, the individual's WTP also increases. Further, loss number of hours and travel expenditure portray positive relationship towards WTP showing that these relationships with WTP is consistent with the demand theory. It is also evident that except age of the respondents, all other explanatory variables are significant and have shown correct signs.

Table 6: Average WTP for month to reduce the traffic delay to a half for each category

Vehicle type	WTP per month (Rs.)
Owned Vehicle User except three wheels and Motorcycles	3,200
Public or Private Bus User	724
Drivers	1,220
Three wheel users	640
Motorcycle user	185

Note: Average WTP of each group is given in this table

According to the regression results given in Table 7, when income is increasing by one unit, WTP of the commuters will increase by 0.018. If we multiply this figure by average income (Rs. 68,200), it is Rs. 1,227, which is almost similar to the mean WTP (Rs. 1,194) of the sample. As shown in the results when the loss hours increases by one unit, WTP increases by Rs. 245 which shows average hourly opportunity cost of the labour in entire sample. While coefficient of travel expenditure appear very low, coefficient of education appears a significant value of the model, which is Rs. 432. This implies the when education increases by one more year, WTP increases by Rs. 432. It is obvious that the opportunity cost of higher educated people's is relatively higher which is clearly shown by the results. The coefficients of distance, family size, and gender are significant and can be interpreted as the same way. Interestingly, it shows that the own vehicle owners WTP is relatively higher than other groups which is consistent with the results reported in Table 6.

Table 7: Regression results for identifying determinants of WTP

Variables	Model 1	Model 2
Intercept	32.54 (0.216)	12.34 (0.116)
Income	0.019 (0.021)**	0.018 (0.021)**
Loss Hours	245.08 (0.013)*	244.08 (0.013)**
Travel Expenditure	0.27 (0.001)*	0.26 (0.001)*
Distance		120.56 (0.000)*
Family Size		73.17 (0.021)**
Education		432.401 (0.000)*
Age		8.461 (0.312)
Gender		122.21 (0.000)*
Own Vehicle		431.302 (0.000)*
R^2	0.612	0.662
Adjusted R^2	0.609	0.604
N	220	220

Note: *i. P-values are shown in brackets. * Denotes significant variables under 1% level of significance while ** show significant variables under 5 %*

ii. A- OLS estimators are with robust standard errors

iii. Only variables with personally born monetary values were included into the first model

iv. Correlation matrix shows the value less than 0 .54 among independent variables

We also gathered some information related to the commuters opinion of the impacts of the traffic congestion on their productivity and mental stress. It is evident that 98 % of the respondents perceived that existing traffic congestion has some serious impact on increasing their mental stress level. Further, approximately 97 % of the respondents accepted that traffic congestion results in decreasing their productivity in the workplace. In general, that any time loss irrespective of number of minutes is capable of reducing the overall productivity of workers and this is similar to the people who work in Kandy city area. We also investigated the possible causes of traffic congestion in the city area given the limited infrastructure facilities. It is found that number of crossing roads, number of vehicles parked along the roadsides, crossing rail track, closer location of schools, hospitals, temples, availability of number of boutiques(small hut-type shops) along the roadsides, narrow crossing bridge and availability of main junctions have resulted in increasing traffic congestion significantly in the city area.

Conclusion

With the rapid urbanization, it is evident that commercial and socio-economic activities tend to centralize only in major cities in a country. This has led to increase the number of commuters daily travelling to the cities. As a result, while the economy is contributed by way of increasing production and real income of household, the accumulation of vehicle population creates a huge burden to the society, which is not understood properly by the urban planning authorities in most developing countries. A review of literature in this field shows that a large volume of studies deals with analyzing the social and economic cost of vehicle travel in different contexts. Although a number of studies have studied the different aspects of traffic congestion, none of the studies has estimated manpower loss due to traffic congestion. Therefore, with the upward trend of vehicle population and traffic congestion in Sri Lanka, this study attempts to identify the total manpower loss of road traffic congestion in Kandy district in Sri Lanka which is increasingly major challenge for workers' productivity, health and environment in the study area.

Results of the study clearly show that manpower loss of the own vehicles users as well as the drivers are relatively higher than other groups. Moreover, it is found that the total value of the loss time is the highest for own vehicle users. It is evident that 98 % of the respondents perceived that existing traffic congestion has some serious impact on increasing their mental stress level while approximately 97 % of the respondents accepted that traffic congestion results in decreasing their productivity in the workplace. The analysis of WTP for reducing existing traffic delay to a half show that own vehicle users' WTP is relatively higher than other groups. It is also found that income, loss number of hours, travel expenditure, distance from home, family size, education, gender and vehicle ownership are important in determining commuters WTP to reduce traffic congestion.

Furthermore, it is found that number of crossing roads, number of vehicles parked along the roadsides, crossing rail track, closer location of schools, hospitals, temples, availability of number of boutiques(small hut-type shops) along the roadsides, narrow crossing bridge and availability of main junctions have resulted in increasing traffic congestion significantly in the study area.

The overall findings of this research will help implement policies to mitigate traffic congestion that is increasingly posing a major impediment to efficient mobility of people and freight, urban environmental protection, and sustainable development. Measuring the time cost of traffic congestion is of paramount importance when understanding the real cost of congestion. In general, the research findings will contribute to the sustainable use of road space to improve urban mobility and achieve a transport system that imposes less environmental damage. It also helps increase awareness and generates support for investment in mass transport system development. It will provide an opportunity to make necessary policies that provide incentives to increase the productivity of the work place generate direct benefits the all in the society.

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