ESTIMATION OF TRAFFIC CONGESTION COST AND VALUE OF TIME -A CASE STUDY OF PASHTUNISTAN-AIRPORT ROAD IN KABUL CITY

Kyushu University, Student Member, Habibullah BABAKARKHAIL
Kyushu University, Member, Noriyasu KACHI, Kienchi TSUKAHARA

1. INTRODUVTION

Kabul city is estimated as the fifth fastest growing city in the world with population count increased from 1.5 million to 6 million from 2001 to 2014.[1] However, the city seems to be incapable to keep up with this fast urbanization. Congestion is a significant problem in Kabul city that triggered by many reasons such as the inadequate structure of urban road system, lack of public transportation, lack of road networking, high demand of private vehicles, shortage of traffic maintenance, lack of awareness about traffic rules, link of narrow roads with width road, parallel parking, political situation such as too many blocks/ check points and many other reasons.[2] There are some studies that tried to understand and study the increased congestion problem in different places in Kabul city to offer some solutions. (Safi, Z. U 2011) explored the factors that caus excessive congestion especially the individuals and community actions that contributed to exacerbate the problem.[3] The results indicated the unawareness of traffic laws and regulations and gave recommendation mainly road police and ministry of urban development to regulate the traffic laws. (Noori, W. A 2010) investigated the reasons behind congestion that causes air pollution, costly transportation, accidents and lowers the individual income to less than 100 dollars.[4] The research showed that the city unable to develop new transportation infrastructure such as mass transit, BRT, rail and tram and attempts should be run to improve the current infrastructure and public transport. On the other hand, a limited research was done on the economic aspect, cost benefit analysis on Kabul city inner ring road was done to propose alternatives for the road network under this study.[5] However, gathering data and making exact study is very difficult and there is shortage in data resources in Kabul city.This paper study the congestion at one of the most congested roads in Kabul city (Pashtunistan- Airport) road with a conventional approach to quantify congestion in terms of costs. Therefore, traffic parameters were collected from field survey and data for VOT through stated preference survey. The results can be used by policy makers to reduce congestionand time loss through efficient transport system planning.

2. DATA COLLECTION & METHOGOLOGY

Data for value of time was collected through a stated preference survey. This survey was conducted at various organizations along the road targeting variety of citizens who commute daily on the road. A paper based questionnaire was done where respondents were given multi-choice and hypothetical mode options. The survey is comprised of (32) questions to gather data like age, gender, income, travel destination, mode, expenses, people opinions towards congestion, stated preference, journey time and others.
For traffic volume and characteristics data, video cameras were used at 6 different positions. The data was collected for two days, workday and holiday at each point to record the traffic volume. The delay time was calculated from the difference of experimental travel time and theoretical based on reference speed. Value of time (VOT) is estimated from the survey (socio-economic survey) based on the questionnaire response which will provide information like travel time and travel costs for each travelling mode cars or buses. Additionally, applying this information in equation (1) and (2) as a part of multinomial logit model to estimate the value of time by maximizing log-likelihood.
Where,

$$U_i = B_0 + \beta_1 . TTi + \beta_2 . TCi \quad (1)$$

U_i = Utility of mode i (i= {Car, Bike, Microbus, Taxi, Bus,}). TT_i= Travel time for mode i,
TC_i= Travel cost for mode i. B_0= Intercept,
β_1= Coefficient of travel time [1/min]
β_2= Coefficient of travel cost [1/Afg]

$$VOT = \beta 1 / \beta 2 \quad (2)$$

Consequently, the value of time is used to measure the opportunity costs while, vehicle operating costs can be deduced from fuel consumption and fuel efficiency data. Equations (3) and (4) represent the expressions for opportunity and vehicle operating costs.

$$OC = \sum {}^{m}{}_{m=1} (VOTm \times Delay_m \times V_m \times Vocc_m) \quad (3)$$

Where, OC = Opportunity Cost of traffic congestion, VOT_m = Value of time for specific mode m,
$Delay_m$ =travel delay in time units observed for mode m (estimated at some reference speed). V_m =number of vehicles of type mode per day. $Vocc_m$ = Average vehicle occupancy for specific mode m.

$$VOC = L^* \sum^{m}_{m=1} (FC_m \times Delay_m \times V_m) \quad (4)$$

Where, VOC= Vehicle operating Cost,
FC_m = Fuel cost in Afg/hr. for specific mode m, and L= length of stretch in Km.

$$FC_m = \sum^{3}_{ft=1} (Fcq\ m^{Ft} \times Fp^{Ft} \times \mu^{Ft}) \quad (5)$$

Where, Fcq_m= Fuel consumption quantity in liters/km or Kg/km of specific mode m, Fp^{Ft} = fuel price of specific fuel types Ft = 1, 2 and 3 such as LPG, Gasoline and Diesel, respectively in Afg./liters or Afg/kg. μ^{Ft}= proportion of specific mode type m using a particular fuel type for travelling on that road.

3. RESULTS AND DISCUSSION

The collected data was applied in the parameters as described above in equations (1) to (4). The average value of the traffic volume collected at the six different locations were shown in Table 1 for different modes of transportation. The peak hours in the road was determined to be 7:30- 10:30 and 15:30-17:30 which is excessively crowdy. the average speed and average time delay were calculated for the peak hour and non-peak hour separately for the all transportation modes to estimate more accurate way as shown in Table 2. it demonstrates that the travel delay is larger for bus and trucks but lower for cars and bike so, the delay is not similar for all modes along the road. The level of service of the road was also calculated that is F.

Table 1. Traffic Volume for different transport modes

Mode	Traffic volume (Veh/day), Peak H	Traffic volume (Veh/day) Non- peak	Vehicle Occupancy
Car	7788	5636	1.9
Taxi	2143	1552	1.9
Bus	71	51	20
Minibus	240	174	14
Microbus	1429	1034	9.4
Truck	122	81	1.2
Bike	128	92	1

Table 2. Average speed and Av travel delay for Peak- H

Mode	Avspeed (Km/hr.)	Avg. delay (Min/ Veh) at ref 30 Kph	at ref 20 Kph
Car	14	15.1	8.5
Taxi	14	15.1	8.5
Bus	7	43.37	36.8
Mini Bus	9	30.8	24.2
Microbus	12	19.8	13.2
Truck	10	26.4	19.8
Motorbike	15	13.2	6.6

Table 3. shows the total traffic congestion costs as around 2,456,193 Afg per day which equals to 35,597 USD per day for working day and 10,239 USD per day Non-working day. According to the Afghanistan calendar 249 days are working day and 116 days are Non working. It means overall Congestion cost is around 10,051,377 USD per year in the road under study, this significant amount of money is lost due to the congestion problem and can be avoided by taking actions in the near future.

Table 3. Total cost of traffic congestion per day in Afg

Heads	**working day**	**Nonworking day**
Opportunity Cost	1,861,734	519,990
Veh Operating Cost	540,363	169,562
Wear and Tear	540,36.2	16,956
Total Cost	2,456,193	706,508

We can extrapolate the congestion cost for the whole arterial roads in Kabul city by calculating the cost for km which is around 1,647,766 USD per km per year. Then multiplying the cost with the existing length of the whole arterial network of Kabul city which is all 330.7/ urban 103 km[6]. the approximate total cost of the whole city will be equal to 169,720,001 USD.

4. CONCLUSION

This paper studied the congestion problem in vital road Pashtunistan-Airport Route in Kabul city, the survey revealed the very bad condition of the road as well as the extra congestion that is exacerbating with time. This research first investigate the congestion cost in the road 10,051,377 USD, which can be used to enhance other parts of Kabul city and relieving congestion problem. The results demonstrate that around 169,720,001 USD are lost per year in Kabul city due to the congestion, that needs a serious action in the near future. Furthermore, the calculated costs in this research are the loss from the traffic congestion that not included the environmental and other associated costs. Moreover, the losses should be extended to the whole city for estimating the total losses. Therefore, further research and immediate action have to be taken by the government and decision makers to relieve this problem in the near future.

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