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Effect of induced traffic on feasibility of highway projects using economic analysis: A case study in India

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ABSTRACT

Induced travel that alters the traffic growth rate of highway projects and their economic impacts has been studied in this paper. Most of the researchers on induced traffic have used the static lane-km elasticity, whereas it is in fact change in travel cost that users react to when the lane-km changes. Hence, this work uses travel-cost elasticity and studies the effects of induced traffic for an Indian highway project in terms of economic impacts and compares the results with the conventional lane-km elasticity method. It has been found from this study that considering induced traffic by both these methods changes the economic indicators by different amounts. Hence, ascertaining the best method by comparing with real traffic counts assumes great importance. This paper also suggests preferring travel cost elasticity as even lane-km indirectly accounts to travel cost savings due to additional lane-km added to the facility.

1. Introduction

Induced traffic is the additional traffic that is generated when the user costs associated with a road facility decreases. This decrease in cost may arise from anything ranging from minor improvements like filling up of pot holes or patches to major alterations such as widening of the road. In the first case, the cost of the trip decreases due to better riding quality and in the second, it decreases due to increased lane width for a given amount of traffic flow. Research has proven that such a decrease in trip cost makes the users to undertake more trips and this occurs irrespective of the roads being in either urban or rural setting. Travel cost refers mainly to the vehicle operating costs and includes two components namely distance related and time related costs. An improvement of the road, as discussed above may result in decrease of both these components.

The phenomenon of latent demand or induced traffic has often been ascribed very less importance in Indian highway (rural roads) projects which are being extensively upgraded by the National Highway Development Program (NHDP), since the year 2000. Induced traffic is very much relevant for Indian rural road networks, as improving connectivity in rural areas of developing countries kindles a spur of associated activities in the adjoining area. Thus, traffic growth projection rates calculated for evaluation of economic feasibility of these projects become erroneous when induced traffic is neglected.

Recognizing the importance of induced traffic; the researchers in developed countries (for example: Hamilton, 2003; Cervero and Hansen, 2002; Cervero, 2003) have dedicated a vast amount of research on induced traffic and have considered the same for both urban road networks and for freeways or intercity highways. Nevertheless, most of the researchers have only adopted lane-km elasticity, which calculates the amount of induced traffic as a proportion of the change in lane-km. This method though widely accepted, lacks a dynamic component as lane-km increase is a onetime post construction change, till the horizon year. Also, this method does not account for congestion, which has a great effect on the trip making behaviour of the road users. Yet another and most important disadvantage of this method is that it leads to increased traffic growth rate estimation in case of uncongested

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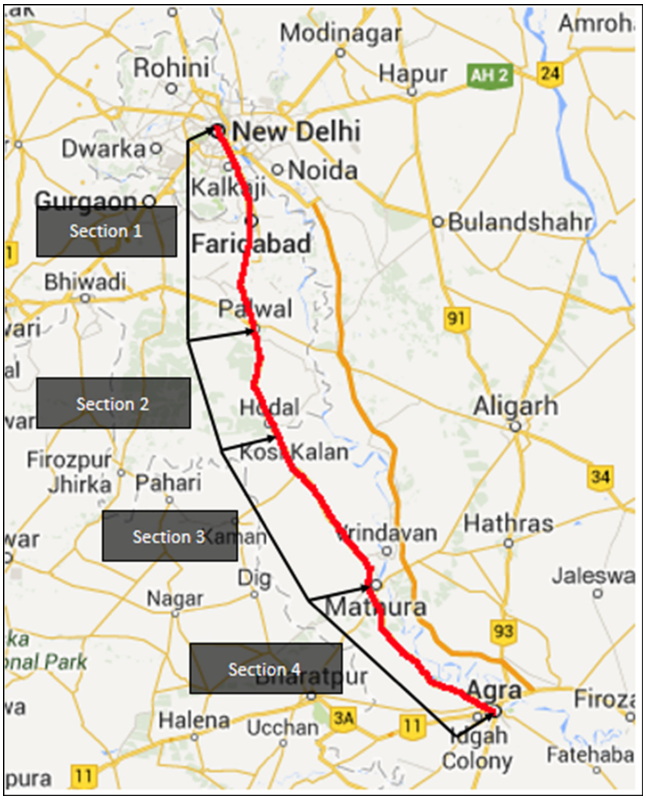

Fig. 1. The study stretch (New Delhi to Agra NH2).

facilities, where there is very less change in travel cost before and after improvement. So, parameters that can explain induced traffic as well as congestion effects would give more robust estimates of induced travel. Travel cost that includes vehicle operating costs (VOC) and value of time (VOT) is one such parameter and is significantly affected by a roadway improvement project. For instance, paving a currently unpaved road reduces costs for all road users and increasing design speeds reduces time costs per vehicle-kilometre, particularly for higher speed modes such as private automobiles. Similarly, expanding un-priced urban highways reduces traffic congestion and therefore time and money costs, expanding tolled urban highways reduces time costs but increases money costs, so it will tend to increase vehicle travel by higher-income motorists and adding bus lanes reduces time and operating costs for public transit vehicles. Many researchers have studied the relation of travel cost with the vehicle kilometres travelled (for example: Hamilton, 2003; Lee and Burris, 2002). Hence, studying the effect of induced traffic with reference to travel cost would give a better estimate of induced traffic.

As induced traffic is often neglected in evaluating feasibility of highway projects in India, this work aims to highlight some of the implications of doing so. National Highway No 2 from Delhi to Agra (Fig. 1), which is due to be widened from four to six lanes in two to three years from now (http://www.nhai.org/fundedbot.asp), has been chosen as an example for the analysis. Using the relevant project data, travel costs for traversing the stretch by different types of vehicles were calculated and from the cost differences, induced traffic was calculated. Further, economic analysis was done with reference to do nothing scenario (base case) against improved road for normal and induced growth rates of traffic scenarios. To understand the economic implications of induced traffic on highway projects, parameters like net present value (NPV) and internal rate of return (IRR) of each type of growth rate were calculated. The analysis was performed using different values of elasticity (0.3, 0.5, and 0.8) and the results obtained while using ‘0.5’ as elasticity factor are exhibited in Tables 1–9, as example, for the purpose of presentation in this paper. For this study, the authors started off the analysis using an average elasticity of 0.5 so as to have an even footing to provide results that would be most likely to follow. The analysis was then expanded to a lower and higher elasticity at equal intervals to that of 0.5, so as to cover as many possibilities as can be done. Finally, the end results are compared for all the elasticity values to demonstrate the effect of considering induced traffic on the feasibility of the highway projects.

Table 1
Section-wise NH-2 project details.

Section no.	Stretch name	Length (km)	Peak hour factor (PHF) (%)	Lane distribution factor (%)
1	Delhi–Palwal	39.5	6.19	52.00
2	Palwal–Kosi	44	6.00	52.00
3	Kosi–Mathura	38	6.33	50.10
4	Mathura–Agra	57.6	5.94	52.00

Table 2
NH-2 section-wise daily traffic details (ADT).[a]

Vehicle type	Section-1	Section-2	Section-3	Section-4	PCU
2-Wheeler (2W)	12,843	5129	3975	5290	0.5
Car (PC)/3-wheeler (3W)	20,767	13,287	9080	8547	1
Light commercial vehicle (LCV)	3603	1034	1216	1569	1.5
Bus	1096	702	560	569	3
2-Axle truck (2AV)	3733	3189	2301	2601	3
3-Axle truck (3AV)	1590	1442	1011	1393	3
Multi axle truck (3AV)	1631	1307	1078	774	4.5
Total (vehicles/day)	51,357	26,302	19,371	21,866	
Total (PCU/day)	45,263	26,090	19,221	20,743	

[a] For analysis, vehicles with same PCU are taken as same category.

Table 3
Normal (projected) growth rates (as per the feasibility report).

Period	Car (%)	Bus (%)	Truck/LCV (%)	2W (%)
2010–2015	6.6	5.5	5.5	7.2
2015–2020	6.1	5.5	5.5	6.1
After 2020	5.5	5.0	5.0	5.5

LCV: light commercial vehicles.

Table 4
VOC distance related congestion factors.

Vehicle type	4-Lane road	6-Lane road
PC	$\mathrm{CFD} = 1.038 + 0.140$[a]$(V/C)$	$\mathrm{CFD} = 1.0225 - 0.0705$[a]$(V/C)$
HCV	$\mathrm{CFD} = 0.781 + 0.947$[a]$(V/C)$	$\mathrm{CFD} = 0.654 + 0.8095$[a]$(V/C)$
Bus	$\mathrm{CFD} = 1.000 + 0.750$[a]$(V/C)$	$\mathrm{CFD} = 0.90 + 0.80$[a]$(V/C)$
MAV	$\mathrm{CFD} = 0.900 + 1.20$[a]$(V/C)$	$\mathrm{CFD} = 0.7605 + 1.5215$[a]$(V/C)$
LCV	$\mathrm{CFD} = 0.90 + 0.70$[a]$(V/C)$	$\mathrm{CFD} = 0.85 + 0.75$[a]$(V/C)$
2W	$\mathrm{CFD} = 0.934 + 0.104$[a]$(V/C)$	$\mathrm{CFD} = 0.8975 - 0.255$[a]$(V/C)$

[a] Congestion factor.

Table 5
VOC time related congestion factors.

Vehicle type	4-Lane road	6-Lane road
PC	$\mathrm{CFT} = 0.951 + 0.578$[a]$(V/C)$	$\mathrm{CFT} = 1.121 + 0.0905$[a]$(V/C)$
HCV	$\mathrm{CFT} = 0.953 + 0.839$[a]$(V/C)$	$\mathrm{CFT} = 0.963 + 0.569$[a]$(V/C)$
Bus	$\mathrm{CFT} = 1.040 + 0.422$[a]$(V/C)$	$\mathrm{CFT} = 1.053 + 0.0402$[a]$(V/C)$
MAV	$\mathrm{CFT} = 0.953 + 0.839$[a]$(V/C)$	$\mathrm{CFT} = 0.963 + 0.569$[a]$(V/C)$
LCV	$\mathrm{CFT} = 1.060 + 0.609$[a]$(V/C)$	$\mathrm{CFT} = 1.0825 + 0.295$[a]$(V/C)$
2W	$\mathrm{CFT} = 1.022 + 0.588$[a]$(V/C)$	$\mathrm{CFT} = 0.9685 + 0.617$[a]$(V/C)$

[a] Hourly traffic flow calculated from ADT in PCU for all 24 h with a PHF of 10%.