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Investigating the Social and Environmental Impacts of Road Closures on High-Profile Convoys and VVIP Movement

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ABSTRACT:

No matter how many demand management strategies are put into place, especially for dealing with chronic congestion, the problem of congestion remains. One specific problem, particularly at peak hours, is non-recurrent congestion caused by events like VIP moves. The environmental and economic effects of traffic jams caused by high-profile vehicles in developing nations are examined in this study, with a particular emphasis on India. In debt-ridden economies, this study finds substantial delays and economic penalties due to practiced standard operating procedures related with VIP movements. In order to calculate the worth of journey time and the impact of road blocks on fuel consumption, travel duration, and carbon emissions, it employs discrete choice modelling and methods. The data from the central blockage locations show that the mode choices made by VIPs throughout their travels are highly influenced by income and gender, and that the estimated value of journey time is high. Also, especially in poor countries, the environment and economy take a major hit when traffic delays last longer than two minutes. To combat the negative impacts and encourage the use of alternate transport modes, immediate measures are required to establish sustainable transport policy and implement effective mitigation techniques. Policy changes to discourage private vehicle use and a two-minute cap for VIP bottlenecks are among the suggestions. In spite of its caveats, the study highlights the importance of environmentally friendly transport policy for improving the lives of people in underdeveloped countries.

Keywords: traffic congestion, discrete choice modeling, value of time

1. Introduction

The problem of urban congestion is widespread, and scientists and practitioners around the world are working to find solutions. The majority of initiatives focus on improving technology and managing demand at the system and mode levels. It is thought that technological advancements in transportation, such driverless cars, will alleviate traffic congestion. However, how they affect traffic jams is highly parameter- and user-dependent in car-following microsimulation models.

There are two basic types of congestion: recurring and non-recurring. Congestion that doesn't repeat itself but does happen during busy times is due to chance, whereas congestion that does happen periodically is due to planned activities. Congestion that does not occur frequently can be attributed to a wide variety of causes, including but not limited to: accidents, natural disasters, road construction, special events (such as the passage of VIPs), mechanical issues, public protests, wildlife crossings, disruptions to air travel, and medical situations.

The movements of VIPs are unique among special event categories due to the deliberate halting and compromising of traffic flow to provide a select few individuals protected one-way travel. These people are typically members of international sports teams, high-ranking government officials, or foreign representatives. The unpredictable nature of these events means that they necessitate separate demand management measures and disrupt regular traffic flow. Furthermore, they are a huge problem in big cities around the world, affecting the economy, the environment, and the quality of life for residents.

Economic growth, gas mileage, and ecological sustainability are all negatively impacted by traffic congestion. Studies that attempt to put a price on the effects of congestion, both regular and occasional, have shown that there are staggering costs. Research on Despite these numbers, there is still a lack of information about user insights. Shared automated vehicles, for instance, are less valuable to residents than conventional cars or private vehicles, and this is after controlling for variables like journey time, cost, and socioeconomic status.

Whereas traffic forecasting necessitates taking into account complicated system dynamics and fluctuating demand, numerous academics have investigated ways optimize road network traffic flow, for instance by utilizing the Nash equilibrium. Legislation establishing road pricing and link-based congestion charging is among the most favored options. In areas where the congestion tax is acceptable, over half of the population would switch from driving alone to taking public transport. In addition, road pricing systems and other policy initiatives can decrease emissions, congestion, and private vehicle travel; for example, if 20% of drivers switched to public transport, we could see a 13% drop in emissions and a 20% drop in trip time.

When organizing a VIP event, it's common practice to take the following factors into account: the time of day (peak vs. off-peak), the day of the week (weekdays vs. weekends), the season (summer vs. winter), and the festival or mourning days of cultural and religious holidays. Because of social and cultural conventions that grant special treatment to certain groups of people, developing countries differ in dynamics from developed nations. The ineffectiveness of the mode shift caused by road pricing and link-based congestion charge can be attributed to problems with service quality, infrastructure, and effectiveness. Public mass transportation is thus primarily seen as a means of transportation for lower-income populations.

In addition, the problem is worsened by inadequate resource management and the burden on developing nations' infrastructure caused by an increase in private automobile ownership as a result of easy credit policies, etc. Because VIP movements are not planned taking into account the time of day, day of the week, or monthly seasons, and because there is an increase in the number of VIP individuals and their movements, this effect would further exaggerate congestion if the government is a victim of the war on terror and has high-level security risk issues for VIPs. Hence, due to the complexity of system dynamics and shifting demand characteristics, developing nations exhibit distinct dynamics compared to developed ones.

In developing nations, where these trends are already apparent, this study looked at the environmental and social effects of road closures. Among South Asian countries, there has been the fastest rate of urbanization in the last decade, coinciding with the registration of million new cars. Major aggravating factors pertaining to travel time, carbon footprints, and the environment include traffic congestion, which has been exacerbated by the rise in motorization and inefficient management. Transportation delays of many hours caused by VIP movements were also included in this study. These have meant a lot of additional work for economies that are already struggling due to debt and conflict.

So far, much of the research has focused on chronic traffic congestion, while the causes of intermittent congestion have received surprisingly little attention. This forces drivers to either put up with gridlock or find alternate routes, which in turn causes delays across the entire network. This causes unnecessary delays and strains vital emergency services provided by the emery-agency, such as fire and ambulance services. The overarching goal of this research is to assist sustainability by providing policymakers with the information they need to make informed decisions by conducting thorough analyses of economic and environmental aspects in order to develop effective mitigation solutions. A decrease in carbon footprints, time savings, and fuel waste is what we're aiming for.

2. Literature Review

This study is an interdisciplinary effort that measures traffic congestion using microsimulation, discrete choice modelling, and other related techniques. This part provides a literature assessment in these three topics covering a variety of nations around the globe.

2.1 Decision-Based Modelling

Included here is a synopsis of seminal publications in the field of choice modelling that deal with topics like data collecting and the worth of trip time estimates. Research such as that of Ramjerdi et al. Wardman conducted a meta-analysis of 98 travel demand studies that evaluated VOTT using declared preference and revealed preference methodologies. Greek drivers' VOTT was calculated using a multinomial logistic model analysis of their disclosed preferences. Future research should incorporate socioeconomic data into their models, according who used phone surveys to gather data in Greece. Using a combination of disclosed and stated data, Bierlaire and Thémans developed models to forecast travel decisions, allowing them to investigate different approaches to traffic management.

By utilising stated preference (SP) data and a modified logit model with log-normally distributed coefficients, Kawamura calculated VOTT for commercial motor carriers in California. Kurri et al. estimated VOTT for freight-specific road and rail travel in two independent investigations in Finland. They offered hypothetical option scenarios and estimated coefficients using stated-preference data and a logic model. As part of their research, Tao and Zhu analysed VOTT for goods. Using an SP survey and a multinomial logistic model, Kumar et al. anticipated VOTT, service headway, and comfort levels for rural bus travelers in India. The SP poll took the vacation and the respondent's socioeconomic status into account.

Several studies have used stated-choice methods to assess users' willingness to pay (WTP). To estimate WTP for various road types, Hensher et al. utilised a stated choice experiment to develop mixed logistic models.

3. Methodology

3.1 Study Area

With a combined population exceeding, the twin cities of Patna and Gaya in Bihar constitute the third-largest metropolitan area, which includes the study area. Patna is both the capital and a sacred site for the country, and both cities are strategically important. This site is perfect for our study because of the high volume of everyday commuters and frequent movements of VIPs between these two cities.

3.2. Designing the Questionnaire

We estimated VOTT using a stated preference (SP) method, and we computed travel delay and carbon emissions owing to congestion caused by VIP movements using VISSIM simulation. the methodology used to accomplish the study's research objectives. The SP questionnaire was designed to

capitalise on its strengths, such as its flexible experimental design and the fact that it includes nonexistent alternatives, which were discussed in the literature review. The rules laid out by The survey asked four types of information: demographics, daily travel details, VIP movements, and preferences.

4. Data Collection

4.1 Stated Preference Survey

The SP survey, which relied mostly on convenience sampling and partly on snowball sampling techniques, used a questionnaire that was created in the first step. In order to collect choice data and identify various socioeconomic elements impacting mode choice behaviour, convenience sampling entails selecting easily accessible consumers. For surveys of difficult-to-reach populations, researchers can use snowball sampling, a non-probability technique in which existing sample participants encourage the recruitment of additional study participants. For this poll, we used both digital and more conventional methods, such as pen and paper.

4.2. Study on Traffic Volumes

Included in the second set of data were details regarding the research area's five locations' current geometry (lane width, number of lanes, etc.), speed limits, signal timings, and traffic volumes. Each site underwent classified traffic counts between 7:00 a.m. and 10:00 a.m. and 4:00 p.m. and 8:00

p.m. to compile the data. The counts encompassed various forms of transportation, including cars, motorbikes, and heavy vehicles (trucks).

5. Analysing Data

Decision-Based Modelling

According to the reviewed literature, the unordered choice model also called the multinomial logit model was chosen. Based on the principle of utility maximisation, this approach allows decision- makers to rank the various options by their perceived value and then choose the one with the highest rank. Since it is impossible to know the precise value, random utility theory was born out of a need to use a probabilistic technique.

5.1 Discussion and Findings

Information About the Sample

Although 285 people took part in the survey, only 401 distinct entities were considered for further analysis due to missing data and incomplete surveys. The gender breakdown of the sample was as follows: 65% men and 15% women. Bihar was the location of choice for the vast majority of responders (72%). The responders' demographics are broken down in Table 1.

Variable	**Sample %Age**	**Variable**	**Sample %Age**
Gender		**Cities**	
Male	65%	Patna	74%
Female	35%	Gaya	26%
Age		**Vehicle Ownership**	
<18	27%	Bikes	27%
22–32	62%	Four-wheeler	22%
33–43	28%	Both	38%
44 above	23%	Don’t own a vehicle	31%

Figures 2 indicate that the VISSIM simulation relied on essential inputs, which were peak hour volumes on each intersection acquired from a detailed traffic count study. As an added bonus, the study's data was a perfect match for the simulation's vehicle mix.

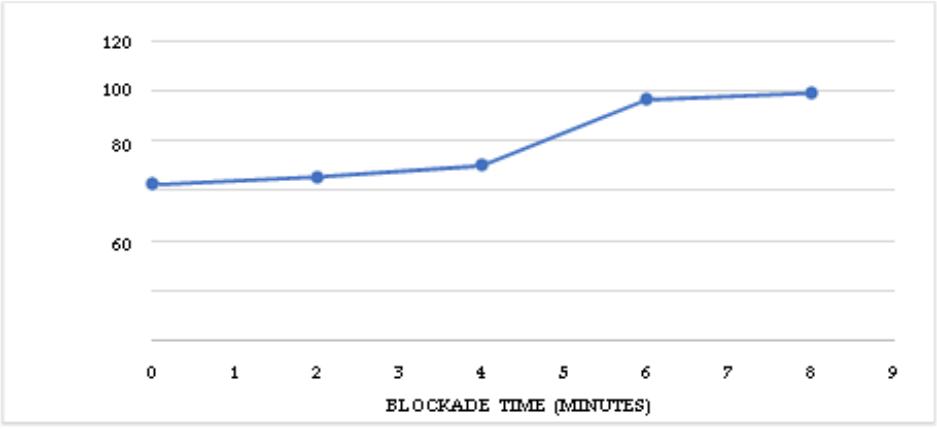
Figure 5. VISSIM Model Patna – Gaya Road

Our simulation faithfully reflected real-world traffic scenarios thanks to these approaches. To make our VISSIM simulation even more accurate, we included speed restriction data in the calibration process. The traffic counts and accompanying speed limitations for calibrating the VISSIM model are summarised in Table 2.

Road name	**Volume**	**Peak Hour**	**Speed Limit (km/h)**
Airport Road	2306	8:30–9:30	65
Patna road	4597	9:30–10:30	45
Gaya	2487	6:00–7:00	73
Gaya Rajghir	1395	8:00–9:00	75

6. Simulation Results Sections of Highway

At each blockade time, the simulation shows how the line length progresses at motorway portions in Fig. At the outset, the queue length was zero across all freeway locations, just like in the simulation. From there, the increase in wait times for blocks 1 t0 2 llong split roadways with multiple lanes was small. At roadblock 4, though, the line grew exponentially on the two-lane divided urban main road.



7. Conclusions

Research in this field has focused on the effects on the environment of traffic jams caused by the movements of famous people in cities. Important factors impacting mode choice, including gender, were trip duration and cost. During VIP movements, women tended to choose public transport over cars or bikes, even if they usually preferred the former. But in this case, age was not a major factor in mode choice. the costs of VIP-induced blockage are comparable to those of congestion in major cities.

findings revealed that VIP bottlenecks negatively impacted both the environment and the transportation network. Prolonged stoppage durations significantly increased fuel consumption and carbon emissions, especially at freeway stretches as compared to signalised intersections. Additionally, the exponential increase in fuel consumption and delay expenses demonstrated how VIP movements harm both the economy and the health of road users, particularly in underdeveloped nations. This data strongly suggests that VIP blockages should be limited to no more than two minutes. Sustainable transport regulations should be put in place to discourage the use of private cars, according to the report. It is crucial to recognise certain limits despite the valuable insights presented. The modelling approach relies on assumptions, which could alter the accuracy of the results, and the conclusions may not fully reflect the complexity of all urban settings due to their contextual nature.

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