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Exploring the Enablers of Smart Transportation for Building and Sustaining Smart Cities

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Abstract: *Background:* India is facing with severe transportation issues since past few years. This has resulted in an imbalance in the time consumed for reaching a destination. Unpredictable accidents and losses have taken a large volume of data in the country therefore what can be done is to seek for measures that can enable smart transportation. *Purpose:* The aim of the paper is to explore the enablers of smart transportation for building a smart city in future. *Methodology:* A comparative study of the transportation facilities of the primary states of India has been done. The critical issues of the transportation have been studied in depth. The research has been followed by both primary and secondary data. The factors promoting smart transportation has been obtained from qualitative study. *Findings:* The current study leads to dig out several factors from different states for promotion of smart transportation in the near future. The research also highlights the good and bad practices of transportation in the primary states of the country. *Implication:* This study contributes to research towards transportation. This study also provides guidance for a smart transportation. *Originality:* The research will add value to the current transportation which has become worst.

Keywords: transportation, policies, road construction, city

1. INTRODUCTION

Transportation has become the critical issue for the developed cities (Kenworthy, 2006). It's high time to think for the enablers of smart transportation so that the city can be sustained. In the coming future, the number of private vehicles is going to increase. The government buses for public transport are crowded every day. This has created several problems in the public transportation also. The increase number of private and public vehicles has made the traffic worse (Peden, 2004). The scenario is even worst during monsoon seasons. The unavailability of traffic signals and traffic police have made the transportation facilities even worse. The road conditions have become very poor due to severe rain. Road constructions

and widening of narrow roads is also the need of the hour. The data about the number of accidents has been increasing due to traffic. The immature and untrained drivers are not only responsible for their lives but also the lives of several innocent drivers. This has brought to the research question that what are the enablers of Smart transportation for sustaining smart cities. Driven by the research question, the objective of the paper is to explore the enablers of smart transportation. The research has undergone primary and secondary data research to frame a model for smart transportation. The enablers of smart transportation have been explored in the study.

2. LITERATURE REVIEW

Transportation is the concerned topic for today's era. The main sufferer of transportation is Ambulances running on roads. These ambulances have patients who have to reach hospitals on time. During peak hours, it is difficult for the ambulance to find space to go. The situation goes worse during monsoon seasons where even the ambulances are stuck in the traffic. The patients have to suffer a lot due to such traffics. Waiting in a long queue in traffics leads to wastage of time. After consumption of a lot of time, the vehicles rush to their estimate destinations. This leads to severe accidents. This usually happens during peak hours when people go to offices, schools or companies or for any other work. In this century, bicycles can not be promoted to that extent. The reason being that the professionals, top as well as middle level managers, academicians and staffs would resist the use of bicycles. In spite of several advantages of riding bicycle for health and the environment, the use cannot be promoted to a large extent.

Public transport is one of the means of transportation which are overcrowded all the time. The developing cities lack the metro facility; air conditioned buses and trams to reduce the traffic conditions. Andrey et al., 2004: There has been a very limited understanding about the traveling decisions affected by the policies. There are two themes which are the enablers of transportation first is the telework and second is the persistence and reasons for auto dependence with travelling households. Mitra, 2013: reviewed transportation behavior in schools. The major theoretical approaches used were to study and explain walking/cycling behaviour.

Björklund, 2011 reported in his research that internal management, image, resources of the firm and governmental means of control are essential for better monitoring. Wardrop, 1952 reported in his study on transportation that random distribution of vehicles on road leads to congestion. The speed of vehicles on road is optimum. Due to random distribution of vehicles the speed of the vehicles gets reduced. This leads to long delays in traffic signals. The delay in traffic signals forms a cycle and the road is congested with traffic during peak hours.

Litman, 2003: Traffic measurement is a very simple means to analyse traffic. Transportation system performance can be measured in many ways reflection what are transporting vehicles, where, how, when and why the means of transportation persist in a place. Different methods favor different types of transport users and modes, different land use patterns and different solutions to transport problems. There is dearth of measures for making the transportation system both convenient and comprehensive.

Anas & Lindsey, 2011: Urban road transportation creates several externalities like accidents, pollution, greenhouse gas emissions and congestions. The road benefits pricing exceeds costs, benefits of congestion relief, public transit and road pricing are the factors of smart transportation.

Mohan *et al.*, 2008: Road and traffic are a key part of life. Therefore it is essential to monitor the road transportation. Traffics in roads are due to several road conditions such as potholed roads, a lot of braking and honking and a heterogeneous mix of 2-wheelers, 3-wheelers, cars, buses and other vehicles. Rich monitoring of traffic can be done through GPS and communication windows. These systems can help to detect potholes, bump detection, audio sensing, video sensing, motion sensing and pedestrians.

Papageorgiou, *et al.*, 2003 : There has been a rapid increase in the number of vehicles in the road. This has led to traffic congestion. Traffic congestion leads to excess delays, increased environment pollution and reduction in the safety measures. The emergence of traffic has led to new innovation needs in the transportation. The traffic flow behavior depends on external quantities that are classified into two. First named as control inputs such as traffic signals and second named as disturbances that can not be manipulated. Measurements of traffic signals are mostly local. There are four possibilities for influencing traffic signals through traffic light conditions namely splitting the road, cycle time, stage specification namely intersection of several roads and offset. Control strategies for traffic includes fixed time strategies and isolated time strategies. Fixed-time strategies for a given time that is morning peak hour are derived and the traffic signals can be monitored during the time period. Isolated strategies are applicable to single intersection where several network of roads intersect. Ramp metering, activated via installation of traffic lights , Link control that comprises a number of possibilities including lane control, variable speed limits, congestion warning, lane instructions, Driver information and guidance systems, proper application of ramp metering, increase in mainline throughput due to avoidance or reduction of congestion, increase in the served volume due to avoidance of blocked off-ramps or freeway interchanges, efficient incident response, improved traffic safety due to reduced congestion, traffic time, route guidance and safer merging.

There is a random distribution of vehicles on the road. All the vehicles run simultaneously in a lane without following any road discipline. Vehicles overtake and create an imbalance in the road transportation. The frequency with which the vehicles overtake is obtained by the speed distribution (Wardrop, 1952).

Urban road transportation creates several externalities like time delay, accidents, pollution, greenhouse gas emissions and extra fuel consumption (Alex and Lindsey, 2011).

Road transportation is influenced by various factors. The factors affecting the road transportation are often ignored. Road traffic cannot solely depend on the past traffic data because, on road traffic event affects the traffic flows, off road events and traffic data are not available for all the links in the road networks. Therefore the idea of traffic networks becomes difficult to now (Abadi *et al.*, 2015). The accuracy and efficiency can be demonstrated by a large network. These network help to predict the random effects and uncertainties.

According to a research report by Peden, 2004, millions of people are killed and injured due to road accidents. Road traffic injuries have become a public health issue. Demographic factors, landuse, alcohol consumption, vehicle related risk factors, nonuse of helmets, non-use of seat belts, traffic light, drug consumption, driving hours and ignorance of traffic rules are the risks which people often take. There are several people who die on roads due to no helmet. There has been a strict rule of road traffic that driving after alcohol consumption is prohibited. In spite of the fact, people still continue to drive after alcohol or drug consumption. This not only leads to end their life but also results in many innocent sufferers. The land use planning leads to proper road construction. Narrow roads often results in increase traffic conditions.

It has been noticed that many people do not use seat belts while driving four wheelers. There are traffic policemen who consistently check on people disobeying traffic rules. It has been observed that people are too careless to follow the traffic rules. Ignorance of such rules results in road traffic accidents and injuries. This ends not only the drivers to suffer but also their families who wonder in and around the hospitals.

Modeling, Simulation, Dynamic Routing, Intelligent Traffic Control and Congestion management are few techniques that lead to smooth transportation. The use of software techniques leads to smooth transportation system (Chen and Harey, 2010).

Measurement of traffic conditions is mostly local and noisy due to various effects (Papageorgiou *et al.*, 2003) Driver information and Route Guidance System is suitable for monitoring traffic conditions. Design and testing of control structures for free road networks also help to reduce traffic conditions. Traffic signal strategies like OPAC, PRODYN, CRONOS and RHODES are not so efficient to control road transportation. Iterative strategies run several simulations and guides to find the most suitable route. The travel time display is an effective measure for road transport.

3. RESEARCH METHODOLOGY

The research has undergone extensive literature, government websites and primary data to undergo the better transportation means. The primary data has been collected from 200 respondents from developing city. Structured questionnaire has been built from the literature. The questionnaire has been pre-tested by the academic experts. After few corrections in the questionnaire, the final structured questionnaire has been floated to the respondents. The ten enablers found from the literature has been ranked and explored.

4. RESULTS AND DISCUSSION

After successful data collection, the data has been analysed in IBM SPSS version21. The reliability of the items has been checked through Cronbach's alpha. It has been found that Cronbach alpha is 0.77 which means that the data is reliable. The closer is the Cronbach's Alpha to 1, the higher the reliability. The generally agreed upon lower limit for Cronbach's Alpha is 0.7 (Hair *et al.*, 2010 and Nunnally *et al.*, 1978).

Table 1
Reliability of the items

<i>Cronbach's Alpha</i>	<i>N of Items</i>
.771	11

The eleven items identified from the literature has been put in the structured questionnaire with Likert scale. The eleven items have been ranked from 1 to 10 on the basis of their mean scores. It has been found that the respondents want metro facilities to be set up in developed cities in order to attain smart transportation. Monitoring of road constructions, automated traffic signals and increase in the number of flyover bridges are other prior factors which enable smart transportation. The table 2 represents the ranking of all the eleven items on the basis of preference of the consumers for smart road transportation. It has been found through the research that bicycles promotion in the era of smart city is given the least priority for smart transportation.

Table 2
Ranking of the Items enabling smart transportation

<i>Variables</i>	<i>Mean Score</i>	<i>Rank</i>
AC buses should be promoted	4.17	9
Bicycles can enable smart transportation	3.91	10
Number of Traffic police should be increased	4.33	6
Narrow roads should be made broad	4.43	4
In several narrow roads buses should not be allowed	4.40	5
Few road constructions should be monitored from time to time	4.62	2
Number of flyover bridges should be increased in the future	4.44	3
During construction of an Industry, apartments should also be constructed nearby. This will help the employees to settle at the apartment and can work easily	4.20	8
Double Decker bus facilities should be promoted	4.21	7
Metro facilities should be started	4.70	1
Traffic signals should be automatic depending upon the number of vehicles	4.44	3

AC buses would not work in developed cities. Minimum uses of bicycles are there, due to climatic conditions. People in developed cities do not use bicycles since it is inconvenient to ride to long distances. Number of Traffic police should be increased. Traffic police has a major role in the transportation system. They are responsible for smooth running of the vehicles. Narrow roads lead to a lot of traffic. Therefore Narrow roads should be made broad. Timings for Trucks are fixed. In several narrow roads buses should not be allowed. Parking facilities in developed cities are well and good. Rainy season consumes a lot of time for travelling as vehicles are stuck in the traffic. Few road constructions should be monitored from time to time. Number of flyover bridges should be increased in the future. During construction of an Industry, apartments should also be constructed nearby. This will help the employees to settle at the apartment and can work easily. This will help to avoid transportation hurdles and sustain the city. Double Decker bus facilities should be promoted. Metro facilities should be started. Automatic signals should be promoted.

5. CONCLUSION

Transportation is the critical issue of living. There are several critical issue of present transportation. This has led to increasing number of accidents, pollution and wastage of time. The research study has identified the key factors from the literature and government websites which can promote smart transportation. These items have been ranked on the basis of their priority as enablers of smart transportation. Metro facilities have been given prime importance by the respondents. It has been found through survey that people want to use metro facilities so that they can save their time and remove the unwanted road traffic. The second key factor given importance is that Few road constructions should be monitored from time to time. Monitoring of the roads should be done so that the traffic rules can be followed by everyone. The width of the road should not be narrow as narrow roads create a lot of congestion and traffic. There is a high need to increase the number of flyovers as the vehicles will be increasing in the coming future. To sustain the roads for the vehicles will become difficult. Buses should be provided with separate lane so that there could be fewer disturbances. The mentioned points should be worked upon so that the roads can be safe and sustained.

6. FUTURE RESEARCH DIRECTION

The present study opens door for further research to implement the enablers for smart transportation in developed cities. The research is limited only to cross sectional data and has not touched upon the transportation policies. Further research can be done on framing policies and automation of smart transportation in the developed cities.

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APPENDIX

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Questionnaire

The results of this survey will help in exploring the enablers of Smart transportation. This survey is solely for the purpose of academic research and you are requested to be absolutely honest with your answers. Complete secrecy shall be maintained on your inputs.

Enablers of Smart Transportation (1 = strongly disagree, 5 = strongly agree)

S.N	Questions	1	2	3	4	5
1	AC buses should be promoted					
2	Bicycles					
3	Number of Traffic police should be increased					
4	Narrow roads should be made broad					
5	In several narrow roads buses should not be allowed					
6	Few road constructions should be monitored from time to time					
7	Number of flyover bridges should be increased in the future					
8	During construction of an Industry, apartments should also be constructed nearby. This will help the employees to settle at the apartment and can work easily.					
9	Double Decker bus facilities should be promoted					
10	Metro facilities should be started					
11	Automatic signals					

Any Other Suggestions

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