Feasibility Study of an Intelligent Transportation System for Urban Area

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Abstract - *The Intelligent Transportation System is one of the burgeoning inventions that uses new technology to solve a variety of issues. Its compatibility with real-world issues in developing nations like India, such as traffic congestion, infrastructure demand, high traffic loads, and non-lane traffic systems. It is critical to assess a technology's potential in order to determine its viability. The goal of this article is to determine the utility cost ratio of implementation so that it may be evaluated without changing the existing infrastructure design. The end result is a utility cost analysis approach that takes social, economic, and environmental issues into account. As a result, the analysis is quickly examined so that the technology may be applied according to its appropriateness.*

Key Words: Investments, Congestion, Intelligent Transportation System (ITS), Benefits.

1. INTRODUCTION

The Intelligent Transportation System (ITS) is a concept for reducing or at least limiting traffic congestion that is still evolving. Population growth and quick development have resulted in an increase in the number of cars on the road. And, in many locations, the growing number of cars began to outnumber the road's capacity. Congestion happens in some areas when the demand limit is surpassed. Several studies on traffic have been released.

Congestion and accidents have been researched and examined by a number of academics and organizations. It has been determined that resource consumption at present rates is unsustainable and may result in extinction. According to most research, ITS play a significant role in reducing travel time and frequency. Because current challenges cannot be addressed by a single solution, a variety of approaches will be required to address transportation-related energy and environmental issues. Many constraints exist, including developing and deploying environmentally friendly cars and fuels, as well as reducing overall travel increase. So, by evaluating the lowest implementation cost for such parameters relative to the advantages consumers may receive, we can implement such parameters according to circumstances, resulting in maximum benefits. As a result, the parameters must be lucrative, and the advantages we may get from them must be user- friendly in order for society to embrace the usage of ITS parameters in road infrastructure.

1.1 Criteria of Smart Cities

Various research on the assessment and monitoring of smart city development have been performed. The European Union (EU) Urban Audit Dataset was used by Caragliu, Del Bo, and Nijkamp (2011) to examine variables that influence the performance of smart cities. The EU Urban Audit provides data on over 250 variables in the areas of population, social factors, economic factors, citizen engagement, training and education, environment, travel and transportation, information society, culture and entertainment for European cities. The dataset, however, does not include an index for measuring intelligence in cities. Focusing on the urban environment, Karags et al. (2011) found that education, accessibility, and the use of ICTs in public administration are all significantly linked to urban intelligence.

i. Smart Economy

Innovation, entrepreneurship, financial image and brand, labor market flexibility, interaction with foreign markets, and the ability to adapt are all part of the smart economy (Gifinger et al., 2008; Monferdzadeh and Berardi, 2015). One of the major motivations for smart cities is towns with high levels of economic competitiveness (Giffinger et al., 2013). Competition, on the other hand, is an absolute concept, and maintaining current and future competitiveness (Economist Intelligence Unit (EIU)) is critical for economic development, the business and regulatory environment, organizational quality, human capital, cultural aspects, and governance (Economist Intelligence Unit (EIU)). As Friedman put it Friedman.

ii. Smart Environment

The attractiveness of natural conditions, pollution reduction, and resource management sustainability are all characteristics of a smart environment (Monfarazade &

Berardi, 2015). The attractiveness of natural circumstances, pollution levels, environmental protection, and sustainable resource management are all factors that influence the smart environment (Gifinger et al., 2013). Important elements of sustainability, such as responsible resource management and energy efficiency, are often highlighted in smart city definitions.

1.2 Basic Objective of Research Work

1. To investigate the benefit-to-cost ratio of ITS characteristics in the Indian context and effect of intelligent transportation systems (ITS) on fuel use.

2. To investigate the effect of IT'S on the social, economic, and environmental advantages that it provides.

3. To conduct a comparative examination of ITS deployment on roads with other modes of transportation.

4. To estimate the cost of infrastructure as well as public opinion on the suggested Intelligent Transportation System.

1.3 Scope of Project In broad Sense

Traffic is made up of a variety of various kinds of vehicles, including automobiles, buses, lorries, two-wheelers, three-wheelers, and other similar vehicles. These two- and three-wheelers are of tiny stature; as a result of their existence, lane discipline is compromised. The flow of traffic has been disrupted. Induction loops may not be helpful for data collection in certain situations, conditions. Currently, researchers are using either manual data collecting approaches or video filming-based technologies to acquire information. We personally gathered vehicle traffic count (PCU) data from a variety of sources. Amravati is a city in India. These techniques are helpful in gathering certain macro-scale information, such as categorized traffic statistics, for analysis flow and is not helpful in gathering microscopic data, therefore we need to do further research. Deployment of ITS and recommendations for implementing so that we may solve these difficulties More advantages should be considered.

2. LITERATURE REVIEW

This part of the paper reviews the findings from the academic literature. Literature review findings are divided into different parts based on their type.

2.1 Prediction of Road Accidents Using Vehicle and Driver Parameters

With car and driver specifications, it is possible to forecast a traffic crash. The speed, location, and direction of travel are all taken into account. as well as car parameters, which are influenced by the driver's actions in certain situations. Perturbation is a significant factor in determining the driver's action, such as irregular acceleration, deceleration, and yaw-rotation.

Weiming Hu et al. (2004) proposed a technique for predicting traffic accidents that is based on vehicle monitoring. A fixed camera is used to capture pictures of traveling trajectories, which are then used in conjunction with 3 dimensional model dependent vehicle monitoring to create the final images in this framework. The activity patterns of the cars are next investigated with the use of a fuzzy self-organizing neural network system. Traffic accidents are predicted using this method, which makes use of a risk model. Several tracking algorithms were used to monitor the vehicle's movements, including region-based tracking, active contour-based tracking, feature-based tracking and model-based tracking. An accident probability model was used to determine the chance of an accident in a road traffic situation. Despite the fact that this concept is ideally suited to an urban environment, it would need to be reconstructed to be used on a highway.

3. Methodology

The purpose of study is to provide the smart solution of our conventional traffic flow. Our main focus on effect of intelligent transportation systems. In this Chapter, the impact of intelligent transportation framework decrease fuel utilization, emission of exhaust pollutants and road-vehicle crashes under heterogeneous activity condition, and their impact on the related destination are examine.

3.1 Overview and Benefits of ITS

The ITS Joint Program Office (JPO), which is part of the USDOT's Research and Innovative Technology Administration, is in charge of conducting research on behalf of the agency and overseeing all main avenues for advancing transportation technology. Transportation safety, mobility, and environmental sustainability may all be enhanced with technology advancements. Information technology applications, often known as ITS, are also utilized. Because ITS applications mainly involve infrastructure and cars, as well as integrated applications involving both infrastructure and vehicles, government financing for the creation of an intelligent transportation system is becoming more limited. Investments are made in order to take advantage of significant initiatives that have the potential to produce revenue or possibilities. Increased safety, mobility, and overall productivity generate substantial money. Electronic toll collection is another prominent ITS technology that is now in use throughout the nation. Services include toll collection, red light cameras, traffic signal synchronization, and public transportation. Other technologies include passenger information systems, signal priority, and others.

3.2 Data Collection

The data of Signalized intersection is collected in term of PCU and considered for calculating average delay so that total fuel consumption per day is calculated and then total fuel consumption monthly, yearly and decade for ITS implementation is calculated.

3.3 Data Analysis

The collected data is analyzed, the fuel saving from difference of without ITS and with ITS implementation is calculated and from that saving cost is calculated by multiplying fuel saving with fuel cost and then comparative graph for fuel consumption with ITS implementation and without ITS is drawn. And likewise comparative graph for Emission rate of gases CO and NOX is drawn and for accident average cost per accident with signal synchronization and without synchronization is calculated and comparative graph is plot.

3.4 Study Area

The study area consisted of the five intersections. The traffic data is collected in term of PCU. The study area conducted of 6 km stretch of Amravati city from Rajapeth to Kathora square of all total 5 intersections. Which includes; Rajkamal square, Irvin square, Panchavati square, Shegaon Naka, Kathora Naka. And for further calculations average PCU is taken.

4. DATA COLLECTION

4.1.1 Primary Data (Collected Traffic Data)

Primary data is about the study of Amravati roads and identification of traffic flow. The site is selected, the stretch from Rajapeth to Kathora Naka and the data is collected i.e. traffic volume count (PCU). In input data the initial cost and operating and maintenance cost is calculated. And for Output benefits the fuel consumption, emission rate and accidental rate is calculated. The data from road intersection, the delay reduction and fuel savings are added to evaluate socio-economic and environment parameters.

4.1.2 Secondary Data (Collected Responses from Questioner)

Secondary data is about collected responses which have been collected manually from questioner. Then the solution using ITS to the existing condition without changing infrastructure is identified. Hence comparisons between present condition and with suggested deployments are done.

4.2 TRAFFIC FLOW CONVERSION IN PCU

The PCU (Passenger Car Unit) is a measure used in transportation engineering to evaluate highway traffic flow rates. In comparison to a normal passenger vehicle, a passenger car unit is a measure of the form of transportation's impact on traffic factors (such as highway, speed, and density). It's also regarded as the equivalent of a passenger vehicle. Because India is a country with unusual traffic circumstances, all kinds of vehicles must be considered when studying. To address this issue, traffic flow has been redirected to PCU. The following are the conversion factors for the PCU:

Table -1: Values of PCU for different types of vehicles

Type of Vehicle	Two-wheeler	Three-wheeler	Four-wheeler	Heavy Vehicle
PCU Factor	0.5	1.00	1.00	3.00

4.2.1 Traffic Count Tally Sheet (Rajkamal Square)

TRAFFIC COUNT TALLY SHEET						
Approach Road	**Rajkamal Square**					
Time Interval	**Motorized**					
	1	**2**	**3**	**4**	**5**	**6**
	Heavy Truck	**Goods Pick Up**	**Bus**	**Car**	**Auto Riksha w**	**Motor Cycle**
7.30-7.32AM	0	6	4	10	20	40
7.32-7.34 AM	0	6	3	15	15	40
7.34-7.36 AM	0	6	4	20	13	37
7.36-7.38 AM	0	8	6	15	14	30
7.38-7.40 AM	0	0	5	15	20	35
7.40-7.42AM	0	13	10	10	10	40
7.42-7.44AM	0	10	8	20	14	44
7.44-7.46AM	0	6	8	15	18	27
7.46-7.48AM	0	6	6	12	25	22
7.48-7.50AM	0	7	7	20	20	20
7.50-7.52AM	0	6	4	12	20	35

7.52-7.54AM	0	5	5	15	28	20
7.54-7.56AM	0	0	5	15	20	34
7.56-7.58AM	0	4	4	20	19	30
7.58-8.00AM	8	5	7	27	20	45
8.00-8.02AM	9	6	8	15	20	33
8.02-8.04AM	9	6	4	13	20	20
8.04-8.06AM	8	5	4	14	20	40
8.06-8.08AM	8	5	3	20	15	30
8.08-8.12AM	5	15	5	30	20	35
8.12-8.16AM	10	9	4	35	20	27
8.16-8.20AM	6	6	5	12	10	33
8.20-8.24AM	10	6	10	30	12	27
8.24-8.30AM	8	6	10	10	25	30
7.30-7.32AM	81	152	145	365	428	674
PCU/1 Hr.	243	152	145	365	428	337

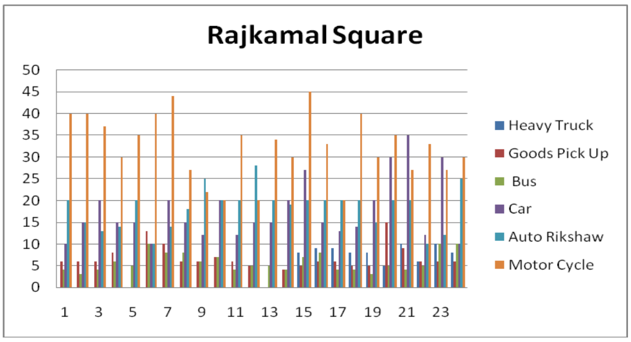

Chart -1: Rajkamal Square (Traffic Count)

4.3 TRAFFIC VOLUME DATA

When calculating traffic characteristics, the size of the cars on the road is critical. The statistics section of this chapter provides data on traffic flow at each junction. The traffic volume data from all incoming lane at each junction is collected. Picture below shows site location of Rajkamal square for traffic data.

Fig -1: Site location Rajkamal Square

5. RESULTS & DISCUSSION

5.1 DISCUSSION OF THE FINDINGS

In this chapter, the results are calculated and are discussed; the impact of fuel consumption per day with ITS (Signal synchronization) and without ITS is calculated from that consumption monthly and yearly can be calculated. Likewise Emission rate of NOx and CO2 is calculated and average cost per accident.

5.1.1 Fuel Consumption calculations yielded this result.

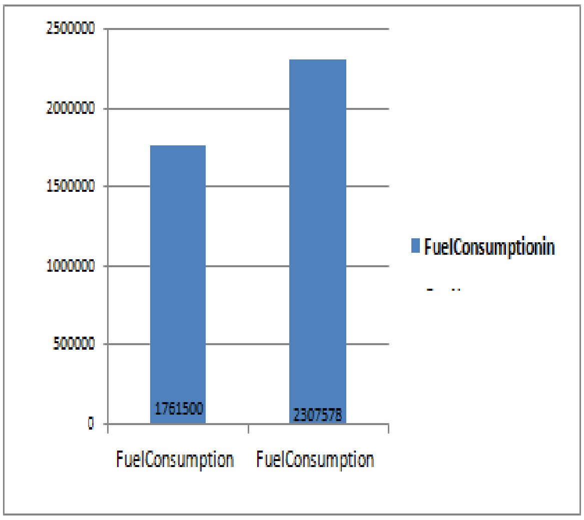

Chart -2: Graph showing reduction of fuel consumption when signal synchronization is used

The graph show the reduction in Fuel consumption if Signal Synchronization is used and from the graph it can be seen that about 8% to 10% of fuel can be saved by their implementation.

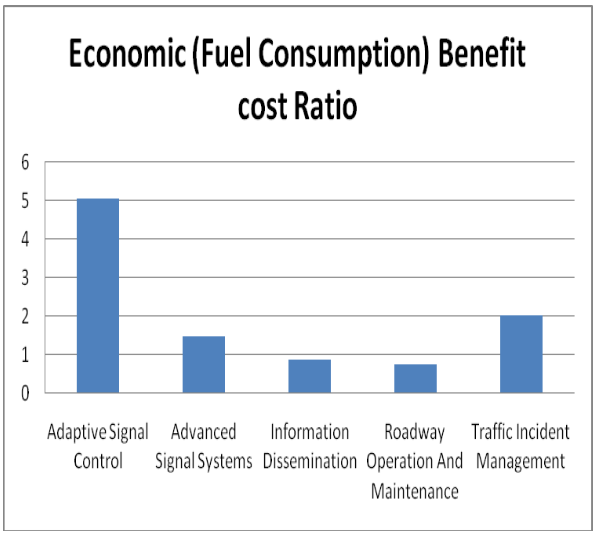

Chart - 3: Economic factor benefit cost ratio graph of ITS deployments

From above graph the fuel saved by using signal synchronization for adaptive signal control and benefit cost ratio is greater, that means evaluated benefits of these deployments are greater and therefore their implementation would be profitable.

Table -2: Questioner Responses (Driving)

How long have you been driving in Amaravati City?					
		Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**
Valid	**1-5 years**	**23**	**25.3**	**25.3**	**25.3**
	11-20 years	**22**	**24.2**	**24.2**	**49.5**
	6-10 years	**36**	**39.6**	**39.6**	**89.0**
	over 20 years	**10**	**11.0**	**11.0**	**100.0**
	Total	**91**	**100.0**	**100.0**	

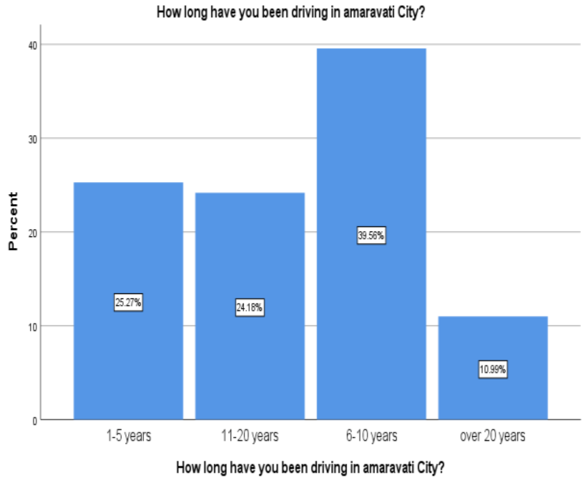

Chart - 4: Questioner Survey Responses

In the graph above, we can see that there are a total of 20 years of data collected from our sample size, which shows that 39.5 percent of people have more than 6-10 years of driving experience and 25.27 percent have 1-5 years of driving experience. 24.1 percent of those polled claim to have 11-20 years of experience. The remaining 10.99 percent claim to have more than 20 years of experience.

Table -3: Questioner Responses (Traffic Congestion)

How many times you face traffic congestion in a week?					
		Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**
Valid		**1**	**1.1**	**1.1**	**1.1**
	1-2 Times	**9**	**9.9**	**9.9**	**11.0**
	2-5 Times	**41**	**45.1**	**45.1**	**56.0**
	5-7 Times	**40**	**44.0**	**44.0**	**100.0**
	Total	**91**	**100.0**	**100.0**	

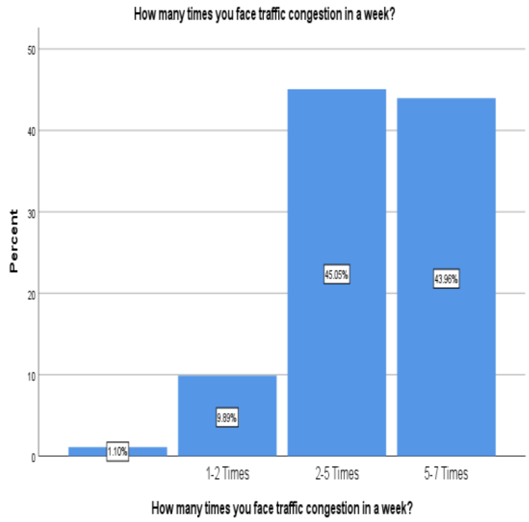

Chart - 5: Questioner Survey (Traffic Congestion)

We can see from the graph above that there was a study of traffic congestion for a week with a sample size of 45.5 percent of persons having more than 2-5 times face the issue and 43.96 percent having 5-7 times confront the situation. 9.89 percent of those who have experienced traffic congestion 1-2 times. The remaining 1.10 percent will be affected at some point in the future.

6. CONCLUSION

1. There is a previous post and a pre-impact in the current debate.
2. The goal of this research is to offer the bare minimal infrastructure and to give current research in the ITS field through a literature evaluation.
3. Expanding ITS may decrease the frequency of accidents and save millions of lives, according to a prior debate.
4. For the Amaravati city we suggest some ITS as shown in fig 4.8 and from over all calculations and from results and discussion the impact of social, economic and environmental factors
5. We have comparative graph, it can be seen that fuel saved is more for vehicular flow and for vehicular emission decrease in exhaust pollutants in society and crashes can be minimized/decrease and thus benefit cost ratios are obtained.
6. The All conclusion are conclude from the below points.
7. Intelligent transportation systems decrease fuel usage by approximately 8% to 10% and even rise when used on a fully operational ITS network; in the long term, it also helps to minimize hazardous pollutants.
8. These ITS advantages will have a positive effect on the country's socioeconomic growth, resulting in many job possibilities.
9. This indicates that ITS is beneficial to society, the economy, and the environment.
10. It is critical to the growth of any metropolitan metropolis, as it aids in the reduction of traffic congestion, accidents, pollution, and fuel consumption.
11. When the socioeconomic and environmental aspects of a specific expansion are taken into consideration
12. The maximum positive benefit cost impact on positive signal control is 5.89 As a consequence, compared to road infrastructure its installation is more expensive and appealing.

7. FUTURE SCOPE

1. Several operational trials for the Rail Intersection Program Region, the newest area of ITS, are under ongoing, but no data has been published so far.
2. Many governments are increasingly exploring the advantages of ITS in facility and equipment maintenance and repair.
3. Over the following several years, as the program develops, more data will become accessible.
4. We can all assess the cost-benefit ratio of expanding intelligent transportation.
5. CO and NOx were chosen as the study's two gases.
6. Other gases may benefit from further study.
7. To get additional advantages, certain ITS deployments may be expanded to other routes in metropolitan areas.

REFERENCES

[1] Drop, N., & Garlińska, D. (2021). Evaluation of intelligent transport systems used in urban agglomerations and intercity roads by professional truck drivers. Sustainability (Switzerland), 13(5). https://doi.org/10.3390/su13052935

[2] Yang, Z., Peng, J., Wu, L., Ma, C., Zou, C., Wei, N., Zhang, Y., Liu, Y., Andre, M., Li, D., & Mao, H. (2020). Speed-guided intelligent transportation system helps achieve low-carbon and green traffic: Evidence from real-world measurements. Journal of Cleaner

[3] Production, 268, 122230. https://doi.org/10.1016/j.jclepro.2020.122230

[4] Grushetsky, S., Brylev, I., Evtukov, S., & Pushkarev, A. (2020). Road accident prevention model involving two-wheeled vehicles. Transportation Research Procedia,

50(2019), 201–210. https://doi.org/10.1016/j.trpro.2020.10.025

[5] Sumalee, A., & Ho, H. W. (2018). Smarter and more connected: Future intelligent transportation system. IATSS Research, 42(2), 67–71. https://doi.org/10.1016/j.iatssr.2018.05.005

[6] Zhang, X., Liu, D., & Wang, J. (2018). Cost Effective Evaluation Study of Intelligent Public Transportation System Based on Social Investigation. Transport and Communications Bulletin for Asia and the Pacific, 88, 43–57.

[7] Khan, A. F., & Ghodmare, S. D. (2017). Sustainability Impact Analysis of Intelligent Transportation System. 3(10), 112–116.

[8] Toulouki, M. A., Vlahogianni, E. I., & Gkritza, K. (2017). Perceived socio-economic impacts of cooperative Intelligent Transportation Systems: A case study of Greek urban road networks. 5th IEEE International Conference on Models and Technologies for Intelligent Transportation Systems, MT-ITS 2017 - Proceedings, 733–737. https://doi.org/10.1109/MTITS.2017.8005609

[9] Alrawi, F. (2017). The importance of intelligent transport systems in the preservation of the environment and reduction of harmful gases. Transportation Research Procedia, 24, 197–203. https://doi.org/10.1016/j.trpro.2017.05.108

[10] Hassanpour, S., Ghanbarzadeh, K., & Nozarigilan, M. (2016). Economic Analysis of Intelligent systems in Urban Transportation (Smart Cameras). 5(3), 227–233.

[11] Razzaq, S., Riaz, F., Mehmood, T., & Ratyal, N. I. (2016). Multi-Factors Based Road Accident Prevention System. 2016 International Conference on Computing, Electronic and Electrical Engineering, ICE Cube 2016 - Proceedings, 190–195. https://doi.org/10.1109/ICECUBE.2016.7495221

[12] Li, M. W., Yun, J., & Liu, N. (2015). Calculating the Contribution Rate of Intelligent Transportation System in Improving Urban Traffic Smooth Based on Advanced DID Model. Mathematical Problems in Engineering, 2015. https://doi.org/10.1155/2015/564230

[13] Barth, M. J., Wu, G., & Boriboonsomsin, K. (2015). Intelligent Transportation Systems and Greenhouse Gas Reductions. Current Sustainable/Renewable Energy Reports, 2(3), 90–97. https://doi.org/10.1007/s40518-015-0032-y

[14] Gokulakrishnan, P., & Ganeshkumar, P. (2015). BEAM-HW: Bandwidth Efficient Acknowledgement based Multicast Protocol for High_Way: A Novel Protocol for Emergency Warning in VANET. Indian Journal of Science and Technology, 8(31). https://doi.org/10.17485/ijst/2015/v8i31/77080

[15] Raut, S. B., & Malik, L. G. (2015). Survey on vehicle collision prediction in VANET. 2014 IEEE International Conference on Computational Intelligence and Computing Research, IEEE ICCIC 2014, December, 735–751. https://doi.org/10.1109/ICCIC.2014.7238552