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The Challenges of Using Big Data Analytic in Smart Transportation

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Abstract: **"**Rapid urbanization puts growing stress on transportation infrastructure which is already burdened". Big data has arisen to explain the vast amount of data available in a variety of fields, a lot of new data is being poured into the project to find out how much travel demand and infrastructure productivity. A survey is very expensive and time-consuming in the current transport scenario. It's complicated, instead of doing large data analysis to render the origin-destination matrix. We may render a journey matrix for a specific road using the OD matrix and geospatial elements. When data is collected, you might be able to conduct the operation in-office, rather than visiting the website. Primary data sources in these studies include GPS points and traces, smart card data, and automatic data, such as APC, AFC, and vehicle location (AVL) to estimate several travel demand factors. In combination with open and crowd-sourced geospatial data, census information, and surveys. Big data analytics tools, such as accident investigation, flow modelling, route planning, and travel planning, are also used in intelligent transportation systems. Finally, this paper addresses several unresolved issues about the use of big data analytics in Smart Transportation.
Key Word: Smart Transportation; Bigdata; QGIS; Census population; Public Transport.

I. INTRODUCTION

Road transport plays an essential role in a nation's economic growth and is the primary mode of transport in India. The most important transport mode in India is road transport that plays the leading role in connecting people, products, marketing, trade, etc. According to 2007-08 statistics, the road network carries 56% of total freight traffic in the region. It promotes sustainable socioeconomic growth throughout the country by facilitating the movement of goods and passengers. It also plays an important role in the country's socioeconomic integration and growth. Road Transport is most significant in its share of passenger and freight transportation in comparison with other modes of transport primarily because of easy access, reliability and potential for extension of services to the remotest corners of the country. In 2016-2017 the transport sector accounted for 4.85% of GVA (Gross Value Added) of the country with 3.12% of GVA being used by road transport.

1.1 Smart transportation

Intelligent Transport Systems (ITS) were described by the European Union as systems including infrastructure, vehicles, and users, as well as systems for the control of traffic, mobility, and other transport modes of interfaces. Intelligent transportation involves the use of a variety of technology, including the simple management system of car navigation. Traffic control systems. and more sophisticated applications that incorporate live data and input from some other sources. ITS technologies enable people to use the transport network more effectively and also open up the way for smarter infrastructure to meet future requirements. ITS technologies allow users to make better use of the transport network and also pave the way for smarter infrastructure to be built to meet future demands. The evolution of intelligent transport systems is offering an increasing range of technological solutions for transport managers seeking to run and maintain systems more effectively and to enhance performance. Improving technology with the advancement of information and communication technologies such as computers, the internet, and smartphones have accelerated the incorporation of these tools. Smart transportation technology offers various benefits.

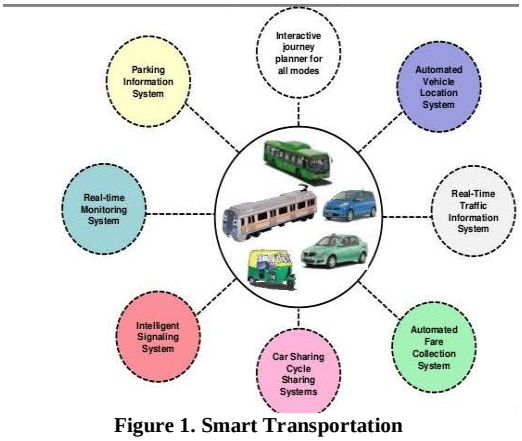


Figure 1. Smart Transportation

- **Smart Transportation is safer:** Automated transport systems have proved to reduce the "human factor" in accidents by integrating machine learning with IoT and 5G.
- **Better management of Smart Transportation**: Data collection is an important key to responsible infrastructure management by the public.
- **Smart transportation is more effective:** More efficient usage is accomplished with better management, Quality data can help define areas where efficacy can be increased.
- **Smart transportation is cost-effective:** Smart transportation makes efficient use of the available resources, preventive maintenance, lower energy usage, and fewer accident resources will minimize costs.

1.2 Big data

Big data is a kind of data processing that manages data sets that are too large or complex to be processed by conventional data-processing application software. Data with many fields provide greater predictive strength, whereas data with a higher level of complexity can result in a higher number of false discoveries. The challenges of big data analysis include data collection, data storage, data analysis, search, sharing, transfer, visualization, querying, updating, the privacy of information, and source of data. Big data was originally related to three concepts: number, variety, and velocity. Big data analysis poses difficulties in sampling, allowing only observations and sampling beforehand. Big data also contains data with dimensions that surpass conventional software's ability to process within a reasonable time and value. Big data analytics lets businesses optimize their knowledge and use it to discover new possibilities. In turn, this leads to smarter business moves, more productive practices, higher income, and happier clients.

- **Cost reduction:** Big data technology, including Hadoop and cloud-based analysis, offer essential cost savings in the storage of vast quantities of data, plus more effective business methods can be found.
- **Faster, better decision-making:** Organizations can quickly analyze information and make decisions based on what they have discovered at the pace of Hadoop and in-memory analytics.
- **New products and services:** The ability to assess customer requirements and satisfaction through analysis provides customers with the power to do what they want.

Figure 2. Big data Analytics

1.3 QGIS

QGIS is a free open-source cross-platform geographic information system (GIS) software until 2013 known as Quantum GIS, which facilitates geospatial data display, editing, and analysis. In addition to writing and exporting graphics maps, QGIS acts as a GIS program for users to analyze and modify spatial information.

All raster maps are provided by QGIS. The program supports several raster pictures formats, and photos can be georeferenced. QGIS includes format files, coverage, personal geodatabases, MapInfo, PostGIS, and other formats. The use of external data is also assisted by online resources including the Web Map Service and the Web Feature Service.

A GIS is made up of:

- **Digital Data:** The geographical details that you can use computer hardware and software to display and analyze.
- **Computer Hardware:** Computers used for data collection, graphics display, and data processing.
- **Computer Software:** Computer programs that run on the hardware of the computer and allow you to work with digital information.

II. URBANIZATION

As per the 20011 statistics (Table 1), India has a population of more than 0.1 million in 393 cities. In addition, the number of urban communities in India, with a population of one million or more, steadily increased in the second half of the last century, from 5 million in 1951 to 35 million in 2001, which is to be increased to 70 million by 2025. The population estimates for Puducherry for the 2007 City Development Plan show that growth trends will stabilizer in the next decade with a view to observing verifiable patterns of populace development in India (Table 2). In the past three decades, the area of Puducherry has experienced rapid population growth. The State saw a growth rate of 33.6 percent in particular during 1981-91, and the district of Puducherry expanded at a rate of 36.8 percent annually. The growth rate of the Puducherry District was at 28.73 percent for the years 2001- 2011. Cuddalore and Villupuram's growth rate was significant (16 percent) between the years 1981-91. After which the growth rate declined to approximately 7 percent. During the last decade (2001-2011) the growth rate has risen back to 16.99 and 13.8 percent for Villupuram and Cuddalore District respectively. Clearly, this growth of the urban population in developing counties has a definite impact on travel demand.

SL/NO	INDICATION NO		VPM	PDY	CUD
1	Population	Total	3458873	950289	2605914
		M	1740819	468258	1311697
		F	1718054	482031	1294217
2	Decadal Population Growth 2001-2011	Total	498500	214957	320519
		M	248377	98830	160789
		F	250123	116127	159730
3	Area In Sq.km		7194	294	3703
4	Density of Population		481	3232	704
5	Sex Ratio	Total	987	1029	987
		M	984	1024	980
		F	1002	1032	999
6	Literates	Total	2195776	726649	1815281
		M	1234479	380946	1000322
		F	961297	345703	814959
7	Scheduled caste	Total	1015716	152406	763944
		M	510869	74129	383943
		F	504847	78277	380001
8	Scheduled Tribes	Total	74859	0	15702
		M	37570	0	7943
		F	37289	0	7759

Source: Director of Census Operations, Tamil Nadu – 2011

Table 1. Demographic profile of Villupuram, Puducherry, Cuddalore

Inference: As per Table 1, Demographic Profile for Villupuram has Highest profile index when compared to other district, and also Villupuram has recorded the literacy rate of 71.9%, lower than the State literacy rate of 80.1%.

Year	VPM		PDY		CUD	
	Population in Lakhs	Average annual Exponential Growth rate %	Population in Lakhs	Average annual Exponential Growth rate %	Population in Lakhs	Average annual Exponential Growth rate %
1901	1237061	—	246354	—	868748	—
1911	1387893	1.16%	257179	0.43%	974673	1.16%
1921	1362937	−0.18%	244156	−0.52%	957148	−0.18%
1931	1441904	0.56%	258628	0.58%	1012603	0.56%
1941	1532516	0.61%	285011	0.98%	1076237	0.61%
1951	1631216	0.63%	317253	1.08%	1145551	0.63%
1961	1747460	0.69%	369079	1.52%	1300513	1.28%
1971	2048400	1.60%	471707	2.48%	1569323	1.90%
1981	2373952	1.49%	604471	2.51%	1827917	1.54%
1991	2755674	1.50%	807785	2.94%	2122759	1.51%
2001	2960373	0.72%	974345	1.89%	2285395	0.74%
2011	3458873	1.57%	1247953	2.51%	2605914	1.32%

Source: Census of India

Table 2. History of growth of population in Villupuram, Puducherry, Cuddalore

Inference: As per Table 2, Exponential Population growth Percentage increases for Puducherry because population is less when compared to Villupuram, cuddalore district. In 1921 population has decreased, Annual Exponential GDP % get Decreased after that Every 10 years Exponential Growth Rate increases.

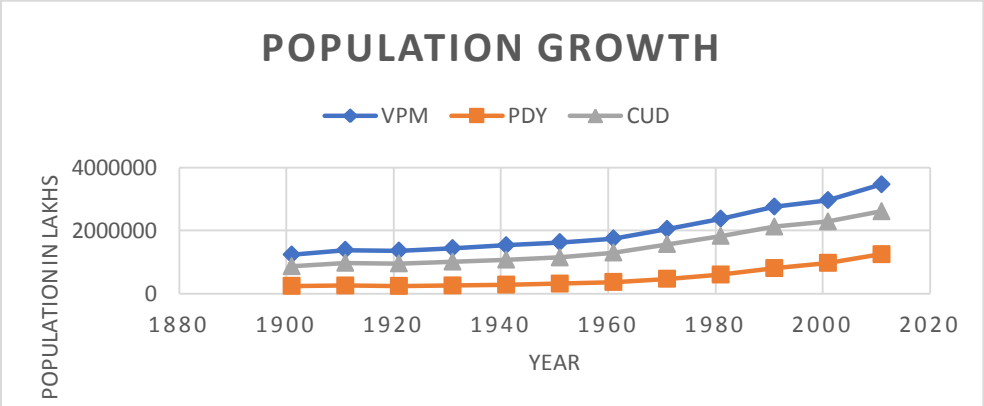


Figure 3. Urban conglomeration according 2011 census

Inference: As Per Figure 3. The Urban Conglomeration flow increases for every 10 Years, since population of the district increases rapidly.

2.1 Occupation Profile

Villupuram District has recorded a literacy rate of 71.9%, lower than the State literacy rate of 80.1%, and has recorded the 3rd lowest percentage of Main workers to Total Workers of 74.0 % among the districts. Puducherry effective Literacy rate of the district has significantly improved from 80.7 in 2001 to 85.4 in 2011. Cuddalore literacy rate of the district is 70.1% as against the State literacy rate of 73.4%.

Category		Puducherry	Villupuram	Cuddalore
Literates	Persons	85.44	71.88	78.04
	Males	91.23	80.55	85.93
	Females	79.86	63.15	70.14
Workers (Marginal & Non Marginal)	Persons	36.63	49.24	44.89
	Males	54.81	58.44	57.15
	Females	18.97	39.92	32.47
Main Wokers	Persons	33.21	36.45	32.13
	Males	50.82	46.32	44.68

	Females	16.10	26.45	19.41
Marginal Workers	Persons	3.42	12.79	12.76
	Males	3.99	12.12	12.47
	Females	2.87	13.47	13.06
Non Workers	Persons	63.37	50.76	55.11
	Males	45.19	41.56	42.85
	Females	81.03	60.08	67.53
Cultivators	Persons	2.70	21.7	14.12
	Males	3.02	23.97	15.48
	Females	1.80	18.33	11.69
Agricultural Labourers	Persons	14.91	48.86	46.11
	Males	12.10	39.73	37.25
	Females	22.81	62.4	61.91
Workers in household industries	Persons	1.82	2.24	2.74
	Males	1.31	1.88	1.97
	Females	3.26	2.79	4.11
Other Workers	Persons	80.57	27.19	37.04
	Males	83.58	34.41	45.3
	Females	72.12	16.48	22.29

Source: Census of India

Table 3. Occupational Profile

Inference: Villupuram has recorded the literacy rate of 71.9%, lower than the State literacy rate of 80.1%. and Cuddalore has least Literate's profile. Puducherry occupational profile falls on literates and Marginal workers, but they won't indulge in agricultural profiles.

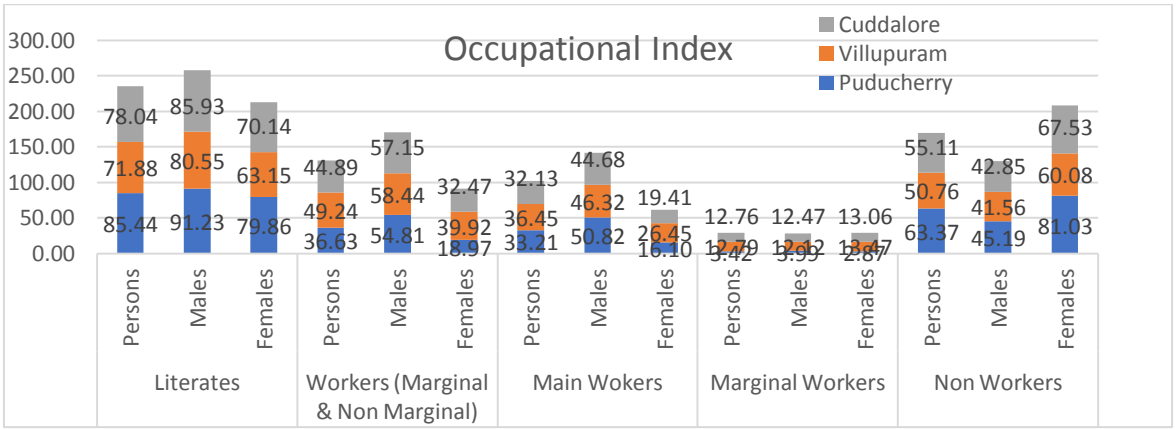
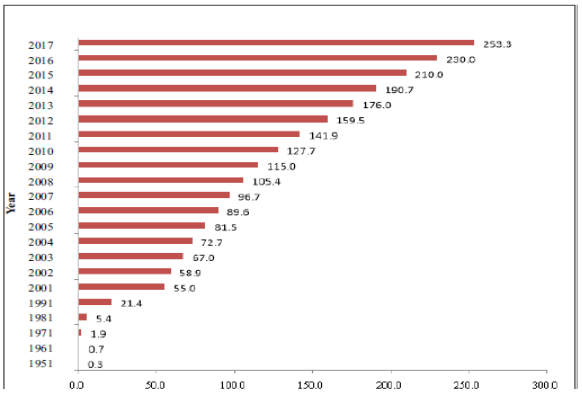


Figure 4. Occupational Index Percentage

III. EFFECT OF MOBILITY

3.1 Register Motor Vehicles in India: Continuous increase in the number of registered motor vehicles in India since 1951. As at 31March 2017, a total of approximately 0.3 million registered motor vehicles were increased to 253 million in March 1951. The total number of registered vehicles in the country increased by 10.11% from 2007 to 2017 at the Compound Annual Growth Rate (CAGR).



Source: Office of State Transport Commission Newly Registered Motor Vehicles during 2016-17
Figure 5. Total Registered Motor Vehicles

Inference: As per Figure 5. In India registered motor vehicles is increases daily, since productivity of vehicles also increases and its demand. People utilizing more on Private mode transport, they are not preferring Public mode.

	Commercial Vehicles									
	Public buses	Private buses	Mini Buses	Auto Rick-shaws	MOTOR CAB	MAXI CAB	OMNI BUSES	Private Service Vehicle	School Bus	College Bus
Cuddalore	517	390	123	4738	2396	2459	5	43	721	171
Villupuram	729	375	172	8064	4639	2274	9	27	824	338
Puducherry	278	175	31	3548	0	53	173	8	200	89

Source: Commissioner of Transport, Chennai-5
Table 4. Commercial Vehicles

District	Non-Commercial Vehicles							
	Motor Cycles	Scooter	Mopeds	Tricycle Auto	Three Wheelers	Four Wheelers	Road Rollers	Others
Cuddalore	281536	77323	163326	28	2218	126	21	1523
Villupuram	232316	41620	116095	18	1067	374	435	2044
Puducherry	29937	25089	2415	28	2	478	14	90

Source: Commissioner of Transport, Chennai-5
Table 5. Non Commercial Vehicles

Inference: As Per Table 4,5 People were utilizing more on Non- Commercial Vehicles zone when compared to Commercial vehicles. Cuddalore has highest usage on Motor Cycles and three Wheelers, and Puducherry is highest four wheelers floating of vehicles.

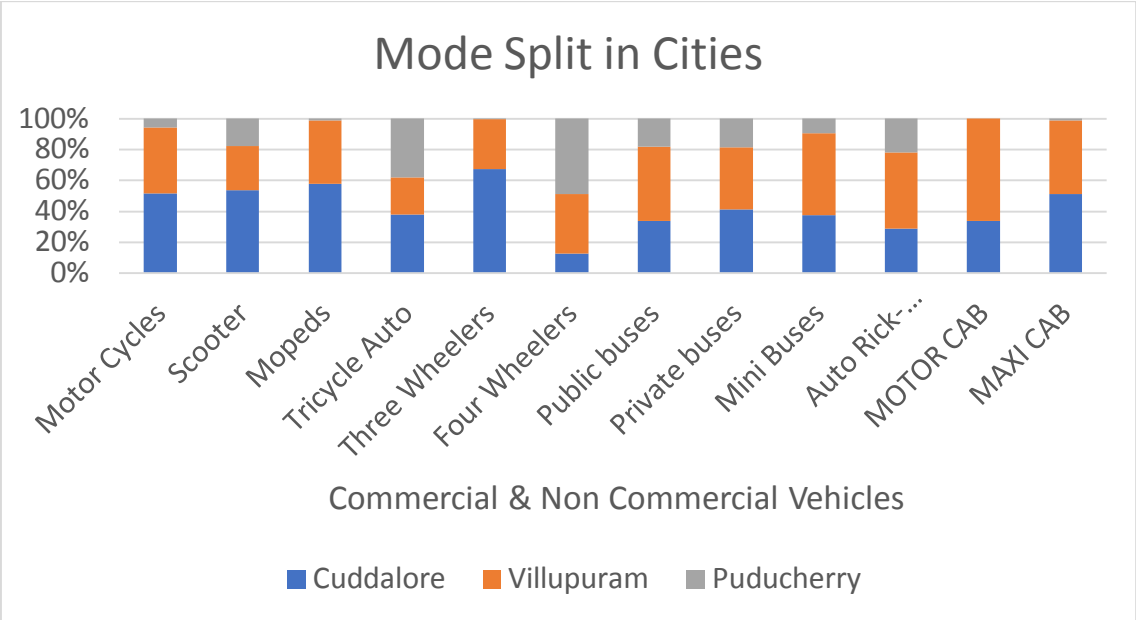


Figure 6. Mode split in Indian cities (Source: MOUD)

Description	Year	PRTC	TNSTC VPM
Average Fleet Held (Number)	2012-13	-	3,400
	2013-14	-	3,469
	2014-15	-	3,528
	2015-16	143	3,590
	2016-17	143	3,576
Average Age of Fleet (Years)	2012-13	-	4.7
	2013-14	-	4.9
	2014-15	-	5.65
	2015-16	7.00	6.20
	2016-17	6.00	7.00
Staff Strength (Number)	2012-13	-	22,629
	213-14	-	22,821
	2014-15	-	22,573
	2015-16	762	22,417
	2016-17	759	22,530
Fuel Efficiency (Km/litre of HSD)	2012-13	-	5.6
	2013-14	-	5.56
	2014-15	-	5.59
	2015-16	4.14	5.59
	2016-17	4.16	5.61
Passenger Kms Performed (Lakhs)	2012-13	-	2,80,069
	2013-14	-	2,84,793
	2014-15	-	2,93,360
	2015-16	131.99	2,98,709.73
	2016-17	162.58	2,99,522.90
Passenger Carried (Lakhs)	2012-13	-	8,568
	2013-14	-	8,498
	2014-15	-	8,450
	2015-16	158.49	8,419.94
	2016-17	239.05	7,819.38

Table 6. Physical Performance of SRTU Undertakings

Description	Year	PRTC	TNSTC VPM
Total Revenue (Rs. Lakh)	2012-13	-	1,42,883
	2013-14	-	1,53,205
	2014-15	-	1,56,358

	2015-16	3,916.00	1,54,212.48
	2016-17	5,028.00	1,64,866.94
Total Cost (Rs. Lakh)	**2012-13**	-	1,47,791
	2013-14	-	1,66,326
	2014-15	-	1,89,776
	2015-16	4,447.00	1,93,269.06
	2016-17	5,193.00	2,02,480.10
Net Profit/Loss (Rs. Lakh)	**2012-13**	-	-4,908
	2013-14	-	-13,122
	2014-15	-	-33,419
	2015-16	-531.00	-39,056.58
	2016-17	-165.00	-37,613.16

Table 7. Financial Performance of SRTU Undertakings
Source: MORTH

Inference: As Per Table 6 & 7 financial and physical performance of TNSTC – VPM has more revenue and capital cost.

Description	Year	PRTC	TNSTC VPM
Average Fleet Held (Number)	**2012-13**	-	3,400
	2013-14	-	3,469
	2014-15	-	3,528
	2015-16	143	3,590
	2016-17	143	3,576
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	2015-16	131.99	2,98,709.73
	2016-17	162.58	2,99,522.90
Passenger Carried (Lakhs)	**2012-13**	-	8,568
	2013-14	-	8,498
	2014-15	-	8,450
	2015-16	158.49	8,419.94
	2016-17	239.05	7,819.38

Table 8. SELECT INDICATORS OF OVERALL PERFORMANCE OF STATE TRANSPORT CORPORATIONS 2016-17
Source: MORTH

Inference: As per Table 8, TNSTC – VPM region has high loss in revenue in the year 2016-2017. If we increase more number of fleet strength, revenue from passenger will be high

Description	Year	PRTC	TNSTC VPM
Total Revenue (Rs. Lakh)	**2016-17**	5,028.00	1,64,866.94
	2015-16	3,916.00	1,54,212.48
Total Cost (Rs. Lakh)	**2016-17**	5,193.00	2,02,480.10
	2015-16	4,447.00	1,93,269.06
Net Profit/Loss (Rs. Lakh)	**2016-17**	-165.00	-37,613.16
	2015-16	-531.00	-39,056.58
Profit before Tax (Rs. Lakh)	**2016-17**	-71.00	-33,465.34
	2015-16	-443.00	-34,857.11

Table 9. Profit/Loss of SRTUs for 2016 -2017
Source: MORTH

Inference: As Per Table 9, Revenue Cost increased as compared to previous year in both SRTU Undertakings. TNSTC – VPM region has high loss in revenue in the year 2016-2017.

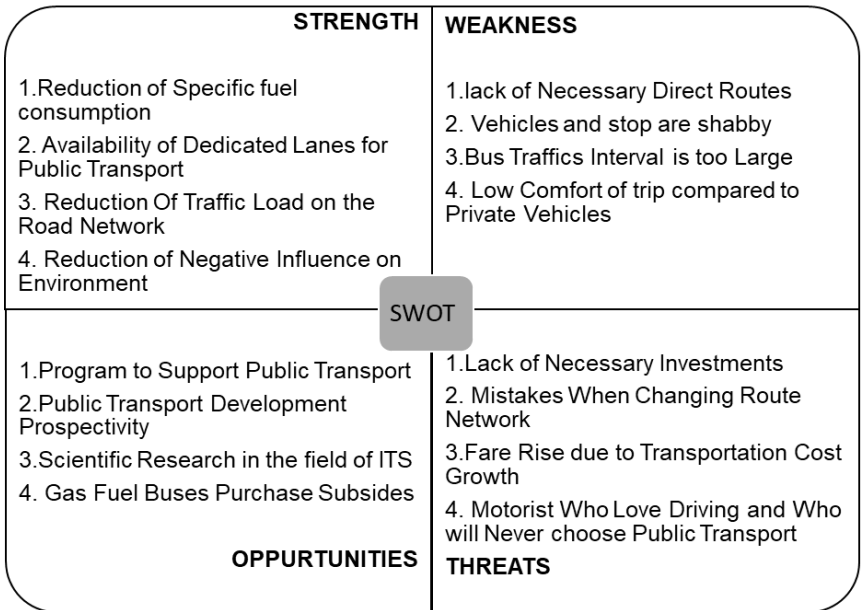
IV. EFFECTS ON SAFETY

Number of Accidents	**2016-17**	58	1,004
	2015-16	51	1,085
Number of Fatal Accidents	**2016-17**	8	228
	2015-16	12	230
Effective Kilometres (Lakh)	**2016-17**	186.48	6,413.27
	2015-16	152.06	6,438.04
Number of Accidents per lakh Effective Kilometres	**2016-17**	0.31	0.16
	2015-16	0.34	0.17
Number of Fatal Accidents per lakh Effective Kilometers	**2016-17**	0.04	0.04
	2015-16	0.08	0.04

Table 10. Road accidents of SRTC 2016 – 2017
Source: MORTH

Inference: As Per Table 10. Effect on Road Accidents majorly on Villupuram, since we have more traffic on passenger usage on public places. If we introduce new routes, we can avoid fatal accidents.

V. SWOT ANALYSIS MATRIX



VII. CONTRIBUTION TO SOCIETY

Smart transportation networks play an important role in keeping mobility old. It can be expected that, precisely because of the demographic growth of the developed nations, future demand for individual and public transport will continue to increase. The current traffic system in terms of energy efficiency and compatibility of the environment must be operating effectively to satisfy this higher demand. The use of intelligent transport systems that can improve traffic efficiency and traffic protection must be made a significant contribution, rural areas should have the same quality of life that people on suburban roads and urban roads deserve. Therefore, it becomes necessary to establish rural areas, which are concerned with economic development and social justice, to enhance rural living standards through the provision of sufficient and quality social services and minimal basic needs.

The solution to smart transportation involves high-tech information and communication systems that have applications in traffic management systems and transportation networks. These technologies also help to minimize traffic congestion and increase the quality of driver's experiences. Developments in technology provide Road Administrations around the world with the ability to change the way that they plan and run their highway networks. Intelligent Transportation Systems (ITS) is a combination of leading-edge information and communication technology used in transportation and traffic management systems to improve the protection, performance, and sustainability of transportation networks, minimize traffic congestion and enhance drivers' experiences. There are infinite possibilities.

- Activities that were typically performed by human intervention may be automated.
- Road network performance can be tracked and modified, in real-time.
- Data that was historically collected by the expensive physical infrastructure can be generated by modern, richer data sources.

VIII. CONCLUSION

In this paper, we discussed the growth of Big Data and the related awareness of ITS. The method of performing Big Data analytics in ITS was explored. We summarised the data source and collection tools, data analytics methods and platforms, and Big Data analytics framework categories in ITS. We presented many applications of Big Data analytics in ITS, including asset maintenance, road traffic flow prediction, road traffic incidents analysis, public transportation service planning, personal travel route planning and rail transportation management and control. Several open challenges of using Big Data analytics in ITS were addressed in this paper, including data collection, data privacy, data storage, data processing, and data opening. Big Data analytics would have profound impacts on the design of intelligent transportation system, and make it safer, more reliable and profitable. Big data could provide a vast amount of information, the information given usually only covers a single mode for a single transit system in question. In view of the notion of multimodality in public transportation where users' decision-making may be affected by the availability of various modes in a service area, designing flexible models that could capture different systems of interest and the related impacts on users' behaviour is of vital importance and should be explored as a potential research avenue.

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