



# Impact of Transportation Telematics to Sustainable Development, India and Poland Case Study

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## ABSTRACT

This paper presents the positive impacts of telematics system in the sustainable development of any country. With the growing population and urbanization, high demand of movement of people and goods are occurring. From last few years in India, transportation system network is expanding rapidly and contributing a huge role into the economic growth. Due to the enhancement of traffic flow, there is need of implementation of telematics system so that the negative effects caused by the increased traffic can be converted in sustainable development of the country. Use of Telematics system in India and Poland can help to improve the efficiency of transport system by minimize the fuel consumption which overall results into sustainable development by reducing the environmental effect by transportation. This paper outlines how the telematics system into transportation system aims to contribute in achieving sustainable development in country with the case studies of India and Poland.

**KEYWORDS:** Telematics, Urban transportation, Sustainable development

## 1. Introduction

The concept of sustainable development in transportation system is relatively latest concept, especially in Asian country like India. In India, rail and road transportation system is one of the most effective ways to communicate with other cities. According to a survey rails and roads dominates the transportation system in India by carrying almost 87 percent of total freight traffic in country in 2007-2008. Due to rapid vehicular growth into the urban areas has put heavy pressure on the transportation infrastructure that is resulting into environmental and health problems. In India, there is average growth of 3 percent urban population per year. It is expected that India's urban population increase from 377 million in year 2011 to 500 million in 2021. According the statics provided by the Ministry of Road Transport & Highways, Government of India, the annual rate of growth of motor bike has increased 10% during the last decades.

The main problem is the concentration of vehicles into main metropolitan cities. Still public transport is the most effective means of commuting into the metropolitan cities in India. Urban congestion is one of the major problems and it has multiple effects on the economics of country. It is necessary for the transportation planners to think because of growing demand of travel with in limited services. Due to the congestion into urban cities, prevents the movement of traffic flow. Urban transportation plays an important role into economy and prosperity growth of government

For all developing or developed countries regardless of their development in particular fields, new innovations and technologies have some negative impact for long terms. The growing interest into the sustainable development is concern about the decreasing environmental quality, social equity, increasing level of the CO<sub>2</sub>. Telematics system into transportation for sustainable development can be divided into three major sections: society, economy, and environment. To enhance the role of transportation system in

sustainable development, it is necessary to plan some strategies to increase the sustainability.

In this paper we will be particularly concentrating on road transportation and the problems in road transportation and how implementation of telematics will overcome these transportation problems in the sustainable development of two countries India and Poland. This paper first consider the motorization and traffic condition of India and problems in traffic, later it contains traffic flow, motorization and traffic condition in Poland, at the end it evaluates the telematics strategies and planning for improved sustainable transportation.

## 2. Overview of road transportation in India

### 2.1. Motorization in Delhi

The growth rate of Indian automotive industry is the second fastest growing industry in the world. The increasing growth rate of vehicle has a direct positive impact on the growth of economic development. In 2009 nearly 121.23 million registered vehicles was examined with a motorization rate of 22 vehicles per 1000 population. Motorization growth of India was lower than many developing countries throughout the world. But over the last few decades motor vehicles are getting double or triple every year with a growth rate of 2 - 3 percent [3]. Vehicle growth is largely concentrated into urban areas which are causing traffic congestion. Because of a drastic growth into the automobile industry in India, that leads the interest of business leaders, government officers and specially environmentalist for many reasons. It is well known that motor vehicle in India has a negative impact on the environment (Fig. 1). In Delhi that is also a capital of India; the main source of air pollution is the automobiles. Near about 94.5 % of air pollution is caused by transport sectors by emitting nearly 261 Tg of CO<sub>2</sub>. Particularly in Delhi, out of 300 metric tones of pollutants, approximately two third is caused by the vehicles. We can see transport system is getting more and more environmentally unsustainable and a factor in contributing green house gas emission.

A transportation system that offers mobility related facilities and services by minimizing the harmful gas emissions, and also reliable and safe can be considered as sustainable transport system. Sustainable transport offers economical way of mobility for all type of passengers. Another factor is lack of transport system in urban cities initiate the number of privately owned vehicles that results in more traffic congestion and overall generates more air pollution. The increased number of motor vehicle not only contributes into air pollution but also results in road accidents

The capital city Delhi, is the fastest city growing cities in the world reaching over 18 million in year 2017 from 400.000 in 1991. Rapid growth into urban areas can be by two factors: by natural increase in population, by the migration of people from rural areas.

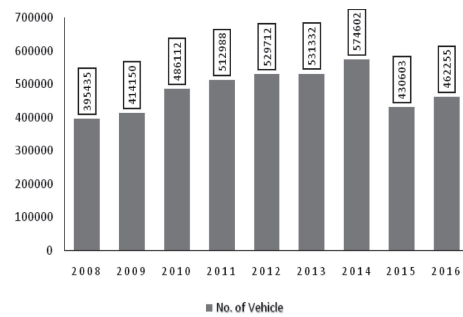


Fig. 1. Year wise vehicle registration in Delhi [11]

### 2.2. Urban transportation in Delhi

According to the data accessed by the Transport Department of Delhi government, the nearly 1.056.7712 total number of vehicles has been registered in 2017. Particularly in year 2016 itself, near about 462.255 vehicles had registered. According to the data of year 2011, the car ownership in Delhi are 157 cars per 1000 population. Different estimates show that there will be an increase of 35 cars per 1000 population by 2025 [7]. This would results in more than 45 - 60 millions of cars on our roads. This tremendous growth into the cars in upcoming years will put serious problems like fuel, security, air pollution, and problems related to the traffic and parking. From now some major cities, started facing problems of traffic congestion and parking.

Despite the major improvements in public transport systems, India's capital city Delhi, is still suffering from these ills affecting both the provision of infrastructure and its related services. From last few years, public transport system is not been able to full fill the rapid demand. Due to lack of bus services, resulting the passengers to turn towards the personalized mode. Large number of personal vehicles, cause traffic congestion, and overall reduces the efficiency and profit of public buses. Delhi transport needs are met by buses, metro, private vehicles, taxi, auto-rickshaws, cycle-rickshaw, and by walking. Inadequate supply of public transport and poor management of these systems causing buses and metro running overcrowded during the peak hours making the public transportation more hectic and unpleasant. Fig. 2 show the utilization of different modes of transportation.

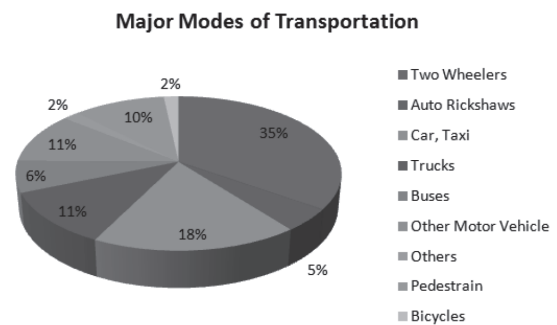


Fig.2. Utilization of major modes of transportation in India 2016 [own study]

Public city buses run as principle mode of transportation in every city. Some urban cities have rail, tram, and metro and some other mode of public transport. Hundreds of cities do not have proper public bus transport, because of that passengers have to choose the private vehicle transport.

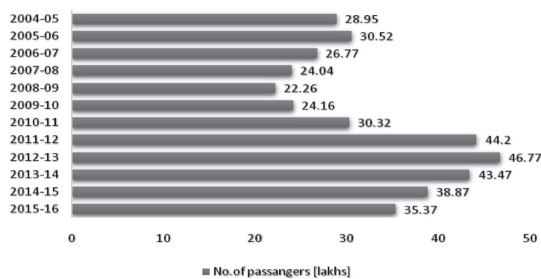
In mostly cities, State Transport Undertaking (STU) is responsible for the operation of plan of the city buses. As India have almost 29 states, and each state have large no of cities inside that. Each state has its own STU's (State Transport Undertake) for the public bus operation. Some of the STU,s is presented here in Table 1. Below mentioned cities are metro cities, and bus transport fleet size is much better than the other cities. In other cities generally they use small mini buses.

**Table 1. List of STU in cities of India [own study]**

No	State/ Region	STU
1	Delhi	DTC
2	Mumbai	BEST
3	Kolkata	CSTC
4	Chennai	CHI-I
5	Pune	PMT
6	Chandigarh	DCHNTU
7	Ahmadabad	AMTS

### 2.3. DTC (Delhi Transport Co-operation) public bus transport

For the bus transport facility, DTU is mainly responsible for planning and operation on public buses. In last few years, rapid decline in the number of passengers travelling through DTC buses. The reason of declination of passengers by public transport has been valid reasons like inadequate fleet size, waiting for buses, traffic congestion and many others. From the data of DTC, the 1.839 buses were procured in 2010-2011 and 32 new buses in 2011-2012. In year 2013 nearly 44,67 lakh passengers per day were noted. With the increase in number of buses, earning of DTC was also increased in year 2013-2014. But with the time passage, an average rate of 8,8 percent per annum is still going on. In the Fig. 3 a declination rate of passengers of DTC buses is shown.



**Fig. 3. Number of passenger of DTC buses from (2004- 2016) [own study]**

The daily passenger load per bus in Delhi came down from 952 passengers in 2013-2014 to 927 passengers in 2015-2016. The reason of declination is poor reliable service mainly less fleet and long waiting time.

## 3. Problems in transportation

The selected problems which have been identified in transportation processes are as follow:

1. Dramatically growth in to the privately owned vehicles especially into two wheelers.
2. Very low level of traffic management system.
3. Rapidly growing population in urban area, and increased number of vehicles into small concentration.
4. Overcrowded, unsatisfactory, dangerous, and very slow public transportation system.
5. In metro cities, extreme level of noise pollution and air pollution has also has impact on environment.
6. Very poor rules for driving, no lane management by the drivers, that's enhances lot of accidents.
7. In small towns, stray animals on roads also make the transportation process slow and uncomfortable.
8. Parking system is not proper, because of those public park vehicles nearby roadside that acquire lots of road area and contribute in traffic jams.
9. There is no doubt that with the rapid growth of Indian population, correspond growth in the travel demand. Sharply increasing vehicles contributes in congestion, air pollution and road accidents. Indian cities are suffering from large number of problems. Some of major problems are discussed here in this section.

### 3.1. Road Accidents

Road transport in India is primary mode of transportation in terms of national economy. With the increased demand of transport, a rapid increase in length of roads and number of vehicles in last few years. With the increased motorization, urbanization is increase in number of accidents and road fatalities. Some other factors of road accidents are width of road network, poor traffic management, human population, low safety rules and regulation. Road accidents cause injuries, fatalities, and hospitalization which directly affects the socio- economy cost of the country. As far now from the recent statics from the Ministry of Road transport and highway of India road are getting increased by 2,5 percent from 489.400 in 2014 to 501.423 in 2015. In road accidents ,total number of killed person increased by 4,6 percent from 139.671 in 2014 to 146.133 in 2015. Every day, nearly 1.347 accidents and 400 people death occurring on Indian roads [4]. For details please see Tables 2 and Table 3.

**Table 2. Road accidents parameters (2015-2016) [4]**

Parameter	2016	2015	% change over previous year
Total accidents in the country	480 652	501 423	-4,1
Total number of person killed in country	150 785	146 133	3,2
Total number of person injured in the country	494 624	500 279	-1,1
Accident severity (Number of person killed per 100 accidents)	31,4	29,1	7,9

**Table 3. Road length, motor vehicle, road accidents (2005-2016) [11]**

Year	Road Length (in km)	Number of registered vehicle (in thousands)	Number of fatal accidents	Number of road accidents	Number of killed person	Accident Severity
2005	3809156	81502	83491	439255	94968	21,6
2006	3880651	89618	93917	460920	105749	22,9
2007	4016401	96707	101161	479216	114444	23,9
2008	4109592	105353	106591	484704	119860	24,7
2009	4471510	114951	110993	486384	125660	25,8
2010	4582439	127746	119558	499628	134513	26,9
2011	4676838	141866	112618	497686	142485	28,6
2012	4865394	159491	123093	490383	138258	28,2
2013	5231922	181508	122589	486476	137572	28,3
2014	5402486	190704	125828	489400	139671	28,5
2015	5472144	210023	131726	501423	146133	29,1
2016	-----		136071	480652	150785	31,4

Apart from increased number of motor vehicles, there are some other factors which influence road accidents:

1. Mostly roads in local area and on state highways are in bad conditions, poor condition and need repair.
2. In India, getting a driver license process is so loose, and also very poor traffic rules.
3. Lack of traffic lights and low traffic management.
4. Unplanned infrastructures and lack of pathways.
5. Unsafe vehicles, overcrowded bus, people mostly sit on the roofs of the buses on two wheelers, three or four people share the vehicle.

### 3.2. Parking problems

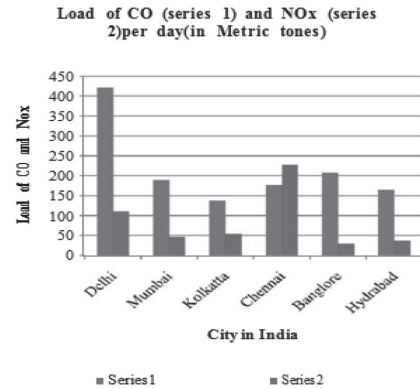
The shortage of parking space in Indian cities increases the time spent in searching for parking spot and induces overall traffic congestion. From a survey of Indian roads, it is found those high portions of roads are occupied by parking [15]. Parking problem is specially occurring in small areas having no infrastructure planning. In Delhi, 14 percent of road length is used for on street parking while Surat has 60 percent of road length is used for on street parking. The reason of on street parking is cheaper than the off street parking's.

### 3.3. Air pollution

In India, the number of motor vehicles has grown from 3 million in 1950 to approximately 80 million in 2016 of which two wheelers accounts of total 70 percent of total vehicular cost. Though two wheelers sales in have been growing in the past few years at double digit rates [16], Fig. 4. However the sale dropped from year 2012-2013 the sale is flat due to increased interest rate. Air pollution in Indian cities is the fifth leading cause of death. Air pollution causes near about 620,000 people death every year in India. Toxic air and its effect on health are seriously affecting the livability of Indian cities.

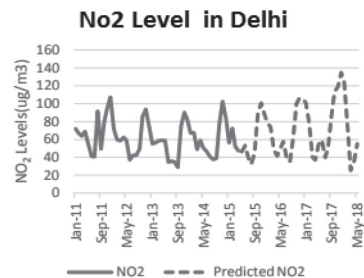
In case of Delhi, vehicular pollution started rising from 1990, with the growth vehicular population and economic development. The Environment Pollution Control Authority reported that during the year 2002 to 2012, the number of vehicles increased by 97 percent and contributing in air pollution. Direct expose of the

toxic gases in air, affecting the 1 million of Delhi people living near within 500 meter near to roadside [21]

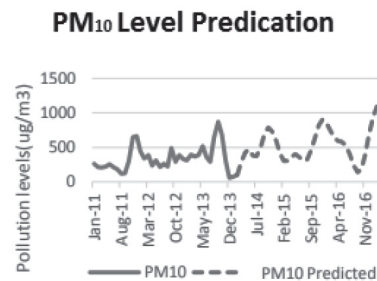


**Fig. 4. Vehicular gases emission in India [16]**

In four major cities of India namely: Delhi, Mumbai, Kolkata and Chennai the problem is rapid increase in urban population, and large number of automobiles in small area accounts 15 percent of whole vehicular population of the country. Other 40 major cities that have population more than 1 million accounted 35% of vehicular population of the country. The consumption of energy of these vehicles is nearly 25 % of total energy is consumed by road transport. In urban cities, vehicles contribute 70% of CO<sub>2</sub> and other harmful gases, see Fig.5 and Fig.6. These high levels of air pollution, by the emission of pollutant gases are mainly responsible for breathing problem, cancer and etc. The average level of Nitrogen Oxide is 40ug/cm<sup>3</sup> and Pm10 is 60 ug/cm<sup>3</sup>. In the graphs below the values of Nitrogen oxide and Pm10 is shown which represents the value of emission is higher than national average which is a serious for environment.



**Fig. 5. Predicted NO<sub>2</sub> level [19]**



**Fig. 6. Predicted PM10 [19]**

### 3.4. Insufficient public transport

India is lacking behind in the public transportation service due to lack of required funding [14]. In India, with the growing population, there is a vast need of improvements in public transportation. Mostly buses into the cities are overcrowded, not maintained, extreme slow and dangerous [1]. In India there is not traffic priority any lanes and singles for buses, which results stuck in on congested roadways and average of 6-10 km/h in many urban cities [6].

## 4. Overview of road transportation in Poland

### 4.1. Motorization in Poland

Poland is one the fast growing city in the Europe. Transport is one of the largest contributors to GDP amounting to 3,6 percent in 2011. Poland is a medium size country by European standards having plains and few mountains areas. The distances between the countries are not so long like India but it has also large network of transportation. Poland is a transit for West-East and North-South European traffic.

Talking about the road network, Poland has 406.122 kilometers of standard roads. The rail network is also relatively well developed having a total track length of 20.200 kilometers in 2010. Out of this much rail network, 58 percent are electric railway. Poland's modern transportation system is far less developed than other developed European countries. In 2010 France, Germany, Spain, have fast running trains acquiring 1.872 km, 1.285 km and 1.599 km. But up to that time Poland did not have any fast running trains. In 2010, there were 857 kilometers of motorway in Poland while other European countries have much more than this numbers. But with the passage of time the situation of Poland economy changed drastically. At the end of 2013, length of road network in Poland amounted to 415.132,6 km. According to annual report of the General Directorate for National Roads and Motorways as the end of o 2013 only 66,1 % of national roads and 12,5% of roads are in poor condition and rest 21,4 % roads are in unsatisfactory condition [10]. By joining the European Union, Poland is getting help to do modernization in to the transport system. The number of highways, expressways, and motorways are growing exponentially and a rapid increase in modernization also occurring. In 2013 116,7 km of motorways and 191,9 km of expressway had built. The number of registered vehicles in end of 2013 amounted 25,7 million (in last 2012 it was amounted 24,9 million). The number of vehicles registered in Poland is growing so rapidly from last few years. In 2015, total numbers of registered vehicles were 16.815.923. After a interval of five years, in 2010 the registered vehicles number reached to 6.221.226 units. Increases in number of vehicles are significant in Poland with the urbanization. In 2009 there were 433 passengers cars per 1000 inhabitants in Poland [12]. In the Fig.7 a regular growth in the number of cars can be seen form 1990-2015.

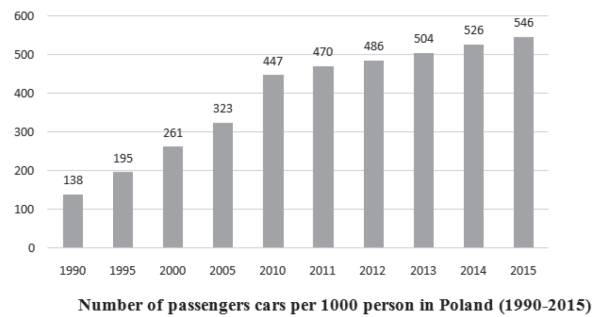


Fig. 7. Motorization rate in Poland [own study based on [23]]

### 4.2. Analysis of statics of accidents in Poland

According to statics of accidents by police, the most common cause of accidents is the over speeding and not following the speed regulation limit while driving. Another major reason of accidents is rash driving, not following the lane, overtaking, sudden breaking, not maintaining a proper safe distance. As shown in Fig.8 from year 2007, 49.536 accidents, to 2015, accidents 32.967. It is noticeable that from year 2007 to 2015, the number of accidents decreased in large numbers. The effect of decrease in accidents can be seen in the Fig.9 of killed person. In year 2007, nearly 5.583 person killed in accidents.

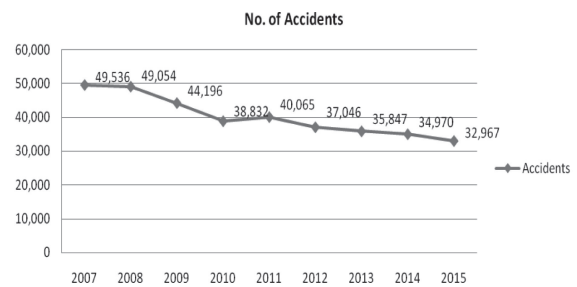


Fig. 8. Number of road accidents 2007 – 2015 [own study based on [23]]



Fig. 9. Number of person killed in rod accidents 2007 -2015 [own study based on [23]]

In year 2015, a decrease in killed person (2.938 person killed) is nearly half as compare to year 2007.

### 4.3. Statics of road transportation in Warsaw

The Warsaw is the capital city of Poland, having a population of 1.702.139 in 2017 and area of 450 km<sup>2</sup> [5]. In Warsaw, at the end of 2013, there were 1.022,3 thousand registered passenger cars, 593

per 1000 population. In 2013, nearly 94,8 thousand vehicles got registered out of which 88,2 percent were passenger cars [18]. Traffic volume on Warsaw roads accommodates more than 50.000-75.000 vehicles per day. The total number of journey within 24 hours is approximately 264.000. Sixty percent of traffic within the Warsaw is contributed by automobiles. Total of 54,6 % of all journey are through public transportation and 22,6% by private transportation, 21.6 % journey by made by walk and rest 1.2 % is other mode of transportation (Fig. 10, Fig. 11).

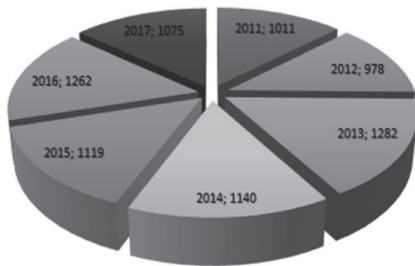


Fig. 10. Number of road accident in Warsaw [own study]

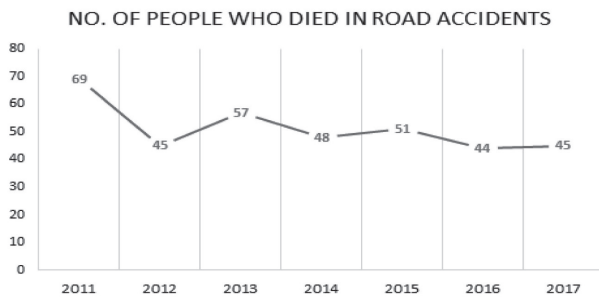


Fig. 11. Number of people died in Warsaw 2011-2017 [own study based on [18]]

## 5. Role of telematics in sustainable development

### 5.1. Sustainability development

Sustainability is a process that is not time definite and time constrained. One of definition of sustainable development is to meet the needs of present generation without compromising the ability of future generation to meet their own needs [13].

Even there is no particular definition of sustainable but it is generally classified into three major sections of Economy, Society and Environment. In this paper it is necessary to get through the information of transportation system effect on these three factors i.e. society, economy and environment. It is not wrong to say that existing transportation system is not sustainable system because of some negative points: Limited natural petroleum resources; Traffic congestion; Increased number of accidents; Negative impact on environment by vehicles.

### 5.2. Telematics system in transportation

Telematics system is an integration of telecommunication and information technology used to automate some system. Physical system such as telematics systems are called as *Intelligent System*. Intelligent system uses number of devices such as:

- Electronic communication system,
- Data acquisition system,
- Operator data presentation system,
- User data presentation system.

The existing transportation system in India and Poland is designed was designed for lower traffic levels. By taking the other factors into consideration the traffic problem caused by traffic congestion, air pollution, there is a need to regulate the traffic flow. For both the countries it is very necessary to develop the sustainable mobility in metropolitan cities to promote the economic growth, create employment opportunities. Implementation of Transport telematics into transportation sector suggests us number of ways to develop sustainable mobility into urban areas.

Transportation telematics is a combination of many technologies like transport engineering, information technologies and telecommunication that combines together and suggests solution of many never ending transport problems [22]. Transport telematics can help us in sustainable development by providing efficient solutions by increasing the efficiency of traffic management increase the efficiency of fuel consumption, increase traffic safety, proper utilization of existing infrastructure, environmental protection, minimize the traffic congestion and fatalities and many more.

As previously discussed the main reason of transportation problem in India and Poland is rapid urbanization and increased number of privately owned motor vehicles. Increased number of vehicles in urban area promotes the implementation of telematics in transportation. Implementation of telematics in transportation has a direct impact on sustainable development and country growth.

Sustainable development is a new concept which is a global concept used in development of decision making or the country growth. The main objective of this concept is protect the natural resources by controlling the social activities and utilizes the resources in a planned way. The definition presented by World Commission on Environment and Development of sustainable development meets the needs of the present without compromising the need of the future generation to meet their own needs [20].

Sustainable development into urban areas has one main objective to improve the environment poor condition and optimize the consumption of energy into urban areas. Implementation of telematics system in transport it to main cities of India will improve the accessibility of cities and provide a high quality and sustainable transport into the cities. Telematics in transportation will build a transport network in urban areas with the increased accessibility and services and will also enhance the life standard of public and improve the environment by minimizing the emission of gases by vehicles. Telematics is a tool through which we can plan the transportation and increase the efficiency of vehicles by utilizing the infrastructure in a more advanced way. General ideas like expansion of road length, increasing the number of public vehicles, for minimizing the traffic congestion can run only for small period

of time. For avoiding these problems related to transportation system in both country India and Poland, a long term idea have to be implemented and that is telematics into transportation system. For efficient transport system it is very important to plan the initial investment to increase the mobility by considering the sustainable development. In India, there is a huge difference between the current transportation planning and a sustainable transport planning.

To implement the telematics system for sustainable development it is necessary to involve the residents of that country. It is very necessary to make them aware the sustainable development of the country to improve the living quality in mobility. Especially in India, people do not follow the traffic rules and other security measures. Firstly its mandatory to make them aware about the how this system will help them to develop their city and overall their country.

The main purpose of telematics system in road transportation is to enhance the efficiency of transport system through better use of the existing infrastructure or to reduce the negative influence on the community and the environment [9]. Indian and Poland traffic can be benefited from several application of intelligent transportation system.

Main objective of telematics system of India and Poland: Increase the corridor traffic throughout; Increase the average travel speed; Reduce the vehicle delays; Decrease the average travel time; Increase utilization and effectiveness infrastructure; Improve accident detection system; Reduce incident duration; Increase field equipment utilization; Improve quality of traffic flow; Improve driver response in driving; E-ticketing; Traffic control; Traffic flow control; Travel information and e-ticketing; Electronic toll collection/ Fee collection.

### 5.3. How telematics can help

A vehicle telematics solution combines wireless GPS tracking with remote vehicle diagnostics and routing tools to give fleet managers a complete accurate and real time condition of their feet motion. Telematics in fleet management can help fleet managers, to improve productivity, maintenance, scheduling, and monitor drivers behavior to decrease the fuel cost by improving the speed of vehicle. Out of many telematics solutions, there are three main solutions that can help in minimizing consumption of fleet fuel by: Idling monitoring, Speed monitoring and automatic vehicle location.

#### 5.3.1. Idling monitoring

In India, due to traffic problem in urban cities, vehicles have to wait for a long time and that waiting time is called as Idling time. Unnecessary idling is one the major factor in the fuel wastage. According to a survey only sixty minutes of idling time consumes the same amount of fuel by driving 80 to 120 minutes. For example one gallon of gas wastes in one hour of idling time, by reducing the idle time by just 10 percent can help us to enhance the fuel efficiency by 10-20 percent. The Table 4 presents the relation between idle time of vehicle and how it enhances the waste fuel cost.

**Table 4. Impact on idle time on fuel [own study]**

Idle time in min. of per vehicle per day	Wasted fuel cost USD per vehicle per day	Wasted fuel cost USD per vehicle per year
30	1,32	343,20
60	2,64	686,40
90	3,96	1.029,60

For 100 vehicles if idle time is 90 min than for a year the cost of fuel waste is USD 100.000. Fuel waste plays a very important role in economy and also in the sustainable development of a country.

By using idling monitoring telematics solution in the fleet management, we can track fleet- wide and specific vehicle idling time. Fleet managers set a maximum value of idling time and receive alerts every time a vehicle idles crosses the maximum value of idle time [17]. By using this information, fleet managers can find out the correct the driver behaviors to minimize the lower fleet wide fuel consumption. According to a case study of a company that is using idle monitoring for 4.500 vehicles fleet identified that between USD 29.000 and USD 86.000 would be wasted in fuel each month from unnecessary idling. A 50% reduction in idling, accomplished by identifying negative driver behavior with a information provided in the idling monitoring reports would result in a cost saving of more than USD 500.000 a year [2].

#### 5.3.2. Speed monitoring

Speed monitoring of vehicles also plays a vital role into the fuel consumption. Excessive speeding of vehicles has a negative impact on the fuel efficiency, and has direct impact on fuel consumption. Studies have proven that reducing driving speed or by keeping the driving speed in a average range can lower the consumption of fuel volume by 14 percent. Here below in the table, we can see how every 5 miles per hour increase in driving speed adds 20 cent per gallon to the cost of gas (Table 6).

**Table 6. Impact of driving speed on fuel [own study]**

Speed (mph)	Percent [%] increase in fuel cost	Actual cost per gallon of fuel (base price of per gallon USD 2,64)
60	7,58	2,84
65	15,75	3,04
70	22,73	3,24
75	30,30	3,44
80	37,88	3,64
85	45,45	3,84

By controlling the speed of vehicles and minimizing the idle time, we can save the fuel as well as minimize the accident. Assume at least percent change occurs by telematics in the fuel reduction and accident reduction it will indirectly save the environment and helps in sustainable and safe transportation.

### 5.3.3. Automatic vehicle location

Mostly public in India do not relies on the public transportation, and that is one reason of increasing number of privately owned vehicles. Public transportation is very slow and public has to face the delay or have to spend time to wait for the buses or trains. There should some tracking system in public transportation so they can track the buses and plan the trip according to that time. At present, when public buses are on the road, no one can know exactly where the vehicles are without constantly contacting the drivers. This lack of communication leads many problems for the passengers. Automatic Vehicle Location (AVL) tracks the vehicles in real-time. Office staff always knows the location of the running buses which allows them to provide the service to the passengers on time. This system also provides the real time alerts to the authority to identify the instances of vehicle misuse.

### 5.3.4. Electronic toll collection

One of the methods to implement the telematics for the transportation sector is by the use of electronic toll collection. Right now in India, when you visit from one state to another state, sometimes there are many tolls barriers and you have to wait long time for your turn. By the electronic toll collection, allows the vehicles a free flow and therefore vehicles are not required to stop to toll fee. This electronic toll collection system is managed by General Director for national roads. Automobiles registered in Electronic Toll Collection (ETC) will be designated a particular lane.

A vehicle fitted with on-board device for toll charging approaches a toll plaza, the toll gates will automatically open after detecting the on board device. In electronic toll collection system, the amount of toll depends on the, total number of miles travelled and also directly related to the cost of infrastructure construction and operation. Above some strategies that are categorized into mainly three sections: Vehicles, Roads and human [8]. By implementation of these into transportation, we can achieve a sustainable transportation (Table 7).

**Table 7. Vehicle-Human-road set [own study based on [8]]**

<b>VEHICLE</b>	<ol style="list-style-type: none"> <li>1. Improved vehicles (improved efficiency, design, meets customers demand);</li> <li>2. Introduction of new technologies (hybrid cars, electrical cars);</li> <li>3. New efficient fuels (green fuel);</li> <li>4. Smart vehicles (ADAS, adaptive cruise, lane detection, e-call, accident detection);</li> </ol>
<b>ROADS</b>	<ol style="list-style-type: none"> <li>1. Intelligent transport system (smart highways, proper routing and management);</li> <li>2. Traffic congestion management;</li> <li>3. Proper highways;</li> <li>4. Pedestrian path planning;</li> <li>5. Lane management system;</li> </ol>
<b>HUMAN</b>	<ol style="list-style-type: none"> <li>1. Cultural enhancement (telecommunication substitution, teleshopping, teleconference);</li> <li>2. Incentives (proper implementation of traffic rules, response on govt. rules and policies);</li> </ol>

## 6. Conclusion

Transportation system is one of the most important foundations of modern life and also it has a deep linkage with the development of the country economy. Transportation plays a vital role in the sustainable development of any country. Transportation has a direct impact on three major factors: economy, environment and society. As the natural resources are very limited, it is a mandatory to build a sustainable transportation to conserve the natural resources for long time. From this paper, we can identify the problems related with the transportation system in India and Poland. By introducing the telematics into the transportation system we can enhance the level of transportation in these countries. The main problems presented here in transportation are: increased pollution level, accidents, long waiting time, unsafe transportation and all. All these problems cannot be eliminated completely but it can be minimized by implementation of telematics in road transportation of urban areas. Ensuring sustainable development is not a simple task and is associated with overcoming the many challenges of urban transport including: traffic congestion, accidents, parking problems, insufficient public transportation, land consumption, high maintenance cost [9].

In this paper some technologies and suggestions have been presented to increase the role of transportation in sustainable development of such as: promoting public transportation, mobility management, enhance road management, improvement in vehicle technologies, transportation planning, telematics technologies into vehicles to have sustainable development of transportation in India and Poland. Transport telematics solutions and strategies in this paper are modern technologies in order to facilitate sustainable urban mobility and to minimize the negative externalities of the urban transport for the environment.

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