In the Framework of Project

SESEI

Seconded European Standardization Expert in India

In Association with

btc European Business & Technology Centre

Enabling Europe India Collaboration

Study Report on **AUTOMOTIVE**

"ITS and e-Mobility"

CEN CENELEC ETSI European Commission EFTA

ACKNOWLEDGEMENTS

The study was performed under the EU Project SESEI and is prepared by EBTC through research and drafting carried out by Mr. Dibyendu Sengupta (Technical Expert & Consultant) for EBTC. Review and additional inputs were also provided by Mr Dinesh Chand Sharma (SESEI Expert) and Mr Nitin Sharma (Assistant Project SESEI). The Graphics and final formatting of the report were done by Mr. Ranjithkumar Jambulingam, Projects and Operations Manager EBTC.

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GLOSSARY

3GPP – 3rd Generation Partnership Project
ASI – Avoid-Shift-Improve paradigm
ANPR – Automated Number Plate Recognition
ANSI – American National Standards Institute
ARAI – Automotive Research Association of India
ATCS – Adaptive Traffic Control Systems
AVL – Automatic Vehicle Location
B-TRAC – Bengaluru Traffic Improvement Project
BIS – Bureau of Indian Standards
BRT – Bus Rapid Transit
CEN –European Committee for Standardization
CENELEC – European Committee for Electrotechnical Standardization
C-DAC – Centre for Development of Advanced Computing
CIRT – Central Institute of Road Transport
CoSiCoSt – Composite Signal Control Strategy
DMS/VMS – Dynamic/Variable Message Signs
EC – European commission
EFTA – European Free Trade Association
ETC – Electronic Toll Collection
ETSI – European Telecommunications Standards Institute
EV – Electric Vehicle
FAME – Faster Adoption of Manufacturing of Electric Vehicles in India
FTA – Free Trade Agreement
GHG – Greenhouse gas
ICAT – International Centre for Automotive Technology
ICE – Internal Combustion Engine
ICT – Information and Communication Technologies
IPT – Intermediate Public Transport
ITACA – Intelligent Adaptive Traffic Control System
ITS – Intelligent Transport System
JNNURM – Jawaharlal Nehru National Urban Renewal Mission
LVDC – Low Voltage Direct Current
MVA – Motor Vehicles Act
NCEM – National Committee of Electric Mobility
NEMMP – National Electric Mobility Mission Plan
NFV – Network function Visualization
NITI Aayog – National Institution for Transforming India
NMT – Non-motorised transport
OEM – Original Equipment Manufacturers
PIS – Passenger Information System
REEV – Range extended electric vehicles
RFID – Radio Frequency Identification
SDN – Software Defined Networking
SCOOT – Split Cycle Offset Optimization Technique
SUTP – Sustainable Urban Transport Programme
WTO – World Trade Organisation

FOREWORD

The SESEI project (Seconded European Standardization Expert in India) is a project co-funded by five European partners (EC, EFTA, CEN, CENELEC & ETSI), operating from New Delhi, India, with the objective to increase the visibility of European standardization in India and to promote EU/EFTA-India cooperation on standards and related activities.

The SESEI's mission is to enhance the visibility of European standardization activities, increase the cooperation between Indian and European standardization bodies and support European & Indian companies facing standardization-related issues hampering market access to India and Europe.

The project supports India in standardization-related aspects, by identifying all potential opportunities for enhanced international cooperation and global harmonization of standards. Ultimately, the SESEI project aims at contributing to the removal of Technical Barriers to Trade (TBT) both between EU and India and globally, thus supporting European and Indian industries by facilitating international trade.

SESEI project through its expert Mr. Dinesh Chand Sharma focuses mainly on the following priority topics, while also keeping a track and extending possible support to both EU and India on the topics of WTO-TBT and Market Access, IPR, R&D and Innovation, National Manufacturing Policy: Make in India, EU-INDIA FTAs, Environment (Energy Efficiency) etc.

- Information and communication technology: M2M/IoT, e-Accessibility, Security, 5G, NFV/SDN…
- Electrical Equipment including Consumer Electronics: Smart Grid, Smart Meter, LVDC, Micro Grids…
- Automotive: Connected Cars, e-Mobility, ITS…
- Smart Cities…

This Study Report on 'Automotive – ITS and e-Mobility' aims at briefly describing the sector Profile, future developments, challenges & opportunities in India, i.e. the regulatory, policy, technical and technological challenges, limiting the market potential and related opportunities, latest developments and current state of play covering standards development and policy initiatives in India to support the sectorial growth. With this study report and through further deliberation on the matter at the "*3rd Indo-European Conference on Standards & Emerging Technology*" scheduled on 26th April 2018 at Hotel The Lalit, New Delhi, the SESEI project aims to determine a list of actions as a way forward to further enable the project and its stakeholders in India and Europe in achieving its objectives and strengthen the cooperation and collaboration between EU and India

EXECUTIVE SUMMARY

The all-encompassing issue for transport professionals has been sustainability and its links with energy, environment and economic growth. This is particularly true with respect to the developing world.[1] Most cities in India have seen an exponential growth in number of vehicles on the road in the last two decades. The high growth rate of population and motor vehicles simultaneously has led to this greater complexity of vehicular traffic and consequent increasing rates of congestion and number of accidents.

The implementation of Intelligent Transport Systems (ITS) and Electric Vehicles (EVs) to alleviate the effects of uncontrolled automotive growth and urbanisation have gained ground in the recent past. Two things stand out – that the Indian market is rapidly evolving and new technologies need the right support to flourish. The present study focuses on the use of standardization in paving the way for adoption of these technologies in the nascent Indian market.

Based on the study, several opportunities have been outlined which include:

- Use of ITS technologies for traffic management and traffic control systems, accessibility of public transport, commercial vehicle operations and fleet management, non-motorised transport (NMT) and pedestrians and safety
- Use of EVs for electrification of corporate fleets, provision of electric feeder services and battery and motor technologies

In order to do that, a three-prong approach has been suggested as follows:

- Development of physical infrastructure in a way that supports implementation of ITS and electric mobility
- Development of standards that account for the Indian uniqueness and complexity and ensure interoperability on a global platform
- Development of technologies focussed on ITS and electric mobility that foster energy efficiency and a clean environment

Several initiatives have already been started to increase cooperation between EU and India in standardization of these technologies. It is hoped that this study will enable further progress in the areas of ITS and EVs between EU and India for harmonising standards and improving bilateral trade.

INTRODUCTION

Currently, India is the fifth largest automobile market in the world and the Indian transport sector has undergone a sea change in the past two decades. With liberalisation of the economy and opening up of the market, infrastructure is being built at a rapid pace. This includes highways, urban roads and its peripheral supporting infrastructure.

Some of the major issues that plague developing nations like India in this rapidly evolving system include increasing motorisation, low quality of public transport and non-motorised transport (NMT) and an all-pervasive lack of resources. [2]

Majority of this growth has been cars and two-wheelers for personal use. This brings in its wake recurrent congestion and safety issues, which make cities of India polluted and their roads among the most dangerous. The coexistence with non-motorized transport modes such as walking and cycling, leads to further complexity. Peak hour congestion on most major roads of large cities begin at around 8.30am and often continues into the evening peak hour, without a clear division between morning, afternoon and evening peaks. The evening peaks often go on beyond 9pm. Thus, the city networks are clogged up with traffic for the better part of the day, and travel at any time of the day remains a significant challenge. Signal-controlled intersections suffer from indiscipline of road users. The uncontrolled growth of vehicles has resulted in an alarming increase in vehicular emissions, resulting in increasing urban heat, air and noise pollution. Most Indian cities are covered in smog during several periods of the year.

INDIAN MARKET

- Largest 3-wheeler market
- Second-largest 2-wheeler market
- Tenth largest passenger car market
- Fourth largest tractor market
- Fifth largest commercial vehicle market
- Fifth largest bus and truck market

Many solutions have been looked at to alleviate the problems of air pollution and congestion and have met with limited success. The Avoid-Shift-Improve (ASI) paradigm of transport planning aims to achieve greenhouse gas emissions (GHG), achieve energy efficiency and reduce congestion by promoting alternative mobility solutions, as shown in Figure 1 below.

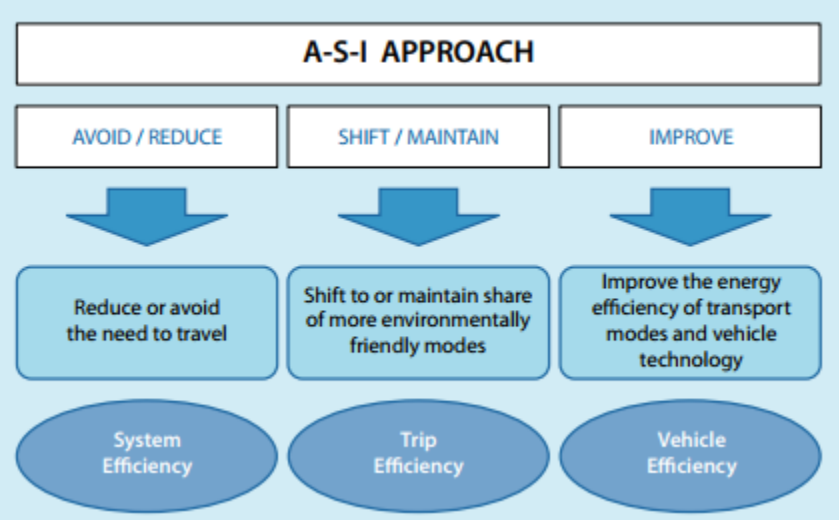
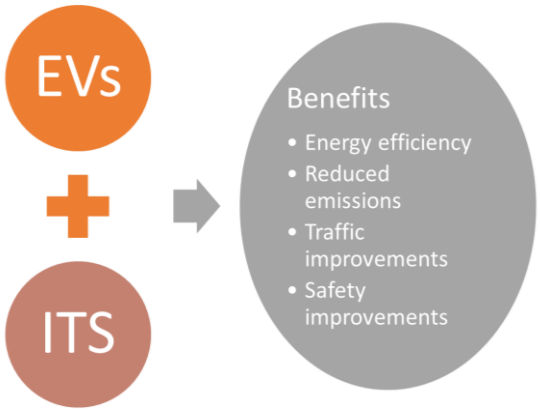


Figure 1: The ASI concept of sustainable mobility [3], Source: GIZ SUTP Factbook

Technologies and their use in transport are slowly ushering in ways and means to resolve these issues and fall under the "*Improve*" pillar of the ASI paradigm. Information and Communication Technologies (ICT) in transport, which fall under the umbrella of Intelligent Transport System (ITS), are being used increasingly to improve connectivity and

efficiency of urban and rural transport. In addition, as we will see later, ITS technologies also have the ability to cause "*Shift*" to more sustainable public transport systems by making it more attractive.



Uses of alternate vehicle technologies in automotive have been evolving rapidly for air quality benefits. Among various vehicle technologies, electric mobility (e-mobility) offers ways to reduce dependency on fossil fuels and also falls under the "*Improve*" pillar of the ASI paradigm. Apart from the benefit of reduced dependency on oil, electric vehicles (EVs) have the ability to pave way for a new market by creating a multitude of well-paying jobs through the establishment of a broad, domestic EV industry, and reduce on-road vehicular emissions. [4]

Together, ITS and EVs have the ability to create a transport system that is less energy intensive, environmentally friendly, efficient and safe. In the present study, we examine the use of both in the context of transport in India and how standardization issues are paramount to catalyse the process of adoption of these technologies in this nascent market.

INTELLIGENT TRANSPORT SYSTEMS

Applications of ICT in transport fall under the aegis of ITS. The ITS dates back to the early 1970s and 80s when along with the development of the highway and freeway systems in the US and Europe, the need was felt to enhance transport systems with the help of technology. Technologies like actuated signals and parking meters are the ones that came to the forefront initially. Further technologies like ramp meters, driver aided information and navigation systems and dynamic message signs (DMS) came to the fold. In the 80s, advanced surveillance, weigh-in-motion and on-board route guidance technologies were developed and deployed.[5]

In Europe, the Network of National ITS Associations is a consortium of organisations with various ITS interests, with the secretariat at ERTICO – ITS Europe which is a public/private partnership promoting the development and deployment of ITS. They connect public authorities, industry players, infrastructure operators, users, national ITS associations and other organisations together. [6]

Indian ecosystem for ITS

In India, ITS is at its nascent stages. Most uses of ICT technologies that have so far been restricted application of Electronic Toll Collection (ETC) technologies on national and state highways, use of technologies for tracking, surveillance and information systems on public transport, and parking management systems in cities. Systems like electronic ticketing and automated fare collection systems have been mostly limited to metro systems.

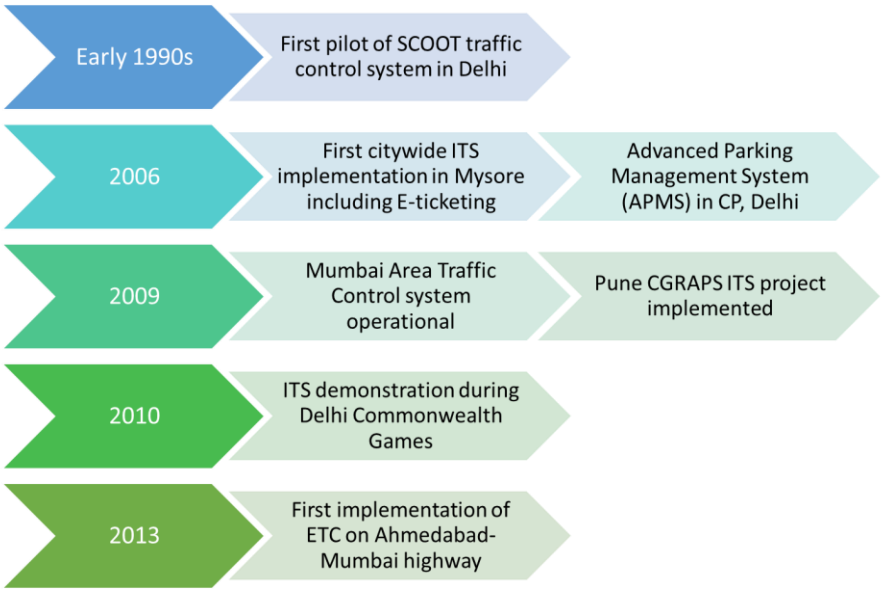


Figure 2: ITS milestones in India

ITS for Public Transport Systems

ITS implementations in public transport systems encompasses several aspects of operations and management of the transport systems to ensure efficiency and increase comfort and safety. ITS can potentially have a big impact on improving the efficiency of the public transport system by causing improvements in operations. [7] Some major implementations in Public Transport are shown in Figure 3.

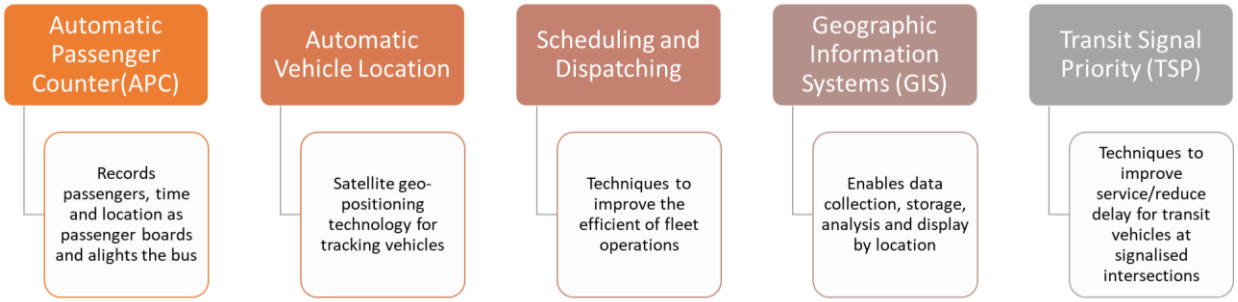


Figure 3: ITS implementations in Public Transport

Karnataka State Road Transport Corporation (KSRTC) has implemented a city-wide ITS project in the city of Mysore. The project attempts to relieve the issue of road congestion by offering state-of-art technologies and encouraging the usage of bus services. It covers 500 buses, 105 bus stops, 6 bus terminals, 45 platforms, which became operational at several stages since 2006. It was developed under the Sustainable Urban Transport Programme (SUTP) with financial assistance from World Bank, Government of India's Jawaharlal Nehru National Urban Renewal Mission (JNNURM) fund and Government of Karnataka. It includes Passenger Information System (PIS), Commuter web portal, Automatic Vehicle Location (AVL) using GPS, and Enterprise Management System. [8]

Demonstration of several ITS technologies were also performed during the 2010 Commonwealth Games in New Delhi, including GPS tracking of buses, taxi and autorickshaws, in order to integrate feeder services to main public transport. ITS implementations for public transport was envisioned and implemented between Ambedkar Nagar and Moolchand on the erstwhile Delhi BRT corridor and subsequently expanded to a wider area under the supervision of

DIMTS (Delhi Integrated Multimodal Transit Systems). It includes PIS, automated fare collection, electronic ticketing machines and an operations control centre. [9]

Signalisation and Traffic Management

Traffic management is an area of ever increasing importance. Rapid increase in motorisation in Indian cities with constrained availability of roads, has left the cities with day-long traffic jams and gridlock conditions in major portions of the cities. In this situation, proper signalisation and utilisation of road capacity calls for proper traffic management with the help of advanced traffic signalisation techniques.

Traffic signals in Indian cities are the responsibility of the Traffic Police who have no in-house traffic engineering and signalization expertise. Currently, most of the existing traffic signals in the cities used basic pre-timed operations and are not designed for optimal signal cycle length to minimize delays, with ad-hoc procedures for installation, timing, operations and maintenance of these signals. In addition, there is no system to allow these signals to adapt their cycles to the road conditions based on real time conditions. As a result, malfunctioning of signals are quite common. Apart from that, lack of standard and properly placed signing and marking causes confusion among driver about turning movements and as a result signal delays are extremely high (e.g. in Delhi).

There are very few existing actuated signals or area-based traffic control systems in India. New Delhi had a small pilot that tested the SCOOT (Split Cycle Offset Optimization Technique) of adaptive traffic control in the early 1990s. It was again implemented between Ambedkar Nagar and Moolchand on the erstwhile BRT corridor and subsequently expanded to a wider area under the supervision of DIMTS (Delhi Integrated Multimodal Transit Systems). Under the Mumbai Urban Transport Project (MUTP), the Intelligent Adaptive Traffic Control System (ITACA) system adaptive control algorithm has been implemented in Mumbai for approximately 255 signals and two command control centres were established. The Indian agency Centre for Development of Advanced Computing (C-DAC) have also developed an indigenous system named CoSiCoSt (Composite Signal Control Strategy), which is backed by research for traffic engineering for Indian conditions including poor lane discipline and two-wheelers. C-DAC implemented the CoSiCoSt system in Jaipur on 11 signalized intersections on an arterial. [10]

Touted as India's first "intelligent traffic management system", a traffic control centre was made operational on Ahmedabad's 132-ft ring road from October 2014, funded by Japan International Corporation Agency (JICA). It consists of ten camera-based traffic sensors which broadcast details of traffic flow, speed, density to a cloud-based traffic control centre. This information is then displayed on screens installed on gantries for road jams, construction work or other hurdles to road users about 200 metres prior to traffic light so that they can take decision on selection of road. [11]

Apart from that, the city of Hyderabad has set up signalling services round the clock at 221 junctions, including linking its automated signals with a main intelligence command centre. [12]

Electronic Toll Collection

Electronic Toll Collection enables road users to pay highway tolls electronically without stopping at the toll plazas. This technology results in better traffic management by reducing congestion, delays and queuing time at the toll gates.

In India, the Mumbai-Pune highway has installed an ETC. National Highways Authority of India (NHAI) has formed the Indian Highways Management Company Limited (IHMCL) to carry out Electronic Tolling and other allied works by NHAI jointly with its Concessionaires and Financial Institutions. In addition, the NHAI has developed two mobile apps (MyFASTag and FASTag Partner) that enable online transactions for an ETC system. [13]

The ETC implementations in India have suffered from several teething problems. Although the Radio Frequency Identification (RFID) technology has been the most popular, there is no standardised ETC technology, resulting in

different ETC technologies. In addition, there also exists a general lack of legal provisions in contracts for ETC interoperability. [14]

Citywide ITS for enforcement and surveillance

ITS technologies can be used for citywide surveillance and the information can be used for traffic management, congestion relief and enforcement for traffic violations. The B-TRAC (Bengaluru Traffic Improvement Project) initiative in Bengaluru began in 2010, with a focus to install ITS for digital surveillance and enforcement cameras. It includes a Traffic Management Centre with a variety of installations including vehicle-actuated signals and the ability to remotely update signal timings. In addition, a traffic training and road safety institute is being planned. [14]

Parking Management

Real-time parking management systems provide information related to available parking lots through publicly displayed electronic sign boards, giving useful information to parking users and staff of the facilities. Combined with sensor technologies and boom barriers, parking management systems improve efficiency of operations and management of parking places. [15]

Among indigenous solutions, ePARK developed by C-DAC uses sensors at the gate boom barrier and variable message signs (VMS) to inform availability status of parking lots and has installations in Pune and Thrivananthapuram. [16]

Apart from the above implementations, several ITS technologies have been implemented in limited fashion. These include smart mobility cards for seamless travel, collision avoidance technologies for railways (several pilots have been conducted for indigenous technologies), automated number plate recognition (ANPR) technologies etc.

Market dynamics and potential

Due to the increasing role of ITS in various areas of the transport market, several players have appeared in India. There are leading academic institutions like Indian Institute of Science (IISc) Bengaluru and Indian Institute of Technologies (IITs) which have undertaken key research in applications and indigenisation of ITS technologies in India. In addition, the Government R&D organisation C-DAC also has an ITS unit that undertakes key research in such technologies. Several private organisations have developed and are in the process of developing key products in ITS areas like ETC, parking management, ANPR systems and wireless communication devices with applications in transport.[17]

Key areas of research and development still remain to be tapped. Areas like adaptation of signal actuation to Indian conditions, application of ITS technologies for work zone traffic control and incident management, research into road safety risks and occurrence with a focus on accident avoidance are key areas that offer potential for development of ITS technologies suited for India.

ELECTRIC MOBILITY

Electric vehicles enable a healthier living environment by reducing dependency on fossil fuels (of traditional internal combustion engines (ICE)) and are therefore an important factor for improvement of traffic.[18] EVs are either partially (hybrid system) or fully powered by an electric motor. They use energy stored in batteries, which are recharged through external electric power points (as in a pure EV with no ICE) or by an on-board ICE (as in a hybrid EV).

In hybrids, the petrol engine provides most of the power during acceleration, while the electric motor provides some electric-only operation. There is a third class of vehicles called range extended electric vehicles (REEV), which have

plug-in battery pack and electric motor, as well as an internal combustion engine. They use the ICE for charging batteries in case of longer drives. [19]

Indian ecosystem for EVs

India is a market that present considerable differences from developed markets like Europe and the U.S. and closer in nature to its south-east Asia neighbouring countries. The traffic is mixed and heterogenous in nature with the large presence of two-wheelers and three-wheelers. The two-wheelers are used by middle class families for their everyday trips, while the three-wheelers are used as a first-mile/last-mile connectivity enabler – often referred to an Intermediate Public Transport (IPT) (although they are privately owned).

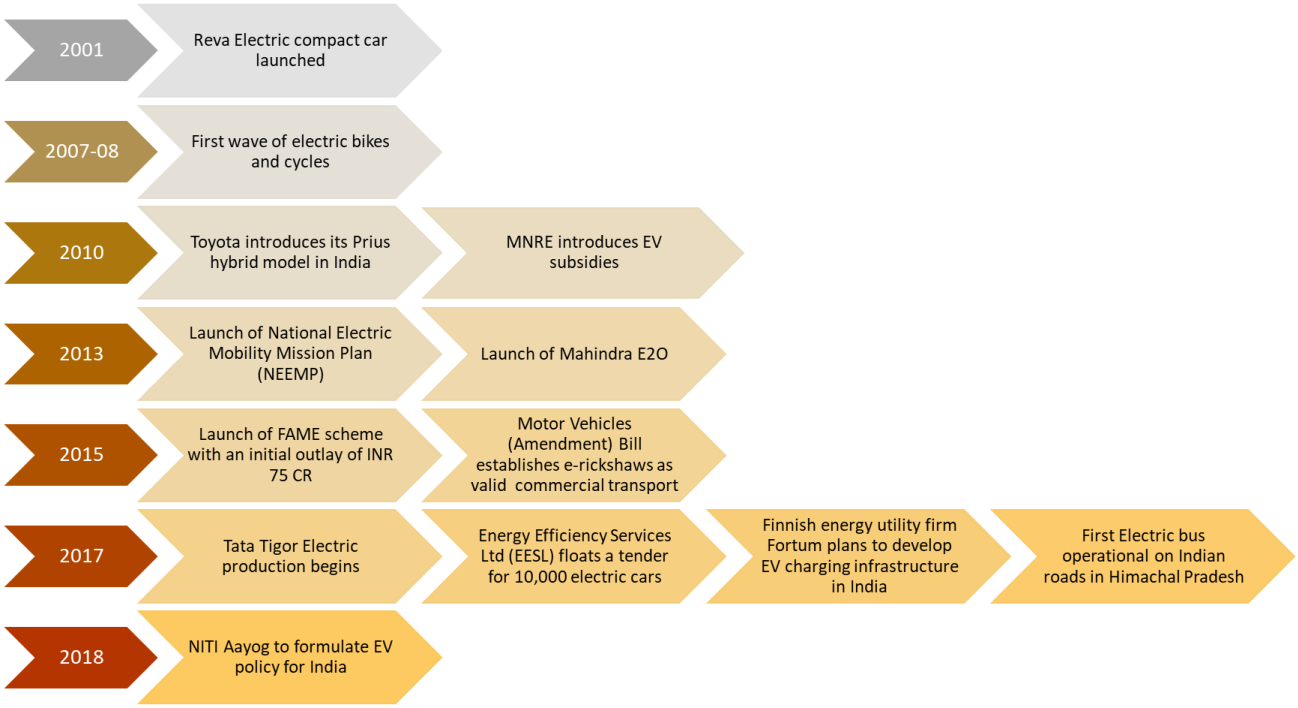


Figure 4: Electric mobility milestones in India

India has been consistently ranked in the top-ten automotive markets in the world for the last several years. Despite consistent rise in automotive sales for the past two decades, the automotive ownership in India is still very low compared to the developed world. Penetration of pure electric vehicle remains quite low in India – approximately 0.1% in passenger vehicles, 0.2% in two-wheelers and nothing in commercial vehicles. [20] This puts the Indian market in a unique place – if the market grows in the right way, the country can save a lot in energy consumption.

Although very limited numbers of EVs have been seen on Indian roads till the late 2000s, there has been a gradual shift in EV-focused policies and industry movement. REVA, India's only electric car company was acquired by Mahindra, a leading automobile company. This was followed by a series of EV-related policy announcements post 2010, which were catalysed into faster implementation around 2015. [19]

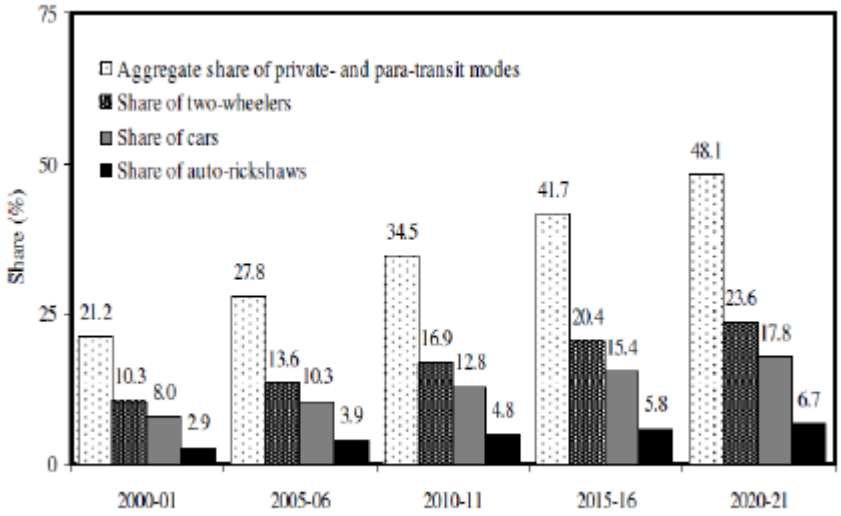


Figure 5 Share of cars and para-transit modes in India

Two- and three-wheelers

Most of the production of EVs for 2-wheelers vehicles was initially limited to the assembly of kits imported from China. Despite capital subsidy announcements by the Indian government, several manufacturers failed in succeeding in producing high quality electric two-wheelers. Since these several unsuccessful ventures, operations in India primarily consist of imported kit assembly. Some manufacturers have changed focus from pure battery two-wheelers to hybrid two-wheelers suited for the Indian market. [19]

In Indian conditions, three-wheelers or auto rickshaws serve an important role in short to mid-distance trips and are referred to as intermediate public transport. Since their advent, electric rickshaws have gained popularity as a replacement for conventional three-wheelers. In Delhi and several other cities, after the initial unregulated use of e-rickshaws and resultant concerns over safety, the Government made amendments to the Motor Vehicles Act (MVA) (Amendment No. 3 of 2015) to regulate their use and address safety concerns.[21]

Hybridization

Hybridization technologies offer fuel enhancement at often a fraction of the cost involved in developing purely electric fleet. Partial electrification by hybridization of vehicles due to several constraints including financial and infrastructural, has often been seen as a viable stepping stone to pure electrification of vehicles.

Several Indian manufacturers such as TATA, Mahindra, TVS and suppliers such as Bharat Forge have invested in hybridization technology over the past several years. [19]

Charging Infrastructure

India also suffers from a nationwide lack of charging infrastructure, with users of EV two- and four-wheelers almost always relying on home charging. Mahindra-Reva has undertaken installation of charging infrastructure with the help of tie-ups with various corporate entities in Bengaluru, Delhi and several other cities. This lack of charging infrastructure has posed a hurdle for a speedy development of EV implementation in India. The National Electric Mobility Mission Plan (NEMMP) includes recommendations for establishment of a public charging infrastructure but these are part of the later phases of the mission and recommends home recharging for small-size battery EVs and hybrid vehicles. [19] TATA Power has also initiated development of electric vehicle charging stations beginning with Mumbai.

Market dynamics and potential

According to a 2011 Deloitte report [22], "the adoption and potential for EVs in India is undeniable given anxieties around energy independence, high cost of imported fuel and the ability to increase the availability of power through the grid by multiple sources like coal, renewable sources, gas and nuclear power." The report also states that in India, "the rapid rise of fuel prices and the desire to be on par with the rest of the world in terms of emission would facilitate the growth of the EV market."

For the Original Equipment Manufacturers (OEMs), EVs offer a great opportunity but also pose a threat, as the technology could change the contours of the industry and render large parts of the value chain that has been created over the last decades worthless. This is particularly true for a country like India, where most of the ICE value chain was created after the mid-1990s. [22]

Several Indian ministries are important stakeholders for the EV industry including the Ministry of Heavy Industries (MHI), the Ministry of Urban Development (MoUD), the Ministry of Environment and Forest (MoEF) and the Ministry of Road Transport and Highways (MoRTH). The Society of Manufacturers of Electric Vehicle (SMEV) is an association of Indian manufacturers of electric vehicles (EV) and electric vehicle components. It works with Indian governments bodies to assist formulation of policies and processes supporting the EV ecosystem. Lastly, all the major automobile players including Tata Motors, Ashok Leyland, Maruti Suzuki, Mahindra & Mahindra, Bosch, Volkswagen, Volvo, etc. have been involved in the production and research of new and/or existing models electric variants

POLICY INITIATIVES AND STANDARDIZATION

Policies and regulations play an important role in developing the right ecosystem by identifying visions, clarifying objectives and strategic intent and exploring incentives. This supportive ecosystem then indirectly prompts the higher adoption of technologies. For upcoming areas like ITS and EVs, it is absolutely imperative that visions, policies and regulations are in place, in order for technologies to find the market and thrive. [23]

A "standard" is "a document, established by consensus and approved by a recognised body, that provides, for common and repeated use, rules, guidelines or characteristics for activities or their results, aimed at the achievements of the optimum degree of order in a given context." **(ISO & IEC)**

Similarly, standards which are voluntary not only help for safety regulation and interchangeability of components, but also for interoperability. Therefore, they help industry, government agencies and the general user in development, application and use of technologies. [18] Although standards give guidelines to development of technologies, they are in constant evolution and revision hence a regular participation of national standards development organisation at Global platform is important for its update and implementation. Domestic Standards and Strict adherence without cognizance may impede further technological evolution.[18] This is especially true for a market like India, which may have its unique conditions and complexities.

Intelligent Transport Systems (ITS)

Policy Initiatives

The NITI Aayog has set up a national-level committee constituting officials from various ministries and States to develop a roadmap for the implementation of the ITS policy. The National ITS policy will aim to reduce urban traffic congestion, improve parking for vehicles in cities, road safety and the security of passenger and goods traffic. The subjects covered under the panel's purview would include traffic management, parking management, electronic enforcement of traffic rules and fleet management. The committee's mandate would also include monitoring and encouraging pilot projects. [24]

Along with the International Road Federation (IRF), NITI Aayog is also designing a policy framework for intelligent transportation systems (ITS) for India. The overall objective is to create a national platform that involves all relevant stakeholders and relevant technical experts for the purpose of developing a national ITS policy.

The Smart Cities mission which was kick-started by the GoI approximately in mid-2014 focuses on urban improvements with ICT technologies as the fulcrum for mapping, connecting, surveillance and data gathering purposes. Under the Smart Cities mission, work has already started on the first phase of 50 cities and a bulk of the work centres around transport improvements. Much of the transport improvements are focused on technology driven solutions including Public Bike Sharing (PBS), signal improvements along critical corridors and coordination and control using central command centres.

The MoRTH is also mulling a policy on tolling based on distance travelled that can be implemented with the help of ITS technologies. [25]

Standardization and Architecture of ITS

Deployment of ITS technologies is enhanced by the use of common standards. The increasing progress of ITS worldwide has led to issues of compatibility and interoperability, leading to countries making efforts to standardize their architecture by formulating national ITS strategy or developing ITS infrastructure. [27] A system architecture for ITS is an "overall framework" that shows the major ITS components and their interconnections. The system architecture identifies and describes the interfaces between major ITS components, which allow communicate with one component of the system with another. Standardization of ITS enables interfaces to be consistent and interoperable. Apart from that, an ITS system architecture also helps in creating a national or regional vision of ITS and define a framework for future development and expansion of ITS. [26] It is in this context that standardization and development of a national ITS architecture is so critical for India, at this stage of rapid expansion of infrastructure.

Leaders in ITS development have established various partnerships that rest on common ITS standards. Associations like ITS America and ITS Japan regularly do collaborative work to produce ITS forms and protocols. [27]

In Europe, standardization one the topic is done by the European Telecommunications Standards Institute (ETSI) and the Comité Européen de Normalisation (CEN). The technical committee Intelligent Transport Systems (ITS) has been created within ETSI for developing standards and specifications. The 3rd Generation Partnership Project (3GPP), which is a consortium of seven telecommunications standard development organizations including ETSI, has been working towards developing 3G and 4G networks to meet the needs of the transport sector and include ITS functionalities in the communication standards. Their development of the 5G technology is also fully integrating the ITS use cases and constraints. Similarly, the International Telecommunications Union (ITU) provides a forum for the development of an internationally acceptable and globally harmonized set of ITS communication standards, including standards for drivers with communication devices in vehicles. oneM2M is another global organization that develops requirements, architecture, API specifications, security solutions and interoperability for Machine-to-Machine (M2M) and Internet of Things (IoT) technologies and have been working on an Open Data Marketplace to help organisations understand travel needs and improve transport operations for Intelligent Mobility services, applications and solutions. [28]

- In Europe, the European ITS Framework Architecture (FRAME) is a Project and Support Action funded by the European Commission, DG Information Society and Media (Now - Directorate General for Communications Networks, Content and Technology) in the 7th Framework Programme
- The EU Legislative Framework on ITS (Directive 2010/40/EU) is also an important instrument for the coordinated implementation of ITS in Europe, for adoption of the specifications (i.e. functional, technical, organisational or services provisions) to address the compatibility, interoperability and continuity of ITS

solutions. Although its mandate is to establish "interoperable and seamless ITS services", it allows the Member States the final decision on the systems to choose from. Directorate-General (DG) Mobility and Transport (MOVE) leads this initiative and is supported by five co-operating DGs. [29] A summary of the ITS architecture designed by FRAME is shown in Figure 6.

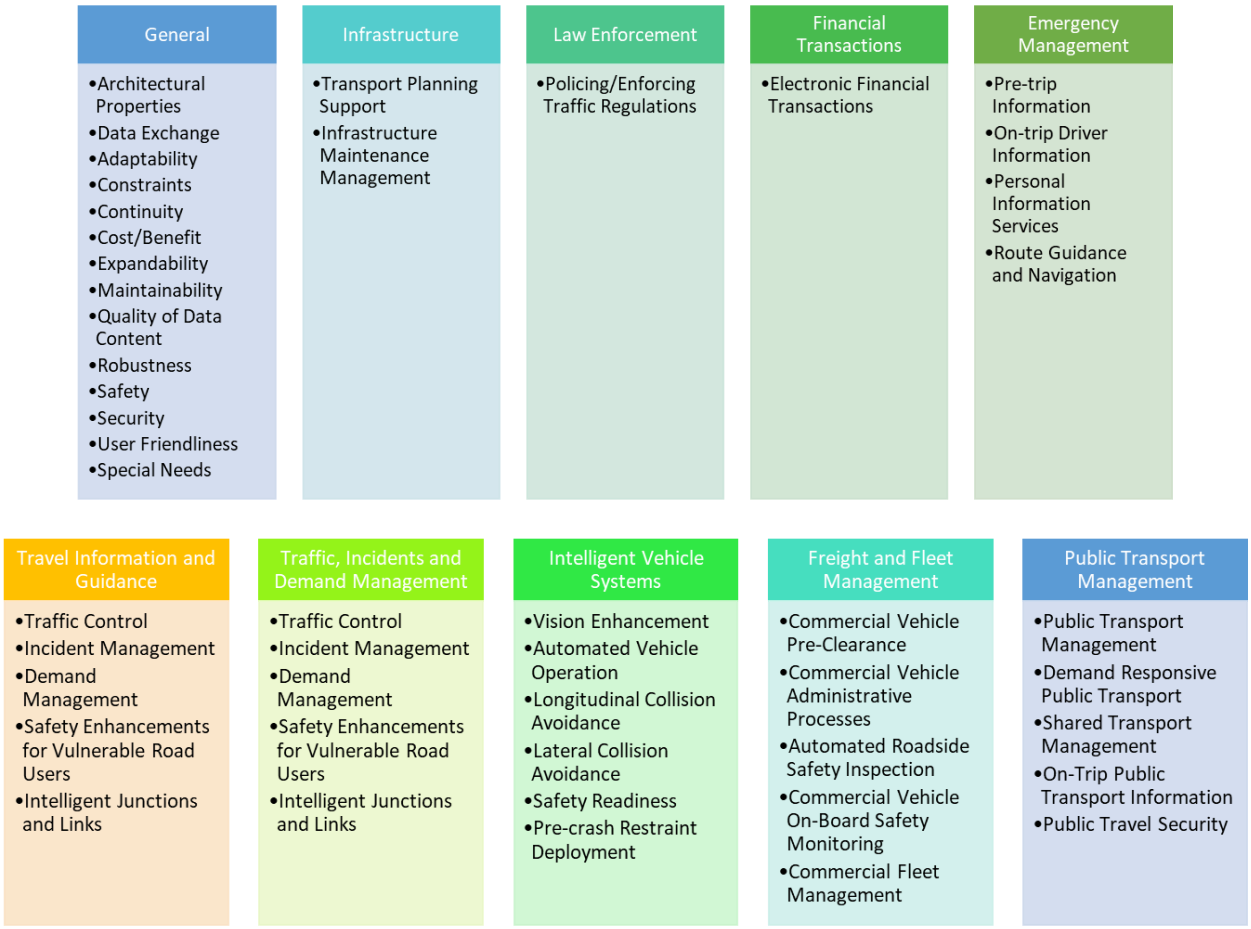


Figure 6 European ITS architecture

Developing national ITS technical and service standards is important and ensures sustainability, compatibility and capacity to expand ITS services. As described by Yokota and Welland[26], it will be potentially difficult and time consuming for developing countries like India to build an ITS architecture that covers all user services. Hence, they suggested an approach to build the architecture in stages as follows:

- Define the ITS user services
- Define the processes (activities and functions) required to provide the user services (logical architecture)
- Define the physical entities (subsystems and terminators) that make up an ITS.
- Define the architecture flows that connect the subsystems and terminators (physical architecture)

Also, as delineated by Sen & Raman[40], an ITS architecture for India would need to take into account many factors, primary of which are choice of applications, sensing method and communication model.

The Bureau of Indian Standards (BIS), the apex body for standards in India have formed a special group TED 28, which is a part of Transport Engineering Department Council (TEDC). TEDC has released a draft standard under the title Intelligent Transport System, including the following:

- TED 28(1071) W regarding specifications for RFID System for Automotive Applications
- TED 28(1058) W regarding Intelligent Transport Systems – Communications access for land mobiles (CALM) – Infra- red systems (adopted from ISO 21214:2015)
- TED 28(10974) W regarding specifications for Automotive Tracking Device (ATD)

In addition, the Automotive Research Association of India (ARAI) has drafted a standards document AIS-140 for ITS requirements for public transport operations, which also includes specifications for autorickshaws.

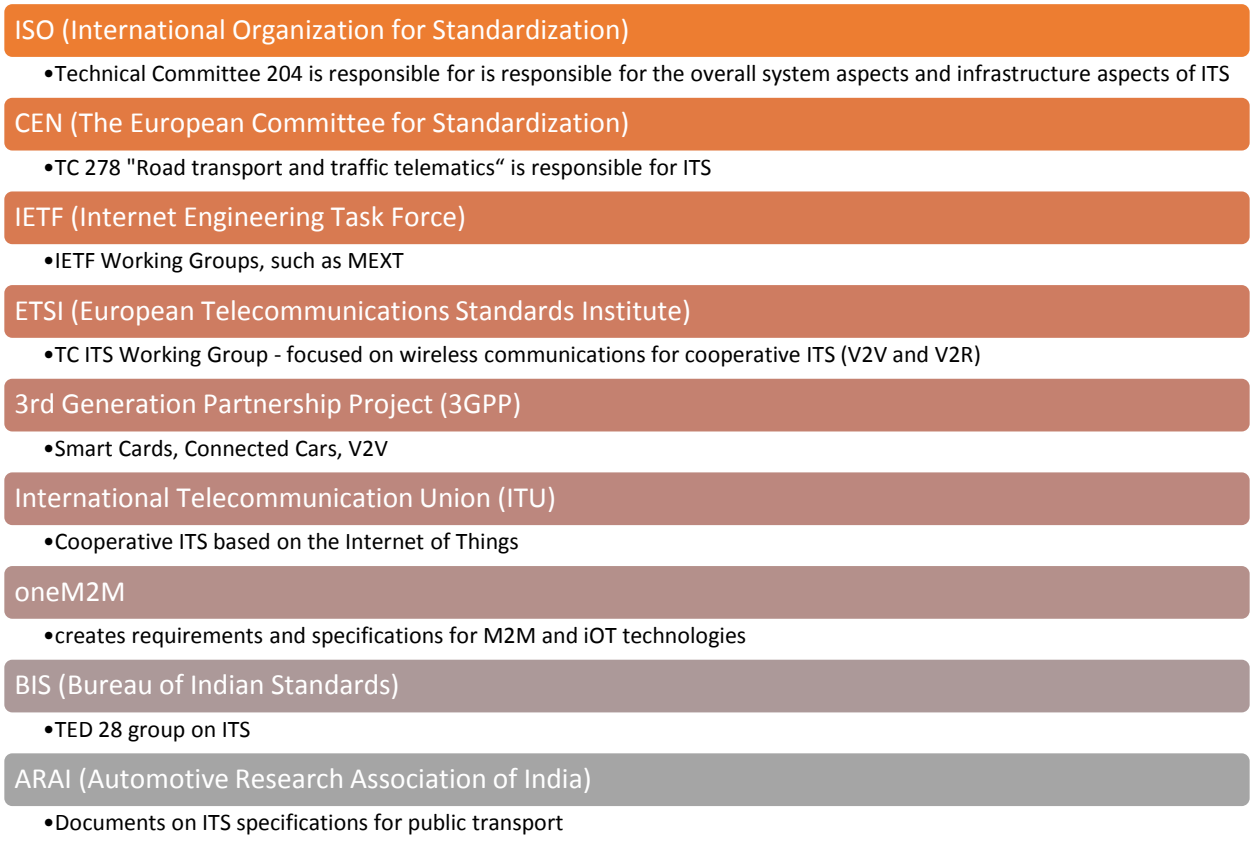


Figure 7: Standardization bodies in ITS worldwide and in India

Standardization will remain an important -activity around the building of an ITS architecture. Standardization will provide consistency, enhance interoperability and help in expanding market. [26]

E-mobility

Policy Initiatives

Indian EV policy had been quite limited in terms of funding and innovation scope, but there has been significant movement in the last couple of years. There have so far been two major EV policy initiatives, of which only one has been implemented.

- In 2010, the Ministry of New and Renewable Energy (MNRE) introduced a subsidy for the purchase of electric two- and three-wheelers and promote research, development and demonstration projects on electric vehicles as part of the Alternative Fuel for Surface Transportation programme. Some of the areas of focus included demonstration of battery operated vehicles and engines and vehicles for hydrogen and fuel cells. [21] It mandated a 30% localization requirement for subsidy entitlement. In addition, manufacturers of EVs received a 20% subsidy on the ex-factory price of the EVs, to a maximum of 1300 EUR per car and 50–60 EUR per two-wheeler.
- In 2013, the incumbent government announced a programme named *National Mission for Electric Mobility* under the Department of Heavy Industries and set up a National Committee of Electric Mobility (NCEM). The idea behind this programme was pushing the development and adoption of EVs, with participation from all stakeholders, including the Ministry of New and Renewable Energy (MNRE), the Ministry of Environment and Forests (MoEF), the Ministry of Urban Development (MoUD), the industry and the academia. The various support options discussed included purchase subsidies, duty exemptions, income tax exemption, government fleet procurement, R&D support for EV projects, etc. A major announcement from the NCEM was the release of the National Electric Mobility Mission Plan 2020 (NEMMP 2020) recommending a government support of 2.5 -3.5 billion Euro for this sector over the next five to six years. [19] The Government of India (GoI) approved the National Mission on Electric Mobility in 2011, followed by National Electric Mobility Mission Plan (NEEMP) for 2020 in 2013.

The NEMMP had an ambitious target of 6-7 million units by 2020. Initially, the electric mobility mission was under the Ministry of Heavy Industries (MHI) which formulated the FAME (Faster Adoption of Manufacturing of Electric Vehicles in India) scheme.[30] The scheme was envisioned to have four focus areas – Technology development, Demand creation, Pilot projects and Charging infrastructure, with a total allocation of one billion EUR till 2017. The bulk of the scheme was devoted to demand incentives and technology creation. Under the technology platform, Original Equipment Manufacturers (OEMs) and vehicle models that look to avail the scheme had to undergo testing at MHI approved centres which included:

- The Automotive Research Association of India (ARAI)
- International Centre for Automotive Technology (ICAT), and
- Central Institute of Road Transport (CIRT)

Using some of these previously initiated schemes, the GoI in 2015 planned a big thrust for the sector and announced its aim to turn India into a 100% electric vehicle nation by 2030. [31] According to the FAME guidelines, the funding will be provided to cities covered under the "Smart Cities Mission" initiative, in the form of demand incentive for buyers (end users/consumers) as reduced purchase price to enable wider adoption. [33]

On the heels of the FAME announcement, came a policy document from Society of Indian Automobile Manufacturers (SIAM) and GoI, which aimed to be a collective vision of the industry and define the trajectory of the automotive ecosystem in India. Specific focus was given to implementation of emission standards across India, in addition to pilot projects, charging infrastructure and component manufacturing for EVs as a part of policy initiative in EVs. [32]

GoI's planning think-tank NITI Aayog (National Institute for Transforming India) has also come out with a policy on EVs for a 15-year roadmap on complete electrification of vehicles in India. The Ministry of Urban Development is planning to launch "Green Urban Transport Scheme", enabling a shift towards electric vehicles for public transport and use of non-fossil fuel for powering vehicles. Total cost of the project is expected to be around EUR 10 billion. The government is giving funding to 100 cities selected through competition. The funding of the scheme will be 50:50 between states and the central government. The ministry has proposed a grant of EUR 3 billion, while the remaining may come from multi-lateral banks and state governments. [33]

In addition, as part of its White Paper on Electric Vehicles, SIAM has proposed incentives including tax reduction of 5 to 12% on electric vehicles and also recommended the below measures:

- a policy push will be required to bring affordability of EVs. Demand incentives or cash subsidies can at best be a short-term measure to kick-start the process. However, tax rebates and other fiscal and non-fiscal measures can be sustained over a longer term and will have a greater impact and outreach.,
- Private charging, both at home and at the workplace, will represent the majority of electric vehicle charging. Therefore, a higher priority may be accorded to have policy measures and regulations around building private charging network (homes, multi-unit dwellings, workplaces, and other such captive places),
- Regulations should be passed that will mandate provision of AC slow charging points in parking areas of residential buildings, workplaces spaces, shopping malls, commercial complex etc.

Lastly, apart from all these policy initiatives, various corporate and industry heavyweights including Mahindra, Ford, Nissan, Honda, Mercedes-Benz, BMW, Volvo and JLR have planned EVs for India and undertaken various endeavours towards it. In addition, Ola, Uber and Zoom have started discussions to replace their existing fleets with electric ones from Mahindra and other companies. [34]

At the recently held Auto Expo 2018, several market ready EV models were displayed including three-wheelers and electric scooters. Auto component manufacturers like Bosch and battery manufacturers like Lithium Urban Technologies, which have already announced plans of production in India, showcased their capabilities.

Standardization of EVs

All vehicles are subject to a number of regulations for circulation. Some are safety-related like braking, lights, seat-belts, while some could be environmental regulations like emissions. In some cases, regulations may refer to national or international standards. [18]

The various organisations active in the area of standardization for electric vehicles are summarised in the graphic below:

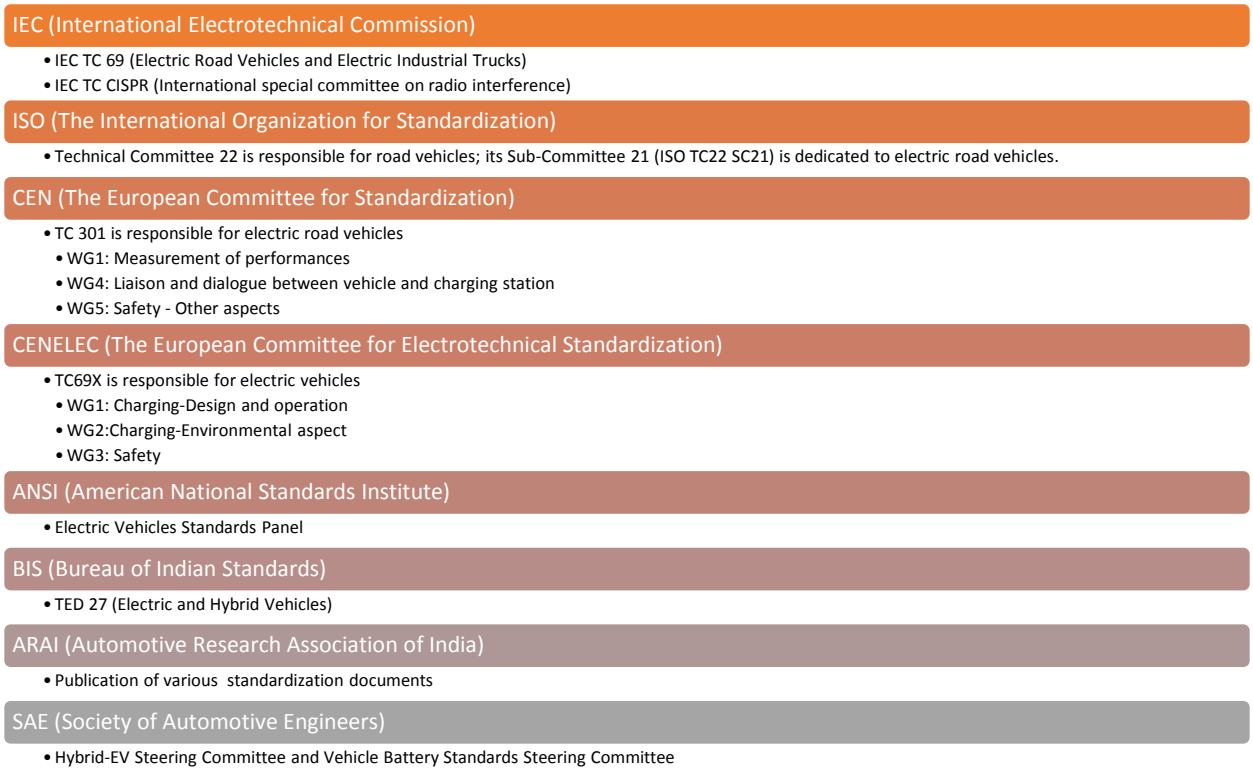


Figure 8: Standardization bodies in E-mobility worldwide and in India

The worldwide activities of all these organisations lead to a structured set of documents describing the different aspects of the electric vehicle technology.

In India, the Bureau of Indian Standards (BIS) through its TED 27 on Electric and Hybrid Vehicle have produced IS 15886 for standardization of Electric and Hybrid vehicles and their components. The ARAI drafted several standards that are related to electric mobility including the following:

- AIS-138 (Electric Vehicle Conductive AC Charging System) for DC charging system for electric vehicles with assistance from existing international standards including IEC 61851-1(General Requirements), IEC 61851-23 (electric vehicle charging station) and IEC 61851-24 (Digital communication).[35]
- ARAI has also published Automotive Industry Standard (AIS) document including AIS-102 (Part 1 & 2) on CMVR Type Approval for Hybrid Electric Vehicles, AIS-123 on CMVR Type Approval of Hybrid Electric System Intended for Retro-fitment and AIS 131 on Type Approval Procedure for Electric and Hybrid Electric Vehicles introduced in market for Pilot / Demonstration Projects intended for government schemes,

In late 2017, the Ministry of Heavy Industries instituted "Committee on Standardization of Protocol for Electric Vehicles" submitted its report titled "*Standardization of Public EV chargers*" which includes national standards for electric vehicle charging stations — Bharat EV Charger AC-001 and Bharat EV Charger DC-001. [36]

Earlier, under the National Smart Grid Mission (NSGM), policies for demand-response (DR) ready appliances and public infrastructure including EV charging facilities were planned to be done by 2014. However, these remain to be implemented.

OPPORTUNITIES AND CHALLENGES

India has been a global leader in the development of information and communication technologies (ICT) products and services. In case of ICT, interoperability is a key component hence its standardisation should be global. India will have to put forth its local requirements to global platforms such as 3GPP, ISO, IEC and ITU to get them harmonised for implementation and achieving economies of scale. This expertise is potentially valuable for development of indigenous technologies in transport that are suited for the heterogeneous traffic conditions of India.

The local presence of EU Projects such as SESEI (Seconded European Standardisation Expert in India) and India-EU Partnership Instrument on ICT Standardization can play an important role in connecting communities from Europe and India, thereby help bringing experts and relevant stakeholders up to speed and as well assist in forming the necessary agreements between BIS and ESOs to facilitate adoption of European standards.

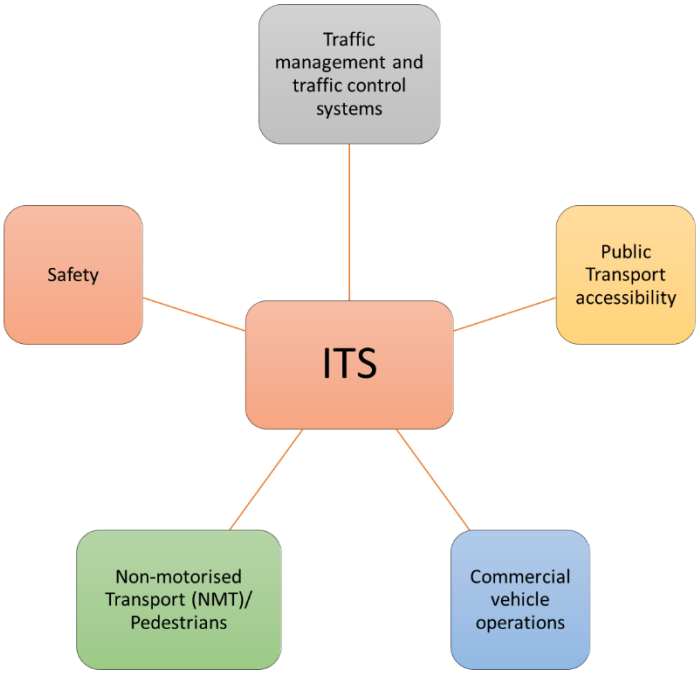
Opportunities

It is estimated that India will become the world's third-largest auto market by 2020. The numbers for electric vehicles however remain underwhelming. SIAM estimates that more than 95% of the electric vehicles on the Indian roads are low-speed electric scooters. According to International Council on Clean Transportation (ICCT), even though the market share of EVs in China is only 1%, more EVs were sold in China in 2015 than in any other country. This point to the latent potential of the Indian market, which is similar in nature to China in terms of car ownership and scale. Similar is the case with ITS technologies, which have just made their foray to the Indian market, with its immense public transport market and unfulfilled potential.

ITS comprises of an entire gamut of technologies that can be used in various ways to obtain efficiency in transport systems. From what we have seen in the earlier sections, it is apparent that only the very little of these have been implemented in the Indian market. This presents immense possibilities, some of which are explored here:

- *Traffic management and traffic control systems*: This in itself represents perhaps the biggest opportunity for application of technologies which have been tried, tested and put to use for decades in the developed world. Almost all signals in urban roads of India still run on pre-timed operations, without sensor actuation. Despite the earlier mentioned failed attempt at implementing the SCOOT based adaptive traffic control systems on the Delhi Bus Rapid Transit (BRT), the various BRT installations in Indian cities offer immense opportunities to implement state-of-art signalling systems like Adaptive Traffic Control Systems (ATCS) and transit signal priority.
- *Accessibility of Public Transport*: ITS has the ability to make transit systems more user friendly with the help of technologies like GPS tracking by providing current information and personalized route planning and optimisation, improving transfers through schedule coordination, automating fare payment and ticketing. [7] Additionally, in India, ITS has ability to connect public transport with feeder systems and intermediate public transport (IPT) for safer and efficient systems for feeder connectivity including aggregators and common mobility cards. This can help increase ridership of high-capacity public transport systems like metro and BRT and develop connected and seamless transport.
- *Commercial vehicle operations and fleet management*: The Indian logistics sector in many ways still lags the global standards. Though RFID is not a new technology, however, India has been slow in developing and using the technology. With the growing Indian economy, manufacturing and exports have substantially risen and logistics as a function is being increasingly outsourced by manufacturers. [15] This points to the immense potential of adapting technology solutions for efficient and safe logistics.

- *ITS for NMT and pedestrians*: Both NMT and pedestrians still account for a large proportion of trips in most Indian cities. In order to develop efficient transport systems, this large section of the trips should be accounted for in any innovation. Hence, this aspect should be kept in mind, during the development that EVs and ITS. Standardization aspects of issues that could be considered include the following, but not limited to:
    - Inclusion of pedestrian and cyclist phases to signals including pelican, puffin, toucan and other known systems worldwide
    - Route guidance and accident avoidance for pedestrians [26]
    - Provision of Non-motorised vehicle (NMV) separation on rural and urban highways to separate high-speed and low-speed vehicles, reduce speed differentials and thereby reduce risk of accidents and fatalities



- *ITS for Safety*: India has the dubious distinction of having the world's most dangerous roads (in terms of accident rates and fatalities). There are several ITS technologies which improve road safety and hazardous conditions. Technology driven solutions like traffic calming devices, variable message signing for detour signing during accidents, collision avoidance systems and on-board warning devices can be low-cost implementations that have a significant effect in reducing accidents.

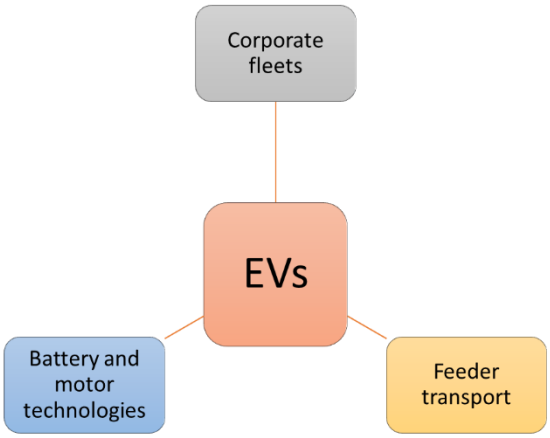
In the case of EVs, several prominent auto companies have announced ambitious plans. Suzuki has planned to set up a lithium ion-battery factory. Tata, Ashok Leyland, Maruti and Mahindra have all announced various measures to invest and increase production and research in electric variants of existing models. JSW Energy has plans to invest in electric cars, batteries, and charging infrastructure. [42]

EVs offer opportunity to OEMs but also pose a threat, as the technology could change the contours of the industry and render large parts of the value chain that has been created over the last decades worthless. This is particularly true for a country like India, where most of the ICE value chain was created after economic liberalization of the mid1990s. [22]

Some specific possibilities for EVs for the Indian market are:

- *Electrification of corporate fleets*: Large Indian cities which have experienced rapid expansion in the past two decades have been grappling with meagre transport systems. A lot of commuter traffic is done by large corporates with the help of private or outsourced taxi fleets, that also bring in ridesharing. These fleets present a large population of cars that can be potentially electrified to provide clean transport.

- *Provision of electric feeder services*: In the past decade, many Indian cities have developed high-capacity public transport systems like metro and BRT. Many of these systems have an inherent deficiency of lack of first mile/last mile connectivity, which is bridged by feeder systems. If high-quality electric feeder systems like e-rickshaws and electric vans are provided on a systematic basis, it will give a big incentive to the public transport as well as make the peripheral transport clean. This segment also offers various other possibilities for low-speed electric vehicles including small and medium sized vans.
- *Battery and motor technologies*: With the planned expansion of EVs on cards, time is ripe for the Indian market to make the next leap in battery and motor technologies, which pave way for more accessible and affordable EVs to consumers. India stands to benefit from mature technologies that the markets such as Japan, Korea has developed, including Lithium-Ion battery technologies and hybrid and induction motors. [37]



In the face of a rapidly evolving market and changing technologies, establishing standards is a way to influence development and reduce risks and costs to stakeholders. In addition, creation of standards helps in the establishment of a larger market for products and consequently generate economies of scale. [38] All of these are reasons why the Indian stakeholders should pursue establishment of standards in EVs and ITS, for a more consistent approach to development of technologies.

Along with the potential, India brings a host of challenges to its potential market, primary of which is an inadequate and inefficient public transport infrastructure. Road and transport infrastructure is crucial for implementation of state-of-the-art technologies and a lack of good roads and infrastructure has been a key deterrent in technology implementation. In addition, there is poor infrastructure for NMT, which occupy a large proportion of the vehicle fleet. Proper NMT facilities have the ability to form crucial links with the high-capacity public transport and personal transport and this alleviate a large part of the traffic concerns of Indian cities. [2]

Challenges in Intelligent Transport Systems (ITS)

Apart from ensuring seamless connectivity of various modes of transport, ITS technologies play an important role in information gathering. Another important benefit of ITS is to advance public transport to make it more attractive than private transport. Improving the quality of public transport through ITS will encourage more usage and therefore reducing traffic issues. The main social and institutional issues facing the deployment of ITS in India are an underdeveloped road network, severe budget restrictions, explosive urbanisation and growth, lack of resources for maintenance and operation and lack of interest among policy makers. [39]

Replication Issues

ITS technologies have the ability of managing traffic flows by making commuters more informed about congestion and safety issues. However, these technologies around ITS in India, cannot be a mere replication of technologies from the developed nations. The technologies will need to be adapted to the complex situation in India, including disorderly traffic with high heterogeneity of vehicles and rapidly evolving economy, after significant research. [40]

Contractual and procurement issues

ITS being a nascent area in India, contractual and procurement issues have often come up in the recent past, resulting in several reissuing of tenders. These have included particular conditions of contract, financial security, flouting of standard procurement norms and problems in concessionaire terms and conditions for Public-Private-Partnership (PPP) designed projects. Also competing tenders at state- or city-level often lead to uncoordinated adoptions of incompatible technologies, generating fragmentation that hampers nationwide and interoperable developments.

Technical issues

For similar reasons of unfamiliarity and unpreparedness, technical issues have also haunted ITS implementations. These range from interoperability issues between various components to improper operations and maintenance of ITS equipment due to lack of proper skilled support staff, resulting in technologies lying waste after implementation.

Coordination and planning

Successful ITS technology implementations almost always have the prerequisite of a robust civil infrastructure. There have been several instances of ITS implementations for public transport that have met an untimely end because they had to be torn down for other planned infrastructure work. [41] This happens mostly due to ill-planned work and lack of coordination, planning and dissemination among various agencies.

Challenges in E-mobility

According to the standardization roadmap for American National Standards Institute (ANSI), for EVs to be successful, the challenges that need to be addressed in the US include safety, affordability, interoperability, performance, and environmental impact. According to the 2011 Deloitte report, the biggest barriers to EV adoption in India include battery charge time, expected purchase price (after government incentives), acceptable price premium, range anxiety, fuel prices, and lack of spare supply parts. That apart, India is a very different market with unique conditions. The major challenges will be as follows:

Lack of charging infrastructure

According to estimates, there are only 100-odd charging stations across India, which makes it difficult for vehicle owners to undertake long travel. This means EVs are still used mostly within city limits.[42] In addition, past surveys have indicated that most EV owners in India do not own the EV as their primary vehicle. This stems from the anxiety caused by an inadequate charging infrastructure. Reports suggested that Mahindra undertook the initiative to install public charging stations in the Bengaluru area, in an effort to boost its EV car sales. Recently, taxi aggregator Ola tied up with oil and gas giant Indian Oil, to set up an EV charging station in the western city of Nagpur. However, setting up city wide charging infrastructure that can adequately serve a decent fleet of EVs looks possible only in the long-term with significant investment.

Consumer acceptance and price sensitivity

One of the key challenges faced by the EV globally is the lack of consumer awareness about EVs and scepticism that persists among consumers while choosing between EV and conventional technology. [43] Traditionally, the Indian consumer is extremely price sensitive and would be hesitant to invest in environmentally friendly products that are too expensive. Unless the battery and other electromobility parts are economically at par with the established ICE engine market, it is difficult for EVs to make a dent in the Indian market. EVs are expensive primarily due to their costly batteries which are mostly imported. The government also plans to set up a lithium-ion battery-making facility under

Bharat Heavy Electricals. [42] In parallel, gradual improvements in the other technologies including motors would bring a decline in the overall costs of EVs and help set the base for market establishment.

Supplier Base and lack of local manufacturing

Although India has a very mature automobile market with various hubs of automotive production and assemblies, for the most part the supplier base is very fragmented. Import of components and batteries is also a major challenge in scaling EV uptake in India. For example, high density batteries that ensure better performance need to be imported, thereby raising the cost of vehicles in India. Indian manufacturing capacities need to be improved considerably in order to reduce dependence on imports. [43] Add to it the nascentness and complexity of the electromobility industry, makes it a difficult proposition for the industry supplier base to develop rapidly.

Financing challenges

A large market like India will face significant challenges in financing the supply chain of a new EV industry. From OEMs to energy services providers, all will have to make adequate financing support to adapt to the new business. [43]

CONCLUSIONS AND RECOMMENDATIONS

In short, there is no quick fix to urban transport problems caused by automotive growth. However, if proper resources and infrastructure are developed, sustainable development options are possible. It is in this context that standardization and technology architecture is so important.

Gaps and Barriers

The implementations of ITS technologies on Indian highways and urban roads have increased manifold in the past two decades. As can be seen from the earlier materials, much of the implementations are on highways, a captive and controlled environment. Due to the complex heterogeneous nature of the Indian urban traffic, it is challenging for many of the state-of-the-art technologies that have been tried and tested in the developed world to be implemented as-is in India. As in other developing countries, a key challenge in ITS adoption will be the coordination of various stakeholders in the public and private sectors, in order to effectively balance multiple objectives and interests in ITS deployment. [27]

If sales of electric vehicles are seen, developments have mostly been in concentrated China, Europe, and the US, which together account for about 90% of the world's electric vehicle sales. These markets are regulating vehicle emissions, offering well-designed incentives, deploying charging infrastructure, and rolling out consumer awareness campaigns to align the market with their electric mobility goals. [44] If India has to succeed in its electric mobility goals, it has to pave a similar approach, considering the market sensibilities and consumer preferences.

The envisioned targets set by NEEMP are very ambitious by any standards. The development of power and charging infrastructure, its management and affordability of EVs is key for the success of electric vehicles. Introduction of EVs on a city-wide level would require charging infrastructure to be integrated into the electricity grid. This calls for cooperation amongst various stakeholders—both regulated and non-regulated. The batteries of electric vehicles can be used to store energy and balance the variability of renewable energy resources but requires very strong and robust ICT which involves large-scale investment.[45] In addition, worldwide it has been observed that stricter regulations in emissions has been a key determinant for increasing penetration of EVs in any market. Ideas can be taken from the case study of Norway, which has put in a mix of measures to become a leader in the EV industry. [23] In parallel, rapid evolution in technology is reducing several of the existing constraints including charging time, battery and motor costs.

Figure 6: EV measures in Norway

Way Forward

It is clear that both EVs and ITS would be paramount to developing a sustainable network of transport systems in India. In order to facilitate that some key factors for paving way towards a more sustainable transport system in India, with a focus on standardization would be:

- *Development of infrastructure:* It is important that the uniqueness of India is recognised and the government stakeholders participate in the infrastructure development in a way that benefits electric mobility and ITS.
- *Development of standards.* Secondly, key standardization bodies of India and their partners work towards developing standards that take into account the uniqueness and complexity of the transport system in India. These local requirements should be tabled at global standardisation platforms for their harmonisation. This will help India in creating common standards while accounting for the Indian uniqueness and complexity, which in turn will ensure its interoperability, bring economies of scale and hence the affordability.

- *Development of technologies:* Lastly, having the infrastructure and standards in place, let the appropriate technologies develop and flourish.

Conclusions

For innovative transport, the future seems quite exciting in India. Despite the scant number of electric vehicles on the roads today, enough progress is being done on the ground for a better future. The electric mobility and ITS initiatives would need to be developed in an integrated manner with peripheral infrastructure and renewable energy sources in order to attain the ultimate goal of energy efficiency and clean environment.

A slew of incentives and projects have been announced in the last several years, of which many have been kick-started including Smart Cities Mission, FAME and Digital India. Make in India is a GoI initiative to encourage companies to manufacture their products in India and includes aspects like enhancing skill development and protecting intellectual property rights. Among the many sectors, several are related to electric mobility and ITS including Automobile, Automobile Components, Aviation, Roads and Highways, Railways, and Renewable Energy. [46] The Ministry of Urban Development (MoUD) has also recently announced the Green Urban Mobility Scheme to address urban mobility

needs of cities. It covers areas like ITS in public transport, promotion of alternate fuels and electric mobility for environmental benefits and urban freight. [47] Starting from the middle of 2017, under the new Goods and Services Tax (GST) regime, EVs are being taxed at 12%, compared to 28% for ICE engines.

At the state level, some states like Maharashtra have announced special subsidies and tax exemptions on EVs and charging stations.

GoI has already shown its intent in leading from the front by opening a bid for 10,000 EVs for government use. Private players are gearing up, with new ventures with foreign collaborators and start-ups being announced in rapid succession.

All of the on-going schemes are adding their weight to the burgeoning areas of electric mobility and ITS in India. The availability of widely recognised standards, and compliance to them, will allow vehicle and technology manufacturers to present their products in India and improve on them with changing circumstances. [18] As a caveat, it must be noted that monetary incentives by themselves have not been able to drive the sales of EV in several places like the US and Europe.

Along with other recent initiatives towards easing business in India, it is expected that proper policy formulation and institutional development that take into consideration the standardization aspects of both ITS and EVs, would pave way for a better all-encompassing transport system in Indian cities and a cleaner environment for healthy and liveable cities.

Standardization is an important activity around the building of an ITS architecture and e-Mobility as it will provide consistency, enhance interoperability and help in expanding market. Developing ITS and e-Mobility technical and service standards are important as it ensures sustainability, compatibility and capacity to expand ITS services.
India has been a global leader in the development and implementation of information and communication technologies (ICT) products and services. In case of ICT, interoperability is a key component hence its standardization shall be a global.

India through its standardization stakeholder community such as BIS, TSDSI, TEC etc. shall more actively participate and engage with global standards development organizations and put forth their local requirements to global platforms such as ETSI, 3GPP, oneM2M. ISO/IEC/JTC1, ITU etc. and get the Indian requirements accepted and harmonized for their standard development and implementation.

Standardization stakeholder community shall also cooperate and collaborate more with regional Standards Development Organizations (SDOs) directly or through their local chapters such as Project SESEI (www.sesei.eu) , India-EU ICT Standardization Collaboration (http://www.indiaeu-ictstandards.in/) to learn, contribute and partner towards creation of global standards. This cooperation and collaboration is potentially valuable for development of indigenous technologies in transport that are suited for the heterogenous traffic conditions of India.

REFERENCES

[1] *Sustainable Transport Development in Developing Countries*, C. Jotin Khisty
[2] *Urban Transport in Developing Countries*, Peter O'Neill, World Bank
[3] *Sustainable Urban Transport: Avoid-Shift-Improve*, GIZ and SUTP
[4] *Standardization Roadmap for Electric Vehicles*, American National Standards Institute, May 2013
[5] *History of ITS*, US Department of Transportation, May 2017. URL: www.its.dot.gov
[6] Wikipedia
[7] *Sustainable transportation for Indian cities: Role of ITS*, P. Chakroborty, Current Science, May 2011
[8] *Intelligent Transport System Project at Mysore City*, URL: http://www.cips.org.in/documents/VC/2014/7th_Nov/Writeup-CIPS.pdf
[9] *Best Practices in Urban Transport,* Institute of Urban Transport, September 2013
[10] *Best Practices for Traffic Signal Operations in India*, Shakti Foundation and IBI Group, April 2016
[11] *Ahmedabad to get Intelligent Traffic System by October*, Traffic InfraTech, August-September 2014
[12] *City bags award for best intelligent transport*, The Hindu, November 4, 2017. URL: http://www.thehindu.com/news/cities/Hyderabad/city-bags-award-for-best-intelligent-transport/article19984335.ece
[13] NHAI launches mobile apps for electronic toll collection, Economic Times report, Aug 17, 2017
[14] *Intelligent Transport Systems (ITS) in India*, D. P. Gupta, UNESCAP Expert Group meeting, October 2016
[15] *Smart Transportation: Transforming Indian cities*, Grant Thornton India, May 2016
[16] *Intelligent Parking Management System*, G. Satheesh, Traffic InfraTech, Volume 5, Issue 6, June-July 2015
[17] *Swinging towards Intelligent Transport Systems: Globally and in India*, D. P. Mishra and G.M. Astutkar, IJEDR Volume 4, Issue 3, 2016
[18] *The Need for Standards in An Emerging Market - The Case of the Electric Vehicle*, P. Van den Bossche. URL: http://etec.vub.ac.be
[19] *Electromobility in India: Attempts at leadership by businesses in a scant space*, A. Chaudhary, German Development Institute, 2014
[20] *Adopting Pure Electric Vehicles: Key Policy Enablers*, White Paper on Electric Vehicles, Society of Indian Automobile Manufacturers, December 2017
[21] *Electric Vehicle Scenarios and a Roadmap for India*, UNEP, November 2014
[22] *Gaining Traction: Will consumer ride the electric vehicle wave?*, Deloitte, August 2011
[23] *The future of Mobility in India: Challenges and opportunities for the auto component industry*, McKinsey/ACMA, September 2017
[24] *Niti Aayog forms panel for 'intelligent' transport*, The Hindu, October 6 2017. URL: http://www.thehindu.com/business/Economy/aayog-forms-panel-for-intelligent-transport/article19813738.ece
[25] *Policy on anvil to pay only for highway stretch used*, Economic Times, October 26, 2017. URL: https://economictimes.indiatimes.com/industry/transportation/roadways/policy-on-anvil-to-pay-only-for-highway-stretch-used/articleshow/61247364.cms
[26] *ITS System Architectures for developing countries*, T. Yokota & R.J. Welland, Technical Note 5, World Bank, July 2004
[27] *ITS for Sustainable Development in Asia and the Pacific*, UNESCAP Working Paper.
[28] *oneM2M and oneTRANSPORT – A global approach to Intelligent Mobility*, oneTransport, May 2017. URL: https://onetransport.io/wp-content/uploads/2017/10/Benefits-White-Paper.pdf
[29] European Commission website. URL: https://ec.europa.eu/transport/themes/its/road/action_plan_en
[30] Department of Heavy Industry, Government of India, April 2015
[31] *Long way to go for electric mobility*, Financial Express, 2016. URL: http://www.financialexpress.com/fe-columnist/long-way-to-go-for-electricmobility/352405/
[32] *Automotive Mission Plan 2016 – 2026*, Society of Indian Automobile Manufacturers (SIAM), 2015
[33] *Electric Bus Market in India*, UITP India. URL: http://www.india.uitp.org/articles/electric-bus-market-in-india

[34] Economic Times, India
[35] *Draft Automotive Industry Standard (AIS), Electric vehicle conductive DC charging system*, September 2016
[36] *Ministry of Heavy Industries circular*, May 15, 2017. URL: http://dhi.nic.in/writereaddata/UploadFile/Standardization%20of%20protocol.pdf
[37] *Cleantech Mapping*, European Business and Technology Centre (EBTC), 2012
[38] *Standards for ITS: A review of the Federal Program*, Transportation Research Board, 2000
[39] *Synthesis report on ITS including issues and challenges in India*, IIT Madras, December 2010
[40] *Intelligent Transport Systems in India*, R. Sen and B. Raman, IIT Bombay,
[41] *BRTS infrastructure on Ahmednagar Road to be brought down for metro work*, Hindustan Times, October 02, 2017
[42] *India is about to embark on the most ambitious electric-car transformation in the world*, Quartz India, September 10, 2017. URL: https://qz.com/1072643/electric-vehicles-india-is-about-to-embark-on-the-most-ambitious-electric-car-transformation-in-the-world/
[43] *Electric Mobility Paradigm Shift: Capturing the opportunities*, Yes Bank and TERI, February 2018
[44] *The transition to electric cars: How can policy pave the way?*, N. Lutsey, International Centre for Trade and Sustainable Development, October 2017
[45] *A long way to go for electric mobility*, R. N. Nayak, Financial Times, August 20, 2016
[46] *India Leaps Ahead: Transformative Mobility Solutions for all*, NITI Aayog and Rocky Mountain Institute, May 2017
[47] *Green Urban Mobility Scheme – Challenges ahead*, My Voice, 8 May, 2017. URL: http://myvoice.opindia.com/2017/05/green-urban-mobility-scheme-challenges-ahead/

CEN - European Committee for Standardization
CENELEC – European Committee for Electrotechnical Standardization
ETSI - European Telecommunications Standards Institute
EC - European Commission
EFTA – European Free Trade Association

SESEI
C/o EBTC, DLTA Complex, 1st Floor,
1, Africa Avenue, New Delhi 110029
Tel: +91 11 33521525, Fax: +91 11 33521501, http://www.
sesei.eu