Towards a Single and Innovative European Transport System

International Assessment and Action Plans of the Focus Areas

Final Report

July 2017

VDI | VDE | IT

Wuppertal Institut

CERTH
CENTRE FOR RESEARCH & TECHNOLOGY HELLAS

European Commission
Directorate-General for Mobility and Transport
Directorate B – Investment, Innovation & Sustainable Transport
Unit B3 – Innovation and Research

Contact e-mail: MOVE-B3-SECRETARIAT@ec.europa.eu

Authors:
Angelos Bekiaris, Centre of Research and Technology Hellas, CERTH
Oliver Lah, Wuppertal Institute for Climate, Environment and Energy
Matina Loukea, Centre of Research and Technology Hellas, CERTH
Gereon Meyer, VDI/VDE Innovation + Technik GmbH
Beate Müller, VDI/VDE Innovation + Technik GmbH
Shritu Shrestha, Wuppertal Institute for Climate, Environment and Energy
Sebastian Stagl, VDI/VDE Innovation + Technik GmbH

Luxembourg: Publications Office of the European Union, 2017

ISBN 978-92-79-71640-9
doi: 10.2832/006045

Towards a Single and Innovative European Transport System

International Assessment and Action Plans of the Focus Areas

Final Report

July 2017

Abstract

The study "Towards a Single and Innovative European Transport System" is developing action plans for the establishment of an integrated transport system in Europe. This report was created in a joint effort between VDI/VDE Innovation + Technik GmbH (Germany), Wuppertal Institute for Climate, Environment and Energy (Germany) and the Centre of Research and Technology Hellas, CERTH (Greece) on behalf of the European Commission's DG MOVE. Focus of the report is the international assessment of six different countries – Brazil, China, India, Japan, South Korea, USA – in five focus areas across all transportation modes. It provides actions plans on how to overcome existing European barriers towards a single and innovative European Transport System based on best practices and lessons learned in the countries under study. In addition to the actions plans, the study also provides recommendations for international collaboration.

Authors

Angelos Bekiaris, Centre of Research and Technology Hellas, CERTH
Oliver Lah, Wuppertal Institute for Climate, Environment and Energy
Matina Loukea, Centre of Research and Technology Hellas, CERTH
Gereon Meyer, VDI/VDE Innovation + Technik GmbH
Beate Müller, VDI/VDE Innovation + Technik GmbH
Shritu Shrestha, Wuppertal Institute for Climate, Environment and Energy
Sebastian Stagl, VDI/VDE Innovation + Technik GmbH

Contact

Study Coordinator: Dr Gereon Meyer, email: gereon.meyer@vdivde-it.de

The team would like to thank Maria Carbone and the Commission staff for their constructive feedback and inputs throughout the process.

Berlin, 19 July 2017

Client	European Commission, DG MOVE
Title	Final Report – Towards a Single and Innovative European Transport System: Lot 2 - International Assessment and Action Plans of the Focus Areas

Executive Summary

This report has been created in the context of the study “Towards a Single and Innovative European Transport System” that develops action plans on how to create an integrated European transport system. Thereby it takes into account the European Commission’s White Paper on Transport. The overall goal of the study is to identify barriers within Europe and to find best practices in the international arena that can be potentially translated to the European context to overcome these barriers. Subject of this report is the international assessment conducted as part of the contract concerning “International assessment and action plans of the focus areas”, i.e. Lot 2 of the original call for tenders.

The Focus Areas are built on five thematic transport research areas in accordance with the Strategic Transport Research and Innovation Agenda (STRIA): (1) connected driving and automation of transport, use of automated optimization of traffic flows, (2) transformation of infrastructure to address connectivity, resilience, new fuels and energy efficiency, (3) smart mobility services (including provision and use of data, and urban mobility), freight and logistics, (4) standardization and interoperability, and (5) alternative fuels other than electrification.

In light of the growing globalization with increasing co-operation between nation states and the elimination of cultural and political differences, learning from each other not only creates opportunities for international collaboration and transfer of knowledge but also reduces redundancies and the likelihood of taking faulty measures. Therefore, analysing other countries’ best practices and lessons learned of successful transportation initiatives and activities is beneficial. The countries in focus – Brazil, China, India, Japan, South Korea and United States of America – represent both highly industrialized as well as industrializing nations with different challenges.

In order to be able to identify best practices, first, a comprehensive picture of the status quo of the transport systems has been drawn. This has been achieved by conducting a state-of-play analysis of the respective countries along their transportation value chain from research to industry and market across all modes. Based on these, an analysis on each country’s strengths, weaknesses, opportunities and threats (SWOT) has been undertaken in all focus area. In addition a Porter’s 5-Forces analysis has been conducted to show the dynamics of one particular value chain in each country. Through this approach the maturity degree of each country’s transport system has been assessed and rated on a five-point scale (see Figure 1). Even though each country has its specific challenges to cope with, many countries seem to be driven by the same societal problems evoking technological and infrastructural shifts. The assessment shows that USA and Japan are leading in almost all of the analysed focus areas. Both China and Korea also benefit from their relatively favourable traffic environments. However, in both countries opportunities have yet to be exploited. Compared to these four countries Brazil and India are lagging behind in all Focus Areas due to disadvantageous framework conditions. Europe’s maturity degree, which is juxtaposed to the thorough analysis, is perceived to be comparable with the highest degrees in the study for Focus Area 1 and 2 and in the middle range for Focus Areas 3, 4 and 5.

Based on these analyses best practices and lessons learned were identified, characterized and eventually analysed in terms of their feasibility for the European situation. Valuable examples were found in all countries and focus areas (see Figure 2). To enhance the international assessment, four best practices outside of the study’s scope were added to the analysis. Where the feasibility analysis returned positive results and where lot 1 identified barriers, actions were defined on how to enable a transfer of the practices to the European context to overcome existing hurdles within the European Union. All actions were synthesized into action plans consisting of activity fields for which the European status quo was assessed and overarching goals formulated. Additionally, responsibilities, time frames (2020, 2030, 2050) and measurements for success have been defined.

In a last step recommendations for international collaboration between the European Union and countries under study have been identified. These recommendations address the strengthening of the EU competitiveness, market access issues, the contribution to dealing with global challenges and the identification of global players and programmes for enabling collaboration, cooperation and joint initiatives.

Résumé

Ce rapport intérimaire a été rédigé dans le cadre de l'étude «Vers un système de Transport Européen unique et innovant». Il prend ainsi en compte le Livre blanc de la Commission européenne sur les transports. L'objectif principal de cette étude est de soutenir l'établissement d'un système de transport intégré, en identifiant les obstacles en Europe et de repérer les bonnes pratiques dans l'arène internationale qui pourraient être retranscrites dans le contexte Européen afin de surmonter ces obstacles.

Les secteurs d'intérêts sont construits autour de 5 domaines de recherche thématiques dans les transports conformément au Livre Blanc sur les Transports ainsi qu'au plan stratégique de recherche et d'innovation en matière de Transports (STRIA): 1) La conduite connectée et l'automatisation des transports, 2) La transformation des infrastructures, 3) Les services liés à la mobilité intelligente, le transport de marchandises et la logistique, 4) la standardisation et l'interopérabilité, et 5) les carburants alternatifs, autres que l'électrification.

A la lumière de la globalisation croissante impliquant un renforcement des coopérations entre états-nations et l'élimination des différences culturelles et politiques, apprendre les uns des autres crée des opportunités de collaborations internationales et de transfert de connaissances tout en réduisant les redondances et la probabilité de prendre des dispositions inadaptées. C'est pour cette raison qu'il est propice d'analyser les bonnes pratiques établies dans d'autres pays ainsi que les leçons retenues de initiatives et activités fructueuses dans le domaine des transports. Les pays concernés ont Brésil, Chine, Corée du Sud, Etats-Unis d'Amérique, Inde et Japon.

Afin de pouvoir identifier les meilleures pratiques, on a d'abord dressé un tableau complet du statu quo des systèmes de transport. Cela a été réalisé en effectuant une analyse de l'état de la situation des pays respectifs le long de leur chaîne de valeur de transport, de la recherche à l'industrie et au marché dans tous les modes. Sur cette base, une analyse des forces, des faiblesses, des opportunités et des menaces (SWOT) de chaque pays a été entreprise dans tous les domaines d'intervention. De plus, une analyse des cinq forces de Porter a été menée pour montrer la dynamique d'une chaîne de valeur particulière dans chaque pays. Grâce à cette approche, le degré de maturité du système de transport de chaque pays a été évalué et noté selon une échelle de cinq points (voir Figure 1). Même si chaque pays a des défis spécifiques à relever, de nombreux pays semblent être motivés par les mêmes problèmes sociétaux qui évoquent les changements technologiques et infrastructurels. L'évaluation montre que les États-Unis et le Japon sont à la pointe dans presque tous les domaines d'étude analysés. La Chine et la Corée bénéficient également de leur environnement de trafic relativement favorable. Cependant, dans les deux pays, les opportunités n'ont pas encore été exploitées. Par rapport à ces quatre pays, le Brésil et l'Inde sont à la traîne dans toutes les zones thématiques en raison de conditions des cadres défavorables. Le degré de maturité de l'Europe est perçu comme étant comparable aux plus hauts degrés de l'étude pour les zones de focalisation 1 et 2 et au milieu pour les domaines d'intervention 3, 4 et 5.

Sur la base de ces analyses, les meilleures pratiques et les leçons apprises ont été identifiées, caractérisées et finalement analysées en termes de faisabilité pour la situation européenne. Des exemples précieux ont été trouvés dans tous les pays et domaines cibles (voir Figure 2). Pour améliorer l'évaluation internationale, quatre pratiques exemplaires en dehors de la portée de l'étude ont été ajoutées à l'analyse. Lorsque l'analyse de faisabilité a donné des résultats positifs et que le lot 1 a identifié des obstacles, des actions ont été définies sur la manière de permettre un transfert vers le contexte européen. Toutes les actions ont été synthétisées en plans d'action composés de domaines d'activité pour lesquels le statu quo européen a été évalué et des objectifs globaux formulés. De plus, les responsabilités, les délais (2020, 2030, 2050) et les mesures de succès ont été définis.

Dans une dernière étape, des recommandations pour la collaboration internationale entre l'Union Européenne et les pays étudiés ont été identifiées. Ces recommandations visent le renforcement de la compétitivité de l'UE, les questions d'accès aux marchés, la contribution à la résolution des problèmes mondiaux et l'identification d'acteurs et de programmes mondiaux permettant la collaboration, la coopération et les initiatives conjointes.

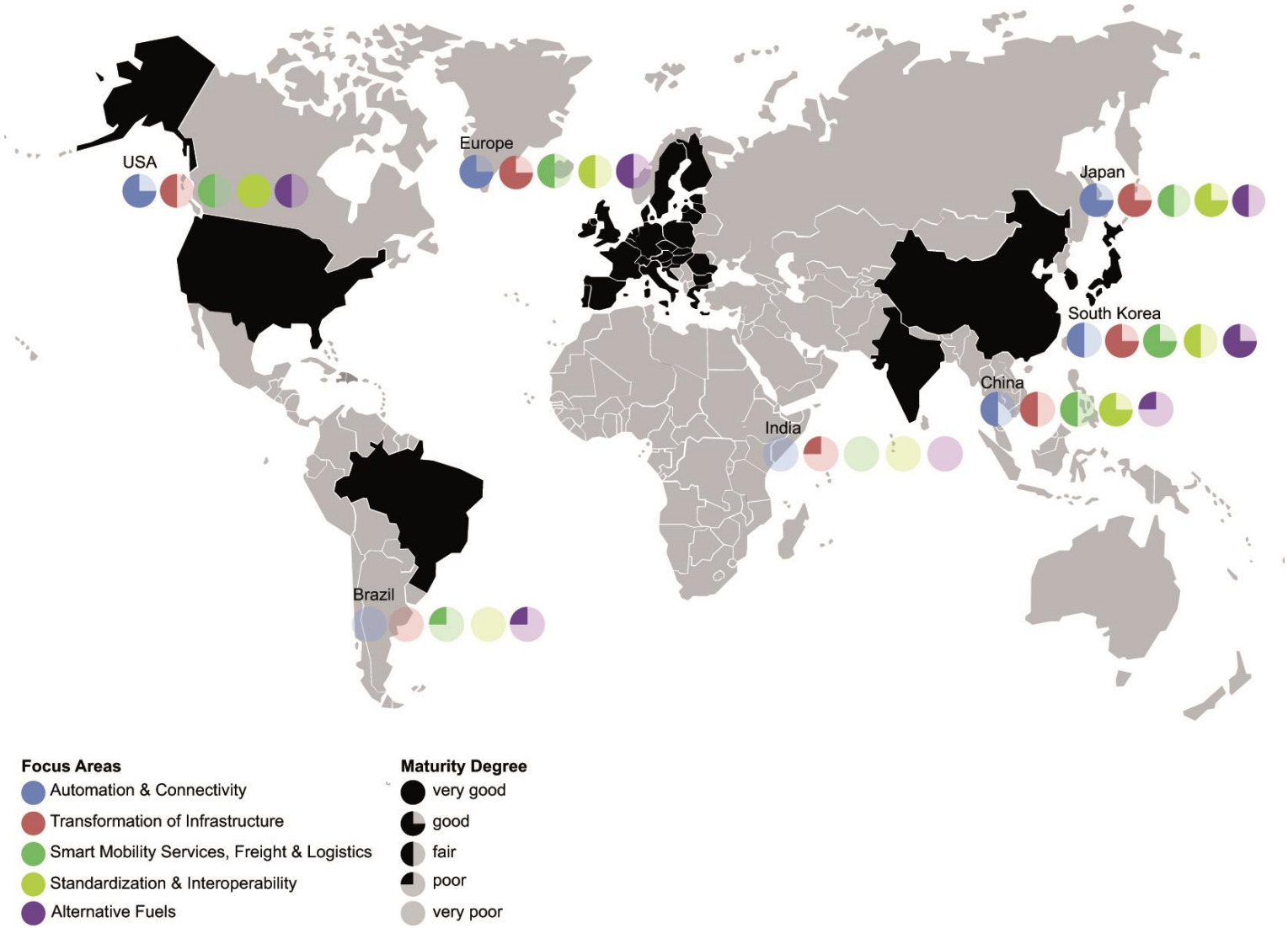


Figure 1: Degree of maturity of the integrated transport system along the focus areas in six countries and in Europe

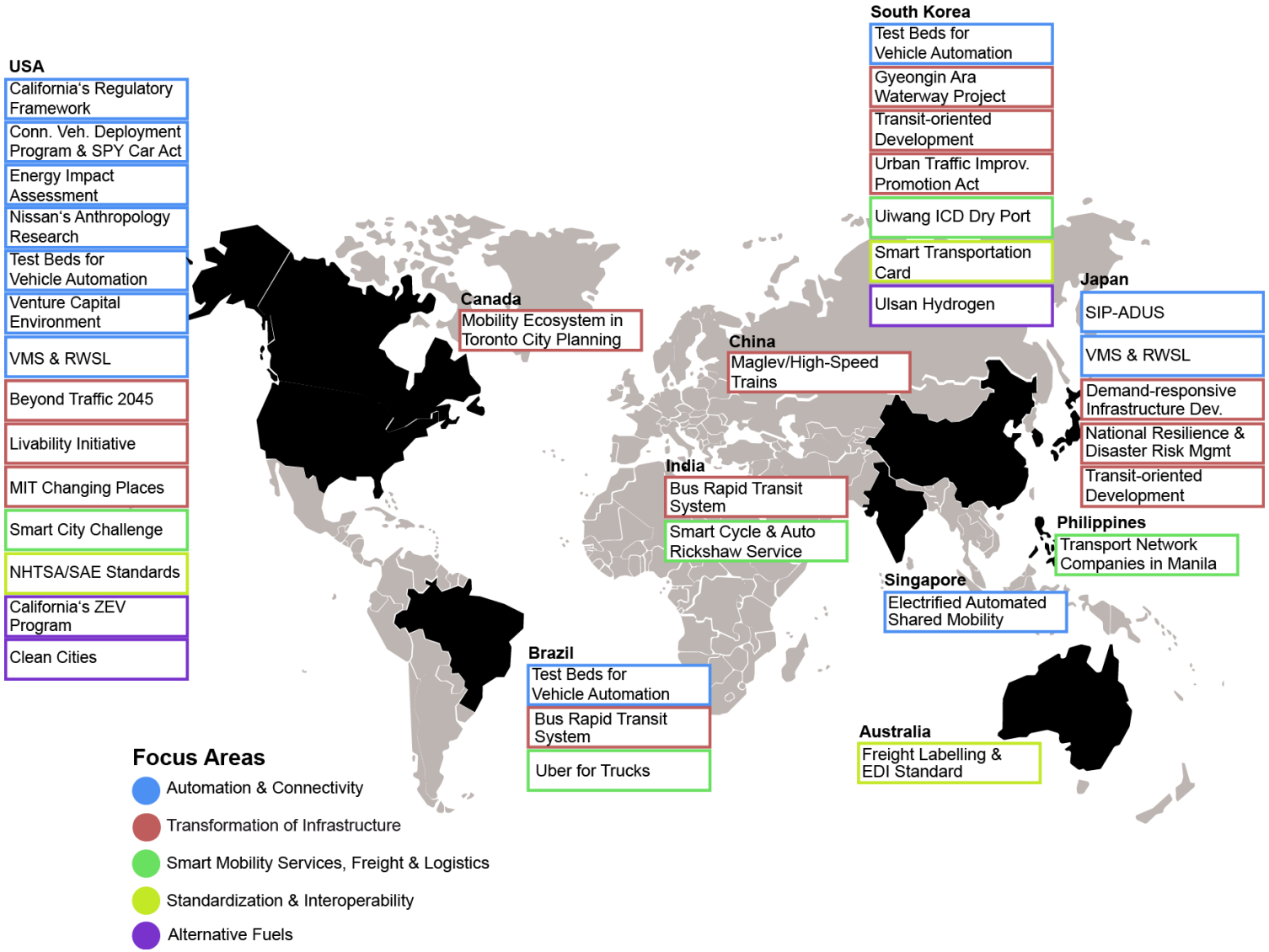


Figure 2: Best practices and lessons learned of integrated transport system along the focus areas in selected countries

Table of Contents

List of Figures

List of Abbreviations

AAI	Airports Authority of India
ADB	Asian Development Bank
ADS-B	Automatic Dependent Surveillance-Broadcast
ADU	Autonomous Driving Unit
AFC	Automatic Fare Collection
AFDC	Alternative Fuels Data Centre
AFV	Alternative Fuel Vehicles
AGT	Automated Guideway Transit
AGV	Automated Guided Vehicle
AHS	Advanced Cruise-Assist Highway
AIIB	Asian Infrastructure Investment Bank
AJTP	ASEAN-Japan Transport Work Plan
ALC	Australian Logistics Council
AMRUT	Atal Mission for Rejuvenation and Urban Transformation
ANATEL	Agência Nacional de Telecomunicações
ANP	National Agency of Petroleum
ANPR	Automatic Number Plate Recognition
APM	Automated People Mover
AQSIQ	General Administration of Quality Supervision, Inspection and Quarantine
ARAI	Automotive Research Association of India
ARB	Air Resources Board
ARIWS	Autonomous Runway Incursion Warning Systems
ART	Advanced Rapid Transit
ASCE	American Society of Civil Engineers

ASV	Advanced Safety Vehicle
ATC	Automatic Train Control
ATO	Automatic Train Operation
ATS	Automatic Train Stop
ATTRI	Accessible Transportation Technologies Research Initiative
AUV	Asian Utility Vehicles
AV	Automated Vehicles
AV OS	Autonomous Vehicle Operating System
AVF	Alternative Vehicle Fuels
AVLS	Automatic Vehicle Location System
BASt	German Federal Highway Institute
BDD	Berkeley Deep Drive
BGGEY	Billion Gallons of Gasoline Equivalent per Year
BIS	Bureau of Indian Standards
BMS	Bus Management System
BOT	Built-Operate-Transfer
BRT	Bus Rapid Transit
BS	Bharat Stage
BTEC	Beijing Transport Energy Environment Centre
BVLS	Beyond Visual Line of Sight
CAAC	Civil Aviation Administration
CAAC	China’s Civil Aviation Authority
C-ACC	Cooperative Adaptive Cruise Control
CAF	Corporacion Andina de Fomento
CAGR	Compounded Annual Growth Rate

Caltrans	California Department of Transportation
CATARC	China Automotive Technology and Research Center
CATS	China Academy of Transportation Science
CBTC	Communication-based train control
CCD	Charge-Coupled Device
CER	Certified Emission Reductions
CESVI	Centro de Experimentação e Segurança Viária (Experimental and Road Security Center)
CET	Engenharia de Trafego
CHP	California Highway Patrol
CIBiogás	International Centre for Biogas
CNG	Compressed Natural Gas
CNIS	China National Standardization Institute
CNPq	Brazilian Council for Scientific and Technological Development
CNY	Chinese Yuan (Renminbi)
CO	Carbon Monoxide
CO	Cabinet Office
COMTRAC	Computer-Aided Traffic Control
Copersucar	Cooperativa de Produtores de Cana-de-Acucar, Acucar e Alcool do Estado de Sao Paulo
COSYS	Cargo Operating System
CPC	Communist Party of China
CRN	Core Road Network
CS	Cabinet Secretariat
CTC	Centralized Traffic Control
CV	Connected Vehicle
CVRIA	Connected Vehicle Reference Implementation Architecture

DART	Dallas Area Rapid Transit
D-ATIS	Digital-Automatic Terminal Information Service
DCL	Departure Clearance
DIMTS	Delhi Integrated Multi-Modal Transit System Ltd.
DMS	Dynamic Message Signs
DMV	Department of Motor Vehicles
DoE	U.S. Department of Energy
DOTC	Department of Transportation and Communication
DRM	Disaster Risk Management
DRT	Demand-Responsive Transport
DSRC	Dedicated Short Range Communications
EDI	Electronic Data Exchange
EDP	Electronic Data Processing
EPA	U.S. Environmental Protection Agency
EPAct	Energy Policy Act
EST	Eastern Standard Time
ETC	Electronic Toll Collection
ETCS	Electronic Toll Collection System
ETMS	Expressway Traffic Management System
EV	Electric Vehicle
FAA	Federal Aviation Administration
FAST	Fixing America's Surface Transportation
FCI	Future City Institute
FDI	Foreign Direct Investment
FHWA	Federal Highway Administration

FTA	Federal Transit Administration
FTC	Federal Trade Commission
FYP	Five-year Development Plan
GAIL	Gas Authority of India Ltd.
GEJE	Great East Japan Earthquake
GHG	Greenhouse Gas
GIS	Geographic information system
G-ITS	Green Intelligent Transport Systems
GLONASS	Global Navigation Satellite System
GPRS	General Packet Radio Service
GPS	Global Positioning System
GRISTEC	National Association of Risk Management and Tracking and Management Technology Companies
GRS–IBS	Geosynthetic Reinforced Soil-Integrated Bridge System
GTX	Great Train eXpress
HC	Hydrocarbons
HOV	High-Occupancy Vehicle
HSR	High Speed Rail
HSR-350x	High-speed rail 350-km/h
HSST	High Speed Surface Transport
HUD	U.S. Department of Housing and Urban Development
HySUT	Hydrogen Supply/Utilization Technology
HyTReC	Hydrogen Energy Test & Research Centre
IC	Integrated Circuit
ICD	Inland Container Depot
ICMC	Mathematics & Computer Science Institute

ICT	Information and Communications Technology
IDC	International Data Corporation
IEC	International Electrotechnical Commission
IFC	International Finance Corporation
IGIA	Indira Gandhi International Airport
IGL	Indraprastha Gas Ltd.
IIMs	Indian Institutes of Management
IISC	Indian Institute of Science
IIT	Indian Institutes of Technology
IMO	International Maritime Organization
ImPACT	IMpulsing PAradigm Change through disruptive Technologies
INCT-SEC	National Science & Technology Institute for Critical Embedded Systems
IoT	Internet of Things
ISO	International Organization for Standardisation
Isro	Indian Space Research Organisation
ITCS	Integrated Traffic Control Systems
ITDP	Institute for Transportation and Development Policy
ITS	Intelligent Transport System
ITS JPO	Intelligent Transport System Joint Program Office
JAFA	Japan Aircargo Forwarders Association
JAP	Japan Airlines
JARI	Japan Automobile Research Industry
JARTIC	Japan Road Traffic Information Center
JCAB	Japan Civil Aviation Bureau
JIFFA	Japan International Freight Forwarders Association

JNNURM	Jawaharlal Nehru National Urban Renewal Mission
JNR	Japanese National Railway
JR	Japan Railway
JSTRA	Japan Ship Technology Research Association
KAICA	Korea Auto Industries Cooperation Association
KAMA	Korean Automobile Manufacturers Association
KATS	Korean Agency for Technology and Standards
KCSI	Korean Customer Satisfaction Index
KEC	Korea Expressway Corporation
KOTI	The Korea Transport Institute
KRRI	Korean Rail Research Institute
KS	Korean Industrial Standards
KSA	Korean Standards Association
KTX	Korea Train eXpress
KUL	Kookmin Unmanned Vehicle Laboratory
L&T IDPL	L&T Infrastructure Development Projects Limited
LED	Light Emitting Diodes
LGV	Laser Guided Vehicles
LNG	Liquefied Natural Gas
LPG	Liquefied Petroleum Gas
LPGV	Liquefied Petroleum Gas Vehicles
LRT	Light Rail Transit
LTC	Lane Trace Control
LTE	Long Term Evolution Wireless Broadband Technology
M2M	Machine-to-Machine Technology

MAFF	Ministry of Agriculture, Forestry and Fisheries, Japan
MAP	Machine Advanced Processor
MART	Montachusett Area Regional Transit Authority
MCMV	Minha Casa Minha Vida
MDR	Major District Roads
METI	Ministry of Economy, Trade and Industry, Japan
MIC	Ministry of Internal Affairs and Communications, Japan
MIIT	Ministry of Industry and Information Technology, China
M-ITS	MART's Integrated Traveller Services
MLIT	Ministry of Land, Infrastructure, Transport and Tourism, Japan
MLTM	Ministry of Land, Transport and Maritime Affairs, South Korea
MoD	Mobility on Demand
MOE	Ministry of Environment, Japan
MoF	Ministry of Finance, China
MOLIT	Ministry of Land, infrastructure and Transport, South Korea
MoRTH	Ministry of Road Transport and Highways, India
MOTIE	The Ministry of Trade, Industry and Energy, South Korea
MoUD	Ministry of Urban Development, India
MSAA	Mobility Services for All Americans
MSR	Maritime Silk Road
NDRC	National Development and Reform Commission
NEDO	New Energy Technology Development Organization
NGV	Natural Gas Vehicles
NHAI	National Highways Authority of India
NHTSA	National Highway Traffic Safety Administration

Nicera	Nippon Ceramic Co. Ltd.
NICT	National Institute and Communications Technology, India
NMT	Non-Motorised Transport
NOX	Nitrogen Oxides
NPA	National Police Agency
NRTP	National Road Transport Technology
NTIC	National Transport Information Centre
NWCMC	Nanded Waghala City Municipal Corporation
OBOR	One Belt, One Road
OBU	On-Board Unit
OD	Origin-Destination
OEM	Original Equipment Manufacturer
PAC	Programa de Aceleração do Crescimento
PEV	Plug-In Electric Vehicle
PIC	Passenger Information Control
PIL	Logistics Investment Program, Brazil
PIMAC	Public and Private Infrastructure Investment Management Center, Korea
PM	Particulate Matter
PNMU	Política Nacional de Mobilidade Urbana
PNPB	National Program for Production and Use of Biodiesel
PPP	Public-Private Partnership
PRC	Programmed Route Control
PRT	Personal Rapid Transport
REL	Runway Entrance Lights
RFS	The Renewable Fuel Standard

RGV	Rail Guided Vehicles
Rinfra	Reliance Infrastructure Ltd.
RIT	Rede Integrada de Transporte ("Integrated Transport Network")
RLSVDS	Red Light-Stop Line Violation & Detection System
RNG	Renewable Natural Gas
RTN-X	Automated Transportation and Sorting Vehicles
RTRI	Railway Technical Research Institute
RWSL	Runway Status Lights
SAC	China Standardization Administration
SASAC	State-owned Assets Supervision and Administration Commission, China
SCMaglev	Super Conducting Maglev
SESEI	Seconded European Standardisation Expert for India
SFC	Smart Freight Centre
SIAM	Society of Indian Automobile Manufacturers
SIP-ADUS	Strategic Innovation Promotion Program – Automated Driving for Universal Services
SKY-RAV	Automated Overhead Travelling Vehicles
SLB	Service Level Benchmarks
SME	Medium-sized Enterprise
SOFC	Solid Oxide Fuel Cell
SPY Car	Security and Privacy in Your Car Act
SREB	Silk Road Economic Belt
STBG	Surface Transportation Block Grant Program
STI	Science, Technology & Innovation
STP	Surface Transportation Program
Sulgás	State Gas Company

TCR	Trans-China Railway
TED	Transport Engineering Department
TEDC	Transport Engineering Division Council
TEU	Twenty Foot Equivalent Unit
THL	Take-off Hold Lights
THRSL	The Hi-Tech Robotic Systems Ltd.
TIGER	Transportation Investment Generating Economic Recovery
TMCC	Transportation Management Coordination Center
TMGR	Trans-Monogolian Railway
TMR	Trans-Manchurian Railway
TNC	Transport Network Companies
TNC	Transport Network Companies
TOD	Transit-Oriented Development
TOPIS	Traffic Operation Information Service
TSR	Trans-Siberian Railway
UAS	Unmanned Aircraft Systems
UAV	Unmanned Aerial Vehicles
UFES	Federal Universities of Espíritu Santo
UMFG	Federal Universities of Minas Gerais
UMTRI	University of Michigan Transportation Research Institute
URBS	Urbanização de Curitiba (Urbanization of Curitiba)
USDOT	U.S. Department of Transportation
USP	University of São Paulo
UWR	United We Ride
V2I	Vehicle-to-Infrastructure

V2V	Vehicle-to-Vehicle
V2X	Vehicle-to-Everything
VAC	Virginia Automated Corridors
VC	Venture Capital
VDS	Vehicle Detection Systems
VICS	Vehicle Information and Communication System
VMS	Variable Message Signs
VRA	Vehicle and Road Automation
WAVE	Wireless Access for Vehicular Environments
WG	Working Group
Wi-Trac	Wireless Traffic Signal Controller
WRI	World Resources Institute
YMTL	Ymananashi Test Line

1 Study Outline

This report, carried out according to the contract signed on March 22, 2016 with the European Commission, summarizes the "International assessment and action plans of the focus areas" (lot 2 part) of the study "Towards a Single and Innovative European Transport System". The study's overall goal is to create action plans on how to create a single and innovative European transport system. Thereby it takes into account the European Commission's White Paper on Transport. The main contractor for the lot 2 part is VDI/VDE Innovation + Technik GmbH (Germany). Part of the work is subcontracted to the Wuppertal Institute for Climate, Environment and Energy (Germany) as well as to the Centre for Research and Technology Hellas, CERTH (Greece).

While the lot 1 part of the study (also called SINTRAS, led by JIIP) provides an assessment of ways and possibilities to overcome European barriers, lot 2's task is to investigate best practices and lessons learned in six selected international countries covering highly industrialized and newly industrializing countries, namely USA, Japan, Korea, China, India and Brazil. Lot 2 assesses whether a transfer of these best practices to Europe is beneficial for the advancement towards an integrated European transport system. Lot 2 will further develop action plans and derive recommendations addressing the strengthening of the EU competitiveness, market access issues, the contribution to dealing with global challenges and the identification of global players and programmes for enabling collaboration, cooperation and joint initiatives.

This is insofar important as transportation policies usually lead to irreversible consequences. This problem can be overcome by sharing information on best practices and lessons learned and thus help reduce trial and error. The continuously increasing globalization efforts support this further by fostering the convergence of attributes such as social and physical infrastructure, cultures, politics, societies and economies.

As stated in the Inception Report for lot 2, this Final Report marks the end of the study's three-step approach. The main outcome of the first step is an analysis of the state of play of the transport system in each focus area regarding its advancing towards an integrated transport system in the respective country (chapter 3). Through this analysis the structure of the transport system, related industries, markets as well as the regulatory framework and the financing system of funding programmes can be revealed. This investigation provides comprehensive information on the relevant regulatory and policy framework conditions and the structures of transport-related industries and value chains, the state of the art of R&D and technologies, methods for financing, innovation in transport and related business models especially in regard of an integrated transport system. Additionally, the respective key players as well as the dynamics in the value chains were identified. These findings will enable an understanding of the structures and dependencies among players as well as the effectiveness of means and mechanisms in the mutual inter-dependency of legislative, industrial and demand side powers.

The standardized and well-structured assembly of the results of the SWOT analyses supports the assessment and help to weigh the relevance of findings. To increase the understanding of outcomes, the results are visualized in a world map to facilitate stakeholder involvement by making it easily and quickly accessible for the reader. In addition one Porter's 5-Forces analysis was established to show different market dynamics in various industries in the countries under study.

Through this approach it was possible to identify best practices and lessons learned in all Focus Areas and analyse countries under study along the entire value chain (chapter 4). All of these best practices and lessons learned are again depicted in a world map to give an overview of international findings. To be able to derive action plans out of the identified best practices, they were first characterised and analysed in terms of their feasibility for Europe. Where this analysis returned positive results, actions were derived to be taken between today and 2050 (chapter 5).

In a last step recommendations for international co-operations are given, based on study outcomes, and especially as put forward during the Expert and Stakeholder Workshops (chapter 6) as well as where no international best practices could be identified.

Before the results are shown, this chapter explains the aim, background and policy context of the study. Additionally, the Focus Areas are specified and discussed, also in view of the difference to lot 1's understanding. Chapter 2 will continue with a brief overview of the methodological approach and stakeholders consulted.

Analyses were conducted along the following Focus Areas as specified in the tender and the inception report:

1) Connected driving and automation of transport, use of automated optimization of traffic flows
2) Transformation of infrastructure to address connectivity, resilience, new fuels and energy efficiency
3) Smart mobility services (including provision and use of data, and urban mobility), freight and logistics
4) Standardization and interoperability
5) Alternative fuels other than electrification

To guarantee consistency throughout the study the Focus Areas have been colour-coded. Through this approach, it was possible to easily allocate outcomes in all steps in relation to each other, and additionally assemble results in different ways without losing orientation.

Like lot 1 we also recognize that there are many overlaps and inter-dependencies between the five areas such as Focus Area 3 dealing with technological advances already presented in Focus Area 1 or that infrastructural questions of logistics/freight are already dealt with in Focus Area 2. Regarding Focus Area 4 we come to the same conclusion that it cuts horizontally across all the other focus areas. Along with lot 1, we avoided the duplication of results by covering the overlap area in one focus area only but tried to refer to it where applicable in order to guarantee cross-feeding and comprehensiveness of information.

Even though we perceive the same interdependencies as lot 1, we identified the following differences in the understanding of the Focus Areas compared to lot 1:

- Focus Area 1: Whereas lot 1 limits its analysis on connected driving and automation of transport, and use of automated optimisation of traffic flows, we would add an item on "Automation of Transport in Modes other than Road" as automation is widely deployed in aeronautics and of increasing importance in rail and waterborne.
- Focus Area 2: Transformation of infrastructure to address connectivity, resilience, new fuels and energy efficiency. For resilience we would suggest to refer not only to climate change related disasters but also to security issues.
- Focus Area 3: We would propose to widen the meaning of Smart Mobility Services such that not just very specific IT solutions like payment systems are considered but also comprehensive solutions and service offers such as ride or car sharing.
- Focus Area 4: Lot 1's definition only covers freight and logistics. We would suggest extending this definition to personal mobility as there are a lot of standardization issues in automation and smart mobility services for passenger transport.

The understanding of the Focus Areas is still subject for discussion in continuous proceedings.

Despite the fact that electrification is particularly exempted from the analysis it has become clear throughout the study that it is an aspect that shall not be neglected since most countries under analysis, as well as Europe, have decided to opt for the development of this technology rather than other propulsion systems. In fact, it is not only perceived as one of the three big automotive revolutions (together with automation and sharing) but also of growing relevance for other transport modes, especially the aeronautics industry. Even though the topic has not been specifically addressed in Focus Area 5, it was included in other Focus Areas where its impact was perceived to be rather big (e.g. Focus Area 2) or where it made up an important part of a best practice (e.g. Singapore: Electrified Automated Shared Mobility).

2 Methodological Approach and Work Steps

The work of lot 2 is carried out in three steps as depicted in Figure 2. Step 1 constitutes the examination stage of the work. The results were validated in the 1st Validation Workshop. Within step 1, the state of play of the focus areas in each of the selected countries was investigated. This built the basis for the work in step 2, the identification and assessment of international best practices and lessons learned, and step 3, the development of international dimension within high-level clusters. Results from step 3 were validated in the 2nd Validation Workshop.

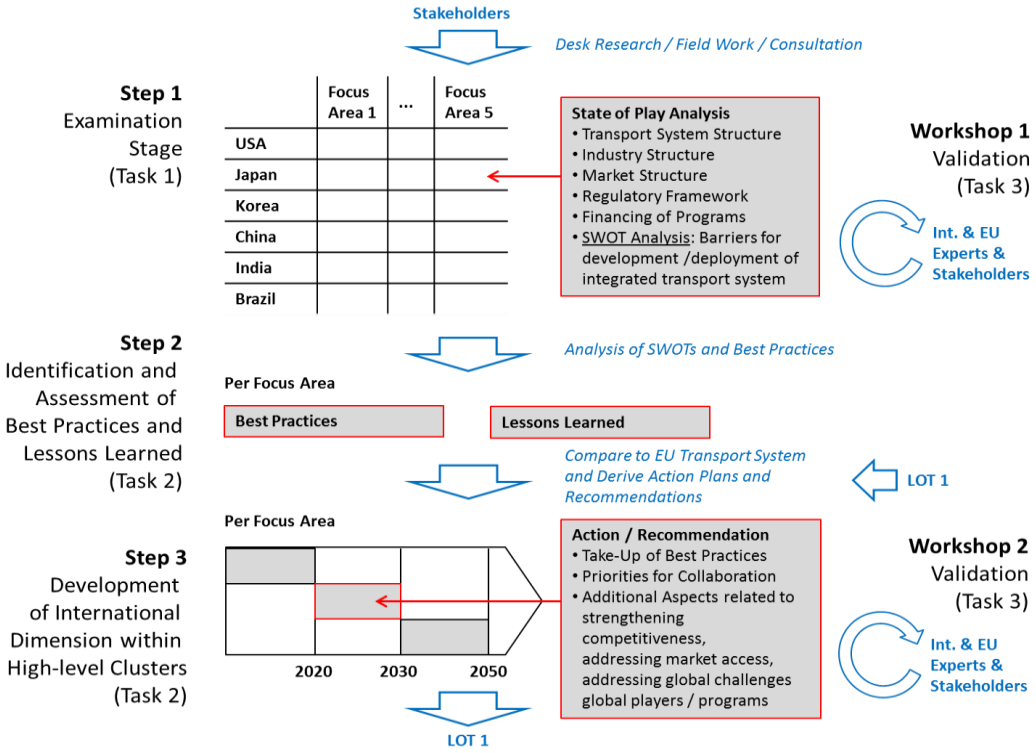


Figure 3: Work flow in lot 2

2.1 Step 1 – Examination Stage

The examination stage involved desk research, field work and stakeholder consultation, based on the partners' extended network of experts acting as "ambassadors" (see chapter 2.4), in order to get an insight into the state of play of the transport research and innovation system within each of the five focus areas in the selected countries. Through a standard data format continuous information on the results of the different partners was guaranteed. Additionally, it helped to identify, early in the process, gaps in the data base as these could then be efficiently addressed by enabling the research team to continuously cross-check. Thus, the standard data format represents an efficient measure for mutual quality control.

2.1.1 Collecting Evidence of the State of Play for all Focus Areas in the Selected Countries

User-friendly surveys and questionnaires for stakeholder consultation covering all relevant aspects of each focus area were established. They focus on national success stories and best practice examples for the development and deployment of innovations that enable integrated and sustainable transport systems. The surveys and questionnaires were designed in such a way that transfer into the standard format was easily achievable. User-friendliness and adaptation to experts' time and availability re-

strictions was guaranteed by allowing participation through web interface (http://www.vdivde-it.de/umfrage/lot2), email, and phone.

The 11th ITS European Congress in Glasgow, United Kingdom, was used as an early-stage opportunity for spreading information and raising awareness of the study in the European context and to establish personal contacts to ambassadors and relevant stakeholders with in-depth knowledge. These contacts were of value for the outcome of the study as well as to identify key persons suitable for the upcoming validation workshops. Close contact to stakeholders was kept during the entire consultation phase in order to uphold their commitment and to ensure relevant and steady feedback.

Complementary and in parallel to the stakeholder consultation, the state of play per focus area in each country was investigated by desk research. Sourcing of content was achieved by scanning scientific journals, relevant newsletters, press and professional publications, relevant websites of identified stakeholder groups, previous studies, policy and strategy documents, etc. Agile interplay of stakeholder consultation and desk research ensured a detailed investigation delivering the necessary facts for the analysis and keeping the focus on barriers and best practices. Knowledge gaps identified through one method were tried to be filled by the other. Finally, the desk research was validated through the stakeholder consultation. Weekly phone conferences were held between the contractor and the subcontractors in order to align the methods, complement the approaches and assess the findings.

2.1.2 Assessing the State of Play per Focus Area and Country

Based on the evidence collected through desk research and stakeholder consultation for each focus area from the viewpoint of the respective country investigated, SWOT analyses on the state of play regarding the integrated transport system were carried out. Based on the state-of-play and SWOT analysis, the performance of selected countries was rated on a five-point scale. The results were visualized in a way that makes the immediate comparison of analysed countries possible by displaying them in pictograms on a world map. The outcomes are additionally juxtaposed to the European situation.

All the results and findings were validated and enhanced in the 1st Validation Workshop involving international experts and European stakeholders. Experts were selected in such a way that the resulting group covered all investigated countries and focus areas. Also delegates from the European Commission and selected relevant European stakeholders shared perspectives and practical experiences in implementing integrated transport solutions.

The workshop also served to collect further best practices and lessons learned from the investigated countries. Specifically, the SWOT analyses that were made for each focus area and each country were discussed on the basis of the report and complemented by practical experiences, expert knowledge of transport policy and the state of the art of technological development. A further aim was to start a discussion about potential fields of international transport research and innovation co-operation with Europe.

2.2 Step 2 – Identification and Assessment of Best Practices and Lessons Learned

Based on the evidence collected in step 1, step 2 delivers best practice examples and lessons learned from the selected countries. Through the systematic analysis in step 1 – that always considered the entire value chain – it was possible to find valuable examples in all focus areas, in all countries and along the entire value chain covering R&D, industry, market, policies and initiatives as well as regulation and legislation. Through a two-fold approach, consisting of a characterisation and a feasibility analysis, information could be gathered on whether the transfer and implementation of the certain best practice or lesson learned would be beneficial for advancing Europe towards an integrated transport system. Thus, step 2 laid a solid basis to derive the international dimension, including action plans, in step 3. The work in step 2 involved desk research, field work and stakeholder consultation. Further important input for best practices and lessons learnt was gained in the 1st Validation Workshop.

2.2.1 Characterisation of Best Practices and Lessons Learned

Each identified best practice was characterized along different categories. These categories comprise of:

- Method of implementation
- Target user group
- Financing
- Business models
- Technologies employed
- Enabling framework
- Other aspects that may be applicable.

The characterisation was done by desk research and, when needed, missing information was retrieved through direct contact to the ambassadors or other relevant stakeholders identified throughout the work.

2.2.2 Assessment of Feasibility of Best Practices and Lessons Learned

Following the characterisation an assessment was undertaken on whether the potential implementation of identified and characterised best practice is feasible in Europe by taking a closer look into the following aspects:

- Availability of Technologies and Know-how within the Necessary Timeframe
- Violation of Legal/Regulatory Framework in the EU
- Necessary Standardization Compliant to EU Standardization Policy
- Available Funding Models
- Public Acceptance due to Cultural Aspects
- Availability of Resources/Raw Materials
- Other Aspects

All best practices which turned out to be feasible were conveyed into single actions that were synthesized into action plans with milestones 2020, 2030 and 2050. The derivation of action plans was undertaken in step 3 of the study.

2.3 Step 3 – Development of International Dimension within High-Level Clusters

Within step 3, the international dimension of the European transport research and innovation cooperation was developed within high-level clusters. Action plans were derived for those best practices and lessons learned that in step 2 had been proven to be applicable and feasible for implementation in Europe in order to support the EU in advancing the integration of the transport system. The work of step 3 was validated through review by relevant European stakeholders and delegates of the European Commission within the 2nd Validation Workshop.

2.3.1 Derivation of Action Plans

In each focus area, actions to be taken are bundled into activity fields. By taking into consideration inner-European barriers identified by lot 1 of the study, not only the status quo but also overarching goals for each activity field was defined. All action items within one activity field shall help attain the goal by overcoming the status quo.

To set clear conditions for each action, not only the activity fields with their status quo and goal were defined but also the area of interest, the timeframe, the responsibility as well as key performance indicators of proposed action. Through the categorisation in different areas – R&D&I, demonstration, manufacturing, skills and education, business models, legislation/regulation, standardization/interoperability, policies/incentives, public/user awareness and infrastructure – roles become clear. The allocation of action items to different time frames – 2020, 2030, 2050 – shall increase the possibility to establish roadmaps on how to create a single and integrated European transport system. Assigning responsibilities for each action item helps manage the different stakeholders in the implementation process. Suggestions for key performance indicators shall facilitate the measurement of the potential success or failure of actions to be taken.

2.3.2 International Co-operation and High-Level Clusters

In addition to these action plans, the results of the SWOT and Porter's 5-Forces analyses as well as the assessment of the best practices and lessons learned pointed to further recommendations for international cooperation. During the 1st Validation Workshop participating experts suggested what best practices or lessons learned shall be transferred to Europe, where Europe shall export its expertise to other countries and where measures are to be taken in a joint effort. During the 2nd Validation Workshop these results together with findings from the action plans were further processed into the following high-level clusters:

1) Strengthening of the EU competitiveness: Measures strengthening the excellence and attractiveness of research and innovation in the European Union will ultimately support its economic and industrial competitiveness. Within the context of international cooperation this will be enabled by global networks and cooperation facilitating the access to external sources of knowledge. Thus, novel approaches and ideas for measures supporting the development and implementation of innovations that advance the integration of the European transport system can be derived and transferred to Europe. Further, agreements on common practices and policies on technological and industrial objectives, common R&D policy objectives and regulatory conditions will optimize the conduction of research and the exploitation of results.

2) Addressing market access issues: Measures to facilitate the access to existing, new or emerging markets including specific trade or development issues will be derived.

3) Contribution to addressing global challenges: Global societal challenges can be tackled more rapidly by developing and deploying effective solutions within international collaborations and by optimizing the use of international and European research infrastructures.

4) Identification of global players and programmes: The identification of key actors and main R&D&I programmes including financing models within the focus areas in each country will enable initiating effective global networks and collaborations and offer the opportunity for joint initiatives or harmonization in R&D&I activities.

As outlined, each of the steps built on preceding steps. Thus, this methodological approach allowed for a consistent, comprehensible and robust analysis starting from the assessment of the state of play in countries under study to the formulation of action plans and potentials for international collaboration.

2.4 Ambassadors

	Connected and Automated Driving	Infrastructure	Smart Mobility	Standardization and Interoperability	Alternative Fuels	General Transport Topics
USA	Steven Shladover, California PATH Program program manager, EERES – COENG Engineering Research, University of California at Berkeley	Jorge A. Prozzi, Professor, Department of Civil, Architectural and Environmental Engineering, University of Texas at Austin	John Halkias, Federal Highway Administration Office of Operations, U.S. Department of Transportation	Joseph McKinney, Consultant	Larry R. Johnson, Director,Transportation Technology Research and Development Center, U.S Department of Energy	Ossama "Sam" Elrahman, Research Coordination and Technology Transfer, Transportation Research & Development Bureau, New York Department of Transportation
	Mohammed Yousuf, Federal Highway Administration		Marie Venner, Consultant			John Munro, University of Maryland
Japan	Takahiko Uchimura, Vice President, ITS Japan	Hironao Kawashima, Professor, Faculty of Science and Technology, Keio University	Shinichi Ishii, Director of Engineering, Business Strategy Consulting Department, Nomura Research Institute, Ltd.	Junichi Hirose, Researcher, Comobility Society Research Center, Keio University	Shinichi Goto, project coordinator, Research Center for New Fuels and Vehicle Technology, National Institute of Advanced Industrial Science and Technology	Hironao Kawashima, Professor, Faculty of Science and Technology, Keio University
South Korea	Seung Ku Hwang, Vice President, Hyper-connected Communication Research Laboratory, Electronics and Telecommunications Research Laboratory	Young-Jun Moon, Research Fellow, Transport Technology Research Group, The Korea Transport Institute (KOTI)	Jae Hak Oh, Vice-President, The Korea Transport Institute (KOTI)	Sang Keon Lee, Vice Director, Global Development Partnership Center, Korea Research Institute for Human Settlements	Ock-Taeck Lim, Professor, Laboratory for Next Generation Fuel & Smart Powertrain, Ulsan University	Young-Jun Moon, Research Fellow, Transport Technology Research Group, The Korea Transport Institute (KOTI)
China	Xiaojing Wang, Chief Engineer, China Research Institute of Highways, Ministry of Transport	Yafeng Yin, Director, Transportation Research Center, University of Florida	Chao Li, China Academy of Transportation Science (CATS)	Miriam Meissner, Research Associate, Mercator Institute for China Studies	Donglian Tian (Ms.), Senior Engineer, China Automotive Technology and Research Center	Xiwen Zhang, Consultant Daizong Liu, World Resources Institute (WRI)
	Philippe Crist, International Transport Forum	Sheldon Qiu, College of Metropolitan Transportation, Beijing University of Technology				
India	Dibyendu Sengupta, Transport Sector Specialist, European Business and Technology Centre	Madhav Pai, Director, EMBARQ India, World Resources Institute	Sameera Kumar, Transport Researcher, India Office, Clean Air Asia	Chhavi Dhingra, Manager Capacity Buidling, World Resources Insitute India	Parthaa Bosu, India Director and South Asia Liaison, India Office, Clean Air Asia	Geetam Tiwari, TRIPP Chair Professor, Department of Civil Engineering, Indian Institute of Technology New Delhi
						Ashish Rao-Ghorpade, Regional Executive Manager SEA, ICLEI
Brazil	Denis Fernando Wolf, Institute of Mathematics and Computer Science Department of Computer Science, University of Sao Paulo	Marcelo Cintra do Amaral BHTRANS)	Daniela Facchini, Projects and Operations Director, EMBARQ Brazil, World Resources Institute	Roberto Gregorio da Silva, Presidente Society of Urbanization URBS	Marcio D'Agosto, Professor, Universidade Federal do Rio de Janeiro	Toni Lindau, Director, EMBARQ Brazil, World Resources Institute
			Magdala Arioli, World Resources Institute		Roberto Schaeffer, Universidade Federal do Rio de Janeiro	

3 State-of-Play Analysis

3.1 Focus Area 1 – Connected Driving and Automation of Transport

3.1.1 Brazil

3.1.1.1 General Information

Autonomous and connected vehicles contribute to improving traffic flow and lowering emissions by communicating their position, speed and the condition of traffic around them to other vehicles and traffic control centers, which can control growing traffic congestion and pollution problems. Automation of transport in Brazil is on the rise together with an integrated traffic controlling system. Up to grade 4 Automation of metro and driverless car/taxi are available in São Paulo. A study by Cisco systems on customer experience stated that Brazil is the most willing to trust autonomous technology or driverless automobiles in which 90% drivers showed the willingness to use self-driving vehicles.[1]

Of the 19 main Brazilian airports listed by Couto et al. for 2015, only four are equipped with the ILS (instrument landing system) category II and only one with (as yet uncertified) category III equipment required to allow for autopilot landings of passenger aircraft (only required/allowed in times of poor visibility).[2] An additional 12 are equipped with CAT I equipment providing only assistance to pilots in times of poor visibility. Related to air traffic control, Departure Clearance (DCL) and Digital-Automatic Terminal Information Service (D-ATIS) systems are being rolled out to 23 airports throughout Brazil (Sao Paulo's and Rio de Janeiro's airports were already equipped).[3] Additionally, Sao Paolo's airport has started the rollout of a real-time cargo-handling automation and monitoring system.[4]

Nothing could be found detailing any automation of maritime or riverine transport in Brazil.

3.1.1.2 Research, Development & Innovation

Various researches are being carried out for driverless car/taxi and trucks in Brazil. A taxi service using an autonomous vehicle is being tested by researchers at the University of SãoPaulo (USP) and travelled on the streets of the city São Carlos in São Paulo State in 2013. It is used through a smartphone app and customers will input the destination by voice command or use a touch screen inside the car. The taxi will then return to its parking spot to await the next call. CARINA, the Intelligent Robotic Car for Autonomous Navigation (Carro Robótico Inteligente para Navegação Autônoma, in Portuguese), is only one of the autonomous cars under development in Brazil. Others are in the process of development at the Federal Universities of Minas Gerais (UMFG) and Espírito Santo (UFES). Autonomous trucks are also under development by the São Paulo group researchers. Various devices fitted to the truck for the autonomous system can control every movement, including small motors to control the steering wheel and brakes. Speed is controlled by an electronic circuit attached to the accelerator. Likewise, cameras, GPS antennas, and sensors were also fitted.

Swedish company Semcon is also going to develop autonomous vehicles in Brazil with an OEM. The development will take place in Brazil, with the involvement of ten Semcon specialists in Brazil and four in Europe in a joint development project.[5]

[1] Korzeniewski, J. (2013). Autonomous cars found trustworthy in global study. Retrieved from http://www.autoblog.com/2013/05/19/autonomous-cars-found-trustworthy-in-global-study/
[2] Guilherme S.and Couto, A. P. (2015). Structural Properties of the Brazilian Air Transportation Network. Retrieved from http://www.scielo.br/scielo.php?script=sci_arttext&pid=S0001-37652015000401653#t01
[3] SITA. (2014). Brazil upgrades air traffic technology for World Cup and Olympics. Retrieved from https://www.sita.aero/pressroom/news-releases/brazil-upgrades-air-traffic-technology-for-world-cup-and-olympics
[4] Dhingra, L. (2013). Sao Paolo Airport Cargo Transport Going Real-Time, Automated. Retrieved from http://insights.wired.com/profiles/blogs/gru-airport-to-lead-cargo-transport-and-facilitate-global-trade#axzz4CzbsLo00
[5] Automotive World. (2016). Brazil not ready for driverless cars, but offers low-cost development opportunities. Retrieved from http://www.automotiveworld.com/analysis/brazil-ready-driverless-cars-offers-low-cost-development-opportunities/

3.1.1.3 Industry

The Federal Government of Brazil introduced an Auto Incentive program - the Programa de Incentivo à Inovação Tecnológica e Adensamento da Cadeia Produtiva de Veículos Automotores (Inovar) in 2012. It fosters industry competitiveness by encouraging automakers to produce more efficient, safer, and technology-advanced vehicles while investing in the national automotive industry.[6] It supports the technical development and provides incentive through a tax reduction measures. It can also support autonomous vehicles development in Brazil. This program, however, lacks the ambition to bring Brazilian vehicle standards into line with international best practices, and unclear future steps of the initiative create uncertainty for investors and undoubtedly delays manufacturers' investment plans concerning advanced technologies.[7] Moreover, due to the lack of necessary infrastructure and enough social capacity, the full benefits from automation might fall.

3.1.1.4 Market

The grade 4 metro automation, São Paulo Metro Line 4, is running in Brazil since 2010. It is the first driverless metro in South America and it was developed by the German company - Siemens Trainguard MT CBTC (communication-based train control). It has an advanced ticketing system in which one does not need to insert ticket or tap the card on the turnstile. One can just hold it in the hand and pass through the block, which will detect the ticket/card and automatically discount the trip while the screen door open.[8] Other future automated metro lines in São Paulo includes line 1, line 2, line 3 and line 6, which are operated by Companhia Do Metropolitano De São Paulo (São Paulo Subway Company). Beside operation, these lines are also modernized with the stations extension.

In order to support connected driving, cities in Brazil, such as Rio, have an integrated controlling system. It was operated since 2010, which allows more than 30 city agencies to monitor what is happening across the city in real time. Four years of monitoring showed that it has reduced emergency response time by 30 percent. Approximately 8,800 buses and municipal vehicles are monitored via GPS to track traffic and provide rapid response to traffic incidents.[9] Belo Horizonte also has its operational center that it has been operating since the World Cup in 2014. In São Paulo, Companhia de Engenharia de Trafego (CET) monitors traffic flow from its command center. CET controls the smooth flow of traffic in the sprawling metropolis, which, in practice, means supporting vehicular traffic in a city that still prioritizes the use of individual automobiles.[10] The penetration of the connected car is projected to rise from 0.76% in 2016 to 2.28% in 2020.[11]

3.1.1.5 SWOT Analysis

Strengths	**Weaknesses**
• Engagement in a multitude of international co-operation to develop automated vehicles • Strong ITS environment developing in the right direction for automation and connectivity • Deployed driverless public transportation in bigger cities	• Knowhow on connectivity and automation technologies is not yet wide spread • Technical education and training for professionals is insufficient • Problem of financing R&D&I • Arising data security and privacy issues
Opportunities	**Threats**
• High consumer willingness to use driverless vehicles • Increase of capacity in public transport and waterborne freight	• Benefits from automation might fall flat because Brazil lacks the necessary infrastructure

[6] ICCT. (2013). Brazil's Inovar-Auto Incentive Program. International Council on Clean Transportation.
[7] Lucon, O., Romeiro, V., and Fransen, T. (2015). Bridging the gap between energy and climate policies in Brazil. World Resources Institute. OCN and IEE USP.
[8] Ferreira, R. (2012). Sao Paulo Metro. Retrieved from http://www.nycsubway.org/wiki/Sao_Paulo_Metro#Line_by_Line
[9] Colin, B. (2015). 4 Inspirations for Sustainable Transport from Rio de Janeiro. Retrieved from http://www.wri.org/blog/2015/03/4-inspirations-sustainable-transport-rio-de-janeiro
[10] Nobre, L. (2012). Space, time, and trajectories. Retrieved from http://audi-urban-future-initiative.com/blog/sao-paulo-5
[11] Statista. (n.d.). Connected Car: India. Retrieved from https://www.statista.com/outlook/320/119/connected-car/india

3.1.2 China

3.1.2.1 General Information

China is ready as a market for the arrival and promotion of automated driving, especially concerning road transport. It is the world's biggest automotive market and is plagued with air pollution, traffic congestion and a chaotic traffic system with unpredictable traffic patterns. For example, more than 260,000 people died in 2013 in traffic accidents, according to data from the World Health Organisation.[12]

Based on the sales lists and numbers of vehicles with relevant advanced driver assistance systems (SAE levels 2+), China has a lead (together with USA), in terms of absolute market size, while concerning the number of new vehicles licensed worldwide, China is coming right after USA (together with Germany).[13]

China can be also considered a leader in the area of the drones evolution and development. While China's drone laws keep changing according to the evolution of the sector, the current legislation defines (among others) that drones under 7kg are allowed to be flown in China, but for drones weighing between 7-116kg a license is required by the Civil Aviation Administration (CAAC). Additionally, any drone more than 116kg requires a pilot's license and an Unmanned Aerial Vehicles (UAV) certification for its operation, while also approval needs to be ensured before drone flights in controlled areas and for all commercial drone flights.[14]

China has been using drones in several services, such as aerial photography, construction and deliveries, while industries of oil and gas as well as the agriculture sector are often served by their use.

3.1.2.2 Research, Development & Innovation

China, competing with USA and Europe that currently have the leading role in the self-driving sector, is preparing a regulatory framework that could provide it with precedence.

The OEM Great Wall Motor Co., which is one of the biggest automotive industries in China, has begun R&D actions in Yokohama aiming also to reinforce and further develop its cooperation with relevant OEMs from Japan, mainly industries relevant of auto-parts production. In parallel, the company also aims to create at least three more overseas research and development centers in India, North America and Europe, in order to be able to deliver products of high quality and expertise in several areas, such as environmental friendly and automated cars.[15]

Additionally, more Chinese OEMs have launched and developed R&D actions related to automated driving. For example, Chongqing Changan Automobile Co has also opened research centers in the U.S., Japan, Britain, and Italy, while Zhejiang Geely Holding Group Co. has created a research centre together with its Volvo Car unit in Gothenburg, Sweden[16]. Moreover, Baidu Inc. has also announced the formation of a relevant team in Silicon Valley, which will be part of Baidu's newly-created Autonomous Driving Unit (ADU)[17].

Furthermore, the Japanese OEM Nissan Motor Co., has signed a cooperation agreement with the China Automotive Technology and Research Center (CATARC) for the adaptation of safety features, like lane keeping and collision avoidance, so it can adjust its work and production to China's driving

[12] World Health Organization (2015). Road traffic deaths - Data by country. Retrieved from: http://apps.who.int/gho/data/node.main.A997

[13] Berger, R. GmbH - Automotive Competence Center & fka Forschungsgesellschaft Kraftfahrwesen Aachen (2016). Automated Vehicles Index – Q1 2016. Retrieved from: http://www.fka.de/consulting/studien/index-automated-vehicle-2016-01-q1-e.pdf

[14] UAV Systems International (2016). China Drone Laws. Retrieved from: https://uavsystemsinternational.com/drone-laws-by-country/china-drone-laws/

[15] The Japan Times (2016). China's Great Wall automaker opens Yokohama R&D division in bid to obtain Japanese technology. Retrieved from: http://www.japantimes.co.jp/news/2016/01/13/business/corporate-business/japanese-rd-base-chinas-great-wall-motor-commences-operations/#.V5mwjPmLSUn

[16] The Japan Times (2016). China's Great Wall automaker opens Yokohama R&D division in bid to obtain Japanese technology. Retrieved from: http://www.japantimes.co.jp/news/2016/01/13/business/corporate-business/japanese-rd-base-chinas-great-wall-motor-commences-operations/#.V5mwjPmLSUn

[17] Yoo, E. (2016). Baidu announces New Autonomous Car Team in Silicon Valley. Retrieved from: http://technode.com/2016/04/25/baidu-announces-new-self-driving-car-team-silicon-valley/

habits and road conditions.[18] CATARC is a research institute established in 1985 to meet China's need of managing the automotive industry. Belonging to the State-owned Assets Supervision and Administration Commission of the State Council (SASAC), CATARC assists the authorities to organize the research on industry policy and also provides consultation to the industrial organizations and enterprises.[19]

Regarding drones, their development will continue to support economic growth in China because it is a pillar of technological innovation. As a rapidly developing sector of technological innovation, in which China invested CNY 1.3 trillion in 2015 (comprising over 2% of the GDP), drones are expected to boost the growth of the Chinese economy in the future[20].

DJI, which is a leader company of China in the production of flying drones and aerial photography systems, allows and even urges its software developers to experiment and create their own applications for some drones, leading them to very interesting results. The company's research is currently focused on activities concerning the improvement of collision avoidance and life of battery, so as to ensure that drones are still operable even if there is a problem with other features (i.e. GPS sensors malfunction), while they have also developed a model for spraying crops in areas with difficult access[21].

3.1.2.3 Industry

China is planning to have a draft roadmap ready within 2016, which will determine technical standards and regulatory guidelines regarding self-driving cars. The Chinese government estimates to have self-driving vehicles ready for highways within the next 3-5 years, as well as autonomous vehicles for urban driving until 2025. This draft roadmap is being prepared by the National Technical Committee of Auto Standardization (NTCAS) that has the support of the Ministry of Industry and Information Technology and is expected to set up a common language for communication between vehicles and (V2V) but also between vehicles and infrastructure (V2I). Its issuance is of great importance, as it is going to set a unified framework for the whole of China concerning autonomous driving[22]. The draft roadmap is to obtain information from several Chinese Ministries, as well as industry players. It will be approved by the State Council. The adoption and use of cellular data technology will probably be included in the draft, as for instance LTE (Long Term Evolution wireless broadband technology) or 5G which is more advanced technology than the one used in Europe or in USA, for the communication between cars. Another very important issue that will be taken under consideration by the Committee is the clarification of legal issues (i.e. who is responsible in case of a collision?). Important players of the Chinese automotive industry, like SAIC Motor and Changan Automobile Group, have internal goals that could go along with this roadmap[23].

The leader in China is the company Baidu, which is involved in the automated vehicles sector since 2013. Baidu is currently cooperating with BMW, while also testing its technology in the United States. It has also cooperated with Google and Tesla Motors, showing great progress in terms of the cutting-edge technology of driverless vehicles. The company is also preparing to introduce automated services in public transportation of China over the next 2 years. Baidu already enjoys the support of several local Chinese governments – in terms of both regulations and infrastructure – which will be used to introduce small automated buses. After it started its autonomous car project in 2013, Baidu cooperated with big players, such as Google and Tesla Motors and now has made great progress in terms of

[18] Bloomberg News (2016). China's Changan Auto to Send Driverless Car on 1,200-Mile Test. Retrieved from: http://www.bloomberg.com/news/articles/2016-03-23/china-s-changan-auto-to-send-driverless-car-on-1-200-mile-test

[19] CATARC (2016). Profile CATARC. Retrieved from http://www.catarc.ac.cn/ac_en/content/20160506/7488.html

[20] Mitchell A. (2015). Are we ready for self-driving cars? Retrieved from: https://www.weforum.org/agenda/2015/11/are-we-ready-for-self-driving-cars/

[21] Stayton, J. (2016). What does the future hold for drones? China may know. Retrieved from: http://money.cnn.com/2016/05/16/technology/drones-future-dji-china/

[22] Spring, J. (2016). Look Mao, no hands! China's roadmap to self-driving cars. Retrieved from: http://www.reuters.com/article/us-autoshow-beijing-china-selfdriving-idUSKCN0XK021

[23] Spring, J. (2016). Look Mao, no hands! China's roadmap to self-driving cars. Retrieved from: http://www.reuters.com/article/us-autoshow-beijing-china-selfdriving-idUSKCN0XK021

the cutting-edge technology of driverless vehicles[24]. Baidu is also planning to implement road tests of driverless cars in 10 Chinese cities, targeting the commercialization of technology in three years and succeed mass production within the next five years.[25]

The Chongqing Changan Automobile Co., China's partner of Ford Motor Co., performed a test journey of 2,000 km with a couple of its prototype self-driving sedans, covering the distance between its Chongqing headquarters and Beijing within six days. Having his hands in his lap, a test engineer was observing the car using several automation functions such as automatic cruising, lane keeping and changing, speed reduction through traffic sign recognition, driving through traffic congestion and voice control. [26]

According to Changan representatives, a self-driving model should be on the market within the next 2-3 years, while the company also plans to spend CNY 5 billion (USD 773 million) to expand the technology until 2020. The two aforementioned OEMs (Baidu and Changan) are also in discussions for future cooperation.[27]

Additionally, China Yutong Bus, a leading Chinese bus manufacturer, has also realised a self-driving city bus test trip. The bus, equipped with many sensors, including camera and Lidar, covered a route of 32km on an intercity road between Zhengzhou and Kaifeng, in regular traffic, reaching the maximum speed of 68 km/h without any human intervention. The bus passed through 26 traffic lights and it was to change lanes and make overtaking maneuvers.[28]

The Swedish company Volvo also aims to conduct a test with automated cars in China within its Drive Me project that was set up first in Sweden. During this experiment 100 cars are going to be tested on public roads, such as express roads and highways, and in everyday conditions, while local drivers will be used. Volvo, owned by China's Zhejiang Geely Holding Group Co, is now searching for a city that could provide the necessary circumstances (i.e. permissions, regulations, infrastructure, etc.) for the realization of the experiment. The start of the replication of the project in China was not yet communicated.[29]

Additionally, in all the above described private initiatives, it is also important to mention that the Chinese government is also playing a great role in the promotion and development of the driverless market, with central and local governments investing in relevant projects. A good example is the support and enhancement of Baidu to run public transportation.[30] However, an obstacle to this or a retarding factor could be the Federal system, which leads to different governance initiatives between central and local governments.

As far as the air transport is concerned and more particularly the development of drones in China, above mentioned company DJI is a major player in China. The company works on drones related to emergency response, firefighting, as well as surveillance. It has been holding the wheel of the newly established industry since the launch of its Phantom 1 model.[31]

Yuneec is another key player, located in Jiangsu and focusing on developing and manufacturing high-tech electric propulsion systems for aircrafts, small unmanned aerial systems, personal electric

[24] Markoff, J. and Mozur, P. (2016). China's Companies Poised to Take Leap in Developing a Driverless Car. Retrieved from: http://www.nytimes.com/2016/04/04/technology/chinas-companies-poised-to-take-leap-in-developing-a-driverless-car.html
[25] *Xinhua* News Agency (2016). Baidu to produce driverless cars in five years. Retrieved from: http://news.xinhuanet.com/english/2016-06/27/c_135470370.htm
[26] Bloomberg News (2016). Self-Driving Car Completes 1,200-Mile Roadtrip Across China. Retrieved from: http://www.bloomberg.com/news/articles/2016-04-18/china-s-changan-auto-completes-1-200-mile-autonomous-drive-test
[27] Mitchell, A. (2015). Are we ready for self-driving cars? Retrieved from: https://www.weforum.org/agenda/2015/11/are-we-ready-for-self-driving-cars/
[28] Hars, A. (2015). Chinese company unveils prototype of self-driving bus. Retrieved from: http://www.driverless-future.com/?p=830
[29] Shirouzu, N. (2016). Volvo plans to test up to 100 self-driving cars in China experiment. Retrieved from: http://www.reuters.com/article/us-china-autos-volvo-idUSKCN0X32RO
[30] Stayton, J. (2016). What does the future hold for drones? China may know. Retrieved from: http://money.cnn.com/2016/05/16/technology/drones-future-dji-china/
[31] CATARC (2016). CATARC Profile. Retrieved from http://www.catarc.ac.cn/ac_en/content/20160506/7488.html

transport systems and smart radio systems.[32] Intel Corp. has invested more than USD 60 million to Yuneec to investigate the possible commercial uses of unmanned aircraft[33].

However, drones application is not only restricted to flying, but also companies involved in underwater vehicles are making their appearance into the consumer market. Deepfar, an ROV manufacturer in China, just released their latest series called White Shark that can dive up to 100 meters deep with a life battery of more than 2 hours.

The more essential difference between a drone and an underwater drone is that drones are wireless while an underwater drone is connected to a buoy by a tether because radio waves don't travel as well through water. The buoy is equipped with WIFI to send data to phones and laptops.[34]

3.1.2.4 Market

According to data from the 2015 World Economic Forum survey[35], Chinese people are more eager to ride a self-driving car than Americans (75% of Chinese against 50% of Americans). Within the next 20 years, China will probably become the most important market for autonomous vehicles (is expected to be the largest market by 2040), meeting the needs of at least one quarter of global demand, with the automated taxis introducing this development. An important boost to China's market development for autonomous vehicles can be considered as an economic advantages on world markets due to its low labour costs, as well as the existing manufacturing infrastructure that enables fast production.

The Chinese government reported that 4.8 million new companies were registered from March 2014 until May 2015. The government is encouraging this increase in an effort to solve some economic problems, like unemployment, the transition of economy from being focused on manufacturing to one based on services[36].

China presents also very great progress and development in the area of air transport and particularly in the drones sector, which is a rapidly expanding market at a global level, in terms of both production and usage. More specifically, China, that is already active in the production of parts for other aero-space vehicles, has already begun to emerge as a drone-manufacturing power.

The government of China has also already incorporated the use of drones in several areas and tasks, concerning, e.g. public safety and emergency medical services. China's Civil Aviation Authority (CAAC) has released a series of regulations in early 2016.[37]

However, due to this growth of China in the drones' sector, citizens have begun to express concerns related mainly to issues of safety, security and privacy. This is a reason for the Chinese authorities plan to restrict advanced drone technology exports, in order to immunize national security. In December of 2015, regulatory authorities announced their plan to prohibit drone delivery in crowded cities, especially after an accident that took place in Sichuan, where an unmanned aircraft crashed into power lines causing a massive blackout.[38]

The regulations provided by CAAC categorize drones into seven types according to their weight, addressing concerns regarding smaller consumer drones, by setting guidelines of a threshold of about 7

[32] E-go (2016 ABOUT E-GO, THE PREMIER ELECTRIC TRANSPORTER BY YUNEEC. Retrieved from http://e-go.com/about.php

[33] Clark, J. (2015). Intel Invests USD 60 Million in Chinese Drone Maker Yuneec. Retrieved from: http://www.bloomberg.com/news/articles/2015-08-26/intel-invests-60-million-in-chinese-drone-maker-yuneec

[34] Feng, C. (2016). The Underwater Drone Manufacturer That Wants To Be China's Next DJI. Retrieved from: http://www.forbes.com/sites/cfeng/2016/03/30/the-underwater-drone-manufacturer-that-wants-to-be-chinas-second-dji/#b9b928576fc2

[35] Mitchell, A. (2015). Are we ready for self-driving cars? Retrieved from: https://www.weforum.org/agenda/2015/11/are-we-ready-for-self-driving-cars/

[36] Stayton, J. (2016). What does the future hold for drones? China may know. Retrieved from: http://money.cnn.com/2016/05/16/technology/drones-future-dji-china/

[37] Harsono, H. (2016). Drones: Putting China's economy on autopilot. Retrieved from: https://techcrunch.com/2016/06/03/drones-putting-chinas-economy-on-autopilot/

[38] McNabb, M. (2016). China's New Drone Regulations. Retrieved from: http://dronelife.com/2016/01/19/chinas-new-drone-regulations/

kilograms, which is a major difference from the US registration threshold of 250 grams.[39] In addition, drones that weigh less than 7 kilograms are allowed in less populated and rural areas, while in megacities, like Beijing and Shanghai, many restrictions have been set about the time and location of drone flights. The regulations provide also detailed instructions concerning the expected behaviour while piloting UAVs, whilst they also define that operators must have a license and several certificates, including training and health. Operators must also ask for permission by the administration before each flight.[40]

While the new regulations clarify and define many issues, appointing at the same time penalties for non-compliance, China has also announced a new rule about a currently developed cloud-based monitoring system for drones, in an effort to insure airspace safety by combining technology solutions and regulations.[41]

3.1.2.5 SWOT Analysis

Strengths	**Weaknesses**
• A multitude of ongoing industrial activities in automation and connectivity by major OEMs • Favourable governmental policy framework due to desire to shift to an economy driven by high-tech and consumer industries • Strong IT sector with major companies such as Baidu pushing towards automation • Large-scale test-beds implemented	• Slow uptake of automation and related technologies • Federal system leads to different governance initiatives between central and local governments
Opportunities	**Threats**
• China is expected to be the largest market for autonomous vehicles by 2040 • Economic advantages on world market due to low labour costs • Fast production possible due to existing manufacturing infrastructure • Steep learning curve because of high-volume development and production possibilities	• Chaotic traffic system with high congestion and unpredictable traffic patterns impedes implementation • Lack of (or outdated) planning of funding activities for automation by the Chinese government.

3.1.3 India

3.1.3.1 General Information

Over the past two decades, India has advanced in information technology (IT). The Indian economic boom has resulted in an exponential increase in motorisation, urban traffic congestion and deterioration of air quality in the megacities. India uses intelligent transport system (ITS) to alleviate existing concerns including traffic congestion, air and noise pollution, by enhancing data collection for addressing the transport-related concerns at the vehicule or infrastructural levels. Some of the ITS technologies are Automated speed enforcement, Incident management, Electronic toll collection, Traveller information and Vehicle control technologies like intelligent cruise control and speed alerts.[42]

Along with the development of ITS, research has been carried out on the automation of metros and driverless cars up to automation level 4. Automation level 2-metros are already running in various cities of India. Although India has many car manufacturers, Mahindra is the pioneer to introduce the

[39] McNabb, M. (2016). China's New Drone Regulations. Retrieved from: http://dronelife.com/2016/01/19/chinas-new-drone-regulations/
[40] Global Times (2016). Civil aviation authorities tighten drone flight rules. Retrieved from: http://www.globaltimes.cn/content/964135.shtml
[41] McNabb, M. (2016). China's New Drone Regulations. Retrieved from: http://dronelife.com/2016/01/19/chinas-new-drone-regulations/
[42] EBTC. (2012). Intelligent Transport Systems in India. European Business and Technology Centre. EBTC.

driverless car in the country. Also THRSL (The Hi-Tech Robotic Systemz Ltd.) introduced Automated Guided Vehicle (AGV) - Novus-Drive, which is the first driverless shuttle in India. A study by Cisco systems on customer experience stated that 86% of the Indian population would ride driverless. Thus, Indians are the second most willing to trust autonomous technology after Brazil where 95% were keen to do so.

3.1.3.2 Research, Development & Innovation

As ITS is central to the future development of connected driving in India, it is discussed shortly in this section. The Ministry of Road Transport and Highways (MoRTH) has started the National Road Transport Policy (NRTP) that promotes road infrastructure support, public transport and quality and productivity of goods transportation and infrastructure. NRTP underlines the importance of ITS in the road and highway infrastructure including technologies in real time traffic flow management, parking availability, vehicular traffic, and a basic geographic information system (GIS). In addition, the NRTP also discusses the use of ITS technologies in transport systems in freight and cargo transport, like electronic tagging and automatic toll collection and can greatly reduce waiting/ transit times and lead to increased emissions and fuel consumption.[43]

NRTP states that the government of India is promoting R&D in the use of ITS for addressing the problems of the transport sector. This includes the construction and maintenance of road infrastructure, IT-based vehicle registration and creating a centralized registry/depository of all information on motorized vehicles.[44]

In Delhi, DIMTS (Delhi Integrated Multi-Modal Transit System Ltd) specializes in the development and deployment of Intelligent Transport Systems. It includes:

- Wireless Traffic Signal Controller (Wi-Trac): Wireless operation eliminates road cutting-refilling & cable laying operations, associated with conventional Traffic Controller
- Red Light-Stop Line Violation & Detection System (RLSVDS): Snapshot with number plate details and three seconds video is provided as evidence from RLSVDS Server
- CCTV Junction Surveillance: Real time streaming video from junctions and strategic locations enable effective traffic & incident management from remote Traffic Command Control Centre, and allows operators to directly observe the traffic conditions at all junctions, verify incidents and congestion conditions
- Variable Message Sign (VMS): VMS is an electronic message sign with a systematically arranged cluster of Light Emitting Diodes (LED) which are wired together and electronically driven & controlled.
- Video Incident Detection: Through real-time analysis of images of the camera, the incident detection module is able to detect all major incidents within seconds. Automatic Incident Detection can be done for: stopped vehicles, drivers on the wrong-way, pedestrians, lost cargo, smoke & fire, queue, speed drop among others.
- Control and Command Centre: Integrated Command Centre for various Intelligent Transportation and Traffic Management sub-systems.[45]

3.1.3.3 Industry

Delhi will be the first city in India with metro automation grade level 4 for few lines (Pink line and Magenta line). Inauguration is scheduled for early 2017. Automation level 2-metros are already running in Delhi and Kolkatta.

Regarding the automotive industry Mahindra & Mahindra is the first car manufacturer to introduce or test driverless cars in the country. Mahindra's electric car subsidiary, Mahindra Reva, has submitted

[43] EBTC. (2012). Intelligent Transport Systems in India. European Business and Technology Centre. EBTC.
[44] EBTC. (2012). Intelligent Transport Systems in India. European Business and Technology Centre. EBTC.
[45] Puranik, V. (2013). Intelligent Tranport Systems (ITS). Retrieved from Delhi Integrated Multi-Modal Transit System Ltd. DIMTS. Retrieved from http://www.dimts.in/Services_Transportation_Intelligent_Transport_System.aspx

proof of concepts for driverless cars in the UK and Singapore. Once the experiment of R&D for the car is finished in Bengaluru, it will be tested on the road. However, the test will not be carried out in India, but will be in the UK and Singapore due to the inadequate infrastructure and crowded roads.[46] Mahindra is currently in the process of crowdsourcing some of the innovation in the areas of driverless cars. It introduced a driverless car challenge, which invited engineers to build cars for a potential cash prize of USD 700,000. This project allows engineers to build driverless car prototypes to assist in the decongestion of Indian roads.[47] Likewise, THRSL (The Hi-Tech Robotic Systemz Ltd.) had introduced Automated Guided Vehicle (AGV) - Novus-Drive, which is the first driverless shuttle in India. The first test drive was at the Auto Expo in Greater Noida in February 2016 for ferrying visitors around the exhibition centre. AGVs in India are foreseen to be mainly deployed in controlled environments such as large university or office campuses, elderly health care communities, trade fair and theme parks and within the upcoming smart cities.[48] [49]

Moreover, in order to strengthen connected driving in India, IT companies such as Infosys, TCS, Wipro and HCL are working together with global carmakers, auto parts suppliers, insurers and content providers for integration of technology. Infosys has developed a customized telecom solution – Application Platform, for connected cars and has partnered with a tech start-up to monitor driving behaviour using a Telematics Dongle as an aftermarket solution to auto insurers. Mahindra & Mahindra has announced plans to bring Android-enabled infotainment systems in its flagship Scorpio and XUV models by joining Google-spearheaded Open Automotive Alliance.[50] Wipro is also working on an infotainment system. Telecom operator Vodafone is in talks with Accenture, Huawei and Porsche to integrate machine-to-machine (M2M) technology to power internet applications.[51]

Likewise, with the vision for a connected world as well as safer, more convenient and easier driving, Tech Mahindra is developing smart solutions such as an intelligent Auto Park Assist system. It will make parking the car completely automatic and needs zero intervention from the driver. They are also building an Autonomous Vehicle Operating System (AV OS) with a partner. The AV OS will be a powerful platform on which people can build applications that will eventually power the future autonomous cars. With a versatile and comprehensive AV OS, the path towards autonomous cars will be much more systematic and fast.[52]

Mistral Solutions in India (partnered with KritiKal Solutions) works on selective implementation of intelligent traffic solutions in India. It eases traffic congestion and traffic gridlocks without having to plan for fresh investments in the transportation infrastructure. It uses Intelligent Transportation Systems (ITS) using video surveillance systems, Charge-Coupled Device (CCD) featured global shutters and Automatic Number Plate Recognition (ANPR) etc.[53]

The Indian Railways have developed a real-time train (passenger and freight) tracking device[54] which would help avoid collisions and with train departure and arrival coordination. The railway company has planned (in 2012) to outfit 100 trains with the devices.

[46] Aggarwal, V. (2015). Mahindra experimenting with driverless cars; developing software to control car's movement in India. Retrieved from http://economictimes.indiatimes.com/industry/auto/news/passenger-vehicle/cars/mahindra-experimenting-with-driverless-cars-developing-software-to-control-cars-movement-in-india/articleshow/46461771.cms

[47] India Tranport Portal. (2015). Mahindra Group begin experimentation on the future of driverless car. Retrieved from http://indiatransportportal.com/mahindra-group-driverless-cars-31256

[48] Motorinida. (2016). THRSL receives huge applause for Novus-drive, the driverless vehicle. Retrieved from http://www.motorindiaonline.in/applications/hi-tech-demonstrates-driverless-vehicle-capability-with-novus-drive/

[49] The Hi-Tech Robotic Systemz Ltd. (n.d.). Driverless Vehicles - Our Latest Entrant (NOVUS-DRIVE). Retrieved from http://www.hitechrobotic.com/novus_drive.html

[50] Batchu, S. (2014). Mahindra: It's just a matter of time that connected cars will become a mainstream in India. Retrieved from http://telematicswire.net/mahindra-its-just-a-matter-of-time-that-connected-cars-will-become-a-mainstream-in-india/#JI54vrlj26cOE31B.99

[51] Mukherjee, K. (2016). Time Ripe for India to Get into the Reality of Connected Cars! Retrieved from http://cmrindia.com/time-ripe-for-india-to-get-into-the-reality-of-connected-cars/

[52] Natarajan, K. (2015). The Road to Autonomous Vehicles. Retrieved from http://www.techmahindra.com/sites/blogs/the-road-to-autonomous-vehicles.aspx

[53] Mistral Solutions. (2014). Selective Implementation of Intelligent Traffic Solutions in India. Retrieved from https://www.mistralsolutions.com/selective-implementation-intelligent-traffic-solutions-india/

[54] Desai, V., & Harsimran, J. (2012). Indian Railways to launch real-time train tracking via Google maps. Retrieved from http://articles.economictimes.indiatimes.com/2012-03-27/news/31244984_1_real-time-train-train-accidents-freight-trains

3.1.3.4 Market

The introduction or acceptance of fully autonomous cars in India is in nascent phase. Challenges of the autonomous car in India include increased costs, along with additional risks such as data security and privacy concerns, and lack of vehicle infrastructure.[55]

Although there are basic infrastructure challenges such as reliable connectivity and data rates on one side and the associated costs for the technology/solutions on the other side, the penetration of connected car is projected to rise in India from 0.92% in 2016 and to 2.63% in 2020. [56] [57] Both industry and government bodies understand the importance of connecting vehicles in a country where road accidents are high and the cost of traffic congestion is whopping.[58] The connected car market in India is foreseen to grow at a Compounded Annual Growth Rate (CAGR) of 60.4%. Regarding connectivity technologies, LTE will be the main connectivity solution considering the advantages, such as better end user experience, less network traffic, and faster upload and download speed. Currently, mobile networks have good coverage in all metropolitan areas; although, rural areas has some connectivity problem, which is likely to impact the usability of cloud services. Wi-Fi has application in vehicle-to-infrastructure connectivity, and can be used for functions such as software updates, downloading maps, and data transfer. It seems to be a cost-effective alternative because it does not incur data volume costs as LTE.[59]

ITS applications, in order to enhance connected driving in India, have been introduced in metropolitan cities like New Delhi, Pune, Bangalore, Chennai etc. focusing on stand-alone deployments of area-wide signal control, parking information, advanced public transportation, toll collection etc. However, all of these are small scale pilot studies limited to major cities and are in the beginning stage of deployment. Thus, at present, the development of ITS applications is in a progressive state with traffic management centers in India.[60] Some of the projects with ITS technology are Wireless Traffic Control System, Real Time Traffic Counting and Monitoring System and Intelligent Parking Lot Management System.

Some of the major social and institutional issues facing the deployment of ITS in India include an underdeveloped road network, severe budget restrictions, explosive urbanization and growth, lack of resources for maintenance and operation, less demand for automation, lack of interest among policy decision makers, and lack of user awareness. In order to achieve the full potential of ITS, it has to be implemented at a network level rather than in small corridors. Overall, the existing implementations show promise and potential for the deployment of ITS in India and give an initial empirical basis and data on ITS deployment highlighting the data, methodological, practical and research challenges for Indian conditions. [61]

[55] Boagey, R. (2014). Autonomous cars in India: a developing challenge. Retrieved from http://www.automotiveworld.com/analysis/autonomous-cars-in-india-a-developing-challenge/

[56] Batchu, S. (2014). Mahindra: It's just a matter of time that connected cars will become a mainstream in India. Retrieved from http://telematicswire.net/mahindra-its-just-a-matter-of-time-that-connected-cars-will-become-a-mainstream-in-india/#JI54vrlj26cOE31B.99

[57] Statista. (2016). Connected Car: India. Retrieved from https://www.statista.com/outlook/320/119/connected-car/india

[58] Automotive. (2016). India plans route map for the connected car. Retrieved from http://analysis.tu-auto.com/auto-mobility/india-plans-route-map-connected-car

[59] Research and Markets. (2016). India Connected Car Market By Form Factor Connectivity, Technology, Application - Forecast and Analysis (2015-2020).

[60] Vanajakshi, L., Ramadurai, G., & Anand, A. (2010). Intelligent Transportation Systems: Synthesis Report on ITS Including Issues and Challenges in India. IIT Madras, Centre of Excellence in Urban Transport.

[61] Vanajakshi, L., Ramadurai, G., & Anand, A. (2010). Intelligent Transportation Systems: Synthesis Report on ITS Including Issues and Challenges in India. IIT Madras, Centre of Excellence in Urban Transport.

3.1.3.5 SWOT Analysis

Strengths • Strong industry collaboration among ITS companies • Partially automated public transport already deployed in bigger cities • Strong IT industry and knowhow	**Weaknesses** • No full-scale deployment of advanced systems in India yet, especially in rural regions • Automation is hard to achieve because of a underdeveloped infrastructure • Weak automotive industry and knowhow • Severe budget restrictions because of lack of interest among policy decision makers • Nature of road user is complicated
Opportunities • Relatively high consumer willingness to use driverless automobiles • Urbanisation and growth also leads to new township with innovative technologies in use	**Threats** • Explosive urbanization and growth of new townships • Lack of resources for maintenance and operation • Despite of willingness to use driverless automobiles limited demand for automation due to high poverty rate

3.1.4 Japan

3.1.4.1 General Information

Japan's efforts to push connectivity and automation stems from different factors. The biggest driver is the country's aging society. Apart from that, the country's scarcity of resources, the aim to reduce traffic fatalities, and the avoidance of congestion are further drivers. Additionally, in its programs the government's funding efforts are often related to their hosting of the 2020 Olympic/Paralympic Games. It was defined as a milestone to attain their goal of showing the world to have the most advanced ICT environment.[62]

Whereas the private and public sectors will jointly invest money to build test courses, the development of the necessary infrastructure, such as on-road systems, is solely financed by the public sector.[63]

3.1.4.2 Research, Development & Innovation

The Japanese government has introduced a variety of different programs to push the developments towards automation and connectivity. On the basis of "the Science and Technology Basic Law", comprehensive STI (Science, Technology & Innovation) strategies are formulated every five years since 1996. In their 4th update, which was formulated for the period 2016-2020, a JPY 335-billion action plan for S&T Priority Measures was defined that identified prioritized areas, including energy and next-generation infrastructure. It also introduced the so-called Cross-Ministerial Strategic Innovation Promotion Program (SIP). "Innovation of Automated Driving for Universal Services" (SIP-ADUS) was named one of ten key themes, making up JPY 2.45 billion of the JPY 50 billion heavy program. The program is based on a public-private collaboration in which ITS-related ministries and five car manufacturers (Toyota, Nissan, Honda, Mazuda, Subaru) participate to foster advancements of vehicle automation and connectivity.[64] The program aims at achieving level 2 automation by mid-2010s and level 3 by early 2020s and at contributing to the establishment of standardization and harmonization as well as at nourishing the social acceptance for the realization and promotion of vehicle automation.[65] The scope of the project spans across different fields, including (1) development and verification of auto-

[62] Kawamoto, M. (2014). An Approach to the Next Generation Transportation Systems. Retrieved from http://www.its-jp.org/english/files/2014/07/SIP7_Kawamoto.pdf
[63] ZDNet (2015). Japan focuses self-driving car technology. Retrieved from http://www.zdnet.com/article/japan-focuses-self-driving-car-technology/
[64] Tanuma, T. (2014). The National Program for Innovation. Cross-ministerial Strategic Innovation promotion Program(SIP). Retrieved from http://www.its-jp.org/english/files/2014/07/SIP2_Tanuma.pdf
[65] Yokoyama, T. (2014). Humans and Automated Driving Systems. Retrieved from http://www.its-jp.org/english/files/2014/07/SIP5_Yokoyama.pdf

mated driving technologies; (2) development of evaluation models and simulation technologies on vehicle behavior and collision to effectively reduce traffic fatalities and congestion; (3) international co-operation; and (4) deployment for next generation urban transportation services.[66]

As can be seen in Figure 4 automated driving will be realized integrating on-board technologies on one side and co-operative assist (precise digital map, data acquisition through radio communication and global positioning) on the other side. On-board technologies are already in product level competition and car manufacturers are demonstrating their technologies. Therefore, the scope of SIP-ADUS does neither include on-board technologies nor the development of prototype automated cars. It focuses on areas of cooperation, such as dynamic map, connected vehicles, human factors, impact assessment, next generation transport, security and international cooperation.[67] The vehicle to infrastructure cooperation introduced in 2011 is built on older technology, such as car navigation (1980s), real-time traffic information service (1996) and Electronic Toll Collection ETC (introduced in 2001).

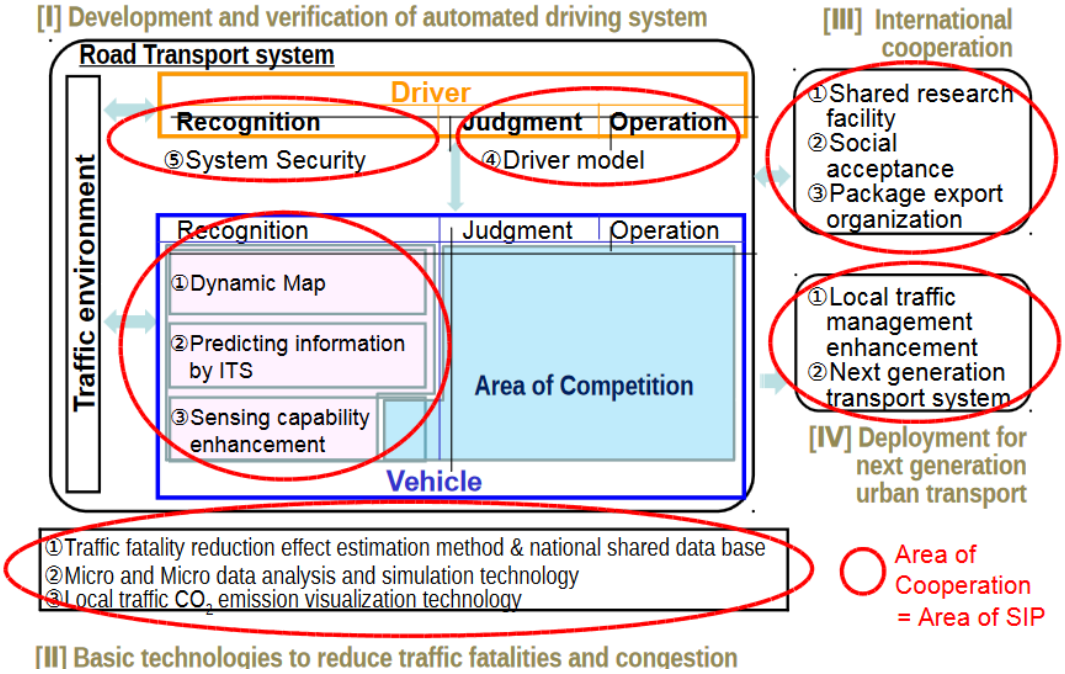


Figure 4: Scope of governmental program SIP-ADUS[68]

Responsible for the collection of traffic-related data is, among others, the Japan Road Traffic Information Center (JARTIC)[69], commissioned by prefectural police headquarters and road administrators subordinated by MLIT. It was founded in 1970 to ensure the safety and convenience of road users by collecting traffic-related data. Over the past 40 years the center has formed a nation-wide information network available via different offline and online channels. It provides collected data to the Vehicle Information and Communication System Center (VICS)[70] that further processes data and communicates it to road users in real-time via three communication and broadcasting media: infrared beacon, radio wave beacon, and FM multiplex broadcasting.

Another JPY 55 billion are invested between 2014 and 2018 for the program “IMpulsing PAradigm Change through disruptive Technologies (ImPACT)” that promotes high-risk, high-impact R&D. In the

[66] Amano, H. (2014). Automated Driving Technology Research in Japan: Strategic Innovation Promotion Program. Retrieved from http://www.its-jp.org/english/files/2014/07/SIP0_Amano.pdf
[67] Amano, H. (2016). A National Project in Japan: Innovation of Automated Driving for Universal Services. In: Road Vehicle Automation 3, Meyer, G., Beiker, S. (eds.).
[68] Amano, H. (2014). Automated Driving Technology Research in Japan: Strategic Innovation Promotion Program. Retrieved from http://www.its-jp.org/english/files/2014/07/SIP0_Amano.pdf
[69] JARTIC (2016)Japan Road Traffic Information Center (n.d.). Retrieved from http://www.jartic.or.jp/
[70] Vehicle Information and Communication System (2016). How VICS works. Retrieved from http://www.vics.or.jp/en/vics/

5th version of the Science & Technology Basic Plan (2016-2020)[71] the ImPACT (IMpulsing PAradigm Change through Disruptive Technologies Program) R&D project shall be continued to act as a model case for extending similar schemes to the R&D projects that may not have a high probability of yield (high-risk research) but that can be expected to have a significant impact if successful. The overall focus is put on the development towards a so-called Society 5.0 or Super Smart Society (after the hunter–gatherer society (1.0), agricultural society (2.0), industrial society (3.0), and information society (4.0)). ICT is expected to further evolve to connect, separate systems in various fields (energy, transportation, manufacturing, and service) using cyberspace. This will involve working on standardizing the interfaces, data formats and the like. Priority areas include an efficient and effective infrastructure, ITS and transport system resilience.

MLIT also established the Auto-pilot System Study Group in June 2012. The study group, made up of the Parliamentary Vice-Minister, academia and auto manufacturers, clarifies and studies challenges to achieve auto-pilot systems. The study group has defined 4 levels of automation (similar to the US SAE standards) as well as public-private ITS Initiatives and a roadmap towards deployment (definition of automation level for automated driving, clarification of time of market deployment in accordance with automation level).[72]

Another important player in automation is the National Institute of Information and Communications Technology (NICT) that promotes the full spectrum of research and development in ICT from basic to applied research with an integrated perspective. NICT forms close ties with the academic and business communities in Japan as well as with research institutes overseas.[73]

Research and development at Toyota is organized in a three-fold structure: basic research (basic vehicle-related technology), forward-looking and leading-edge technology development (technological breakthroughs related to components and systems), and product development (new model development). Automation and connectivity is anchored within basic research which is mainly done in Nagakute City and Aichi in Japan, in one research site in Changshu in China as well as in three research centers in the USA. The US subsidiaries focus on autonomous driving (Ann Arbor, Michigan), “guardian angel driving” (Palo Alto, California) and deep learning respectively (Cambridge, Massachusetts).[74] [75] Toyota is the global leader in the number of self-driving car patents (followed by Germany’s Robert Bosch GmbH, and Japan’s Denso Corp) with 1,400 patents filed so far. Thus, the company has issued more than twice as many patents as any other company until January 2016.[76] Through this approach Toyota also invests a lot in the development of C-ITS such as eco-friendly driving support systems that use road-to-vehicle, vehicle-to-vehicle and pedestrian-to-vehicle communication to reduce the likelihood of traffic accidents. Technologies include Intelligent Driver-support Systems such as the Highway Driving Assist, Lane Trace Control (LTC), and Cooperative-adaptive Cruise Control (C-ACC). The company has also announced that it will equip all of their new models with auto-braking systems to help prevent accident fatalities.

Nissan has seven research facilities: three in Japan (Atsugi, Oppama, Yokohama), one in India (Chennai), two in the U.S. (Detroit, Silicon Valley) and one in Russia (Moscow). Research on automation and connectivity is undertaken in all of its research centers in Japan, in India (due to strong IT industry), and in the youngest subsidiary in Silicon Valley where special emphasis is put on the inclusion of ethnography and design anthropology as foundational components of research on autonomous

[71] Cabinet Office (2015). Report on The 5th Science and Technology Basic Plan. Retrieved from http://www8.cao.go.jp/cstp/kihonkeikaku/5basicplan_en.pdf
[72] Yamamoto, T. (2014). Automated Driving Activities in Japan Activities in Japan. Retrieved from https://higherlogicdownload.s3.amazonaws.com/AUVSI/3a47c2f1-97a8-4fb7-8a39-56cba0733145/UploadedImages/documents/pdfs/7-17-14%20AVS%20presentations/takumiYAMAMOTO%20English(Final1).pdf
[73] National Institute of Information and Communications Technology (2016). Organization. Retrieved from http://www.nict.go.jp/en/about/NICT
[74] Toyota (2016). Toyota's Research and Development Organizations. Retrieved from http://www.toyota-global.com/company/history_of_toyota/75years/data/automotive_business/products_technology/research/bases/index.html
[75] Muller, D. (2016). Ann Arbor picked for third Toyota Research Institute location. Retrieved from http://www.mlive.com/auto/index.ssf/2016/04/ann_arbor_picked_for_third_toy.html
[76] Ingrassia, P. and White, J. (2016). Automakers, not Silicon Valley, lead in driverless car patents: study. Retrieved from http://www.reuters.com/article/us-tech-ces-autos-idUSKBN0UJ1UD20160105

vehicles.[77] All research activities are structured along four identified major societal trends: electrification, aging of society, formation of new information services and urbanization.[78] Automation and connectivity is anchored in all four key domains. Nissan R&D predicts autonomous cars to be marketable by 2020.[79] Nissan Advanced Technology Center[80] is also cooperating with researchers at MIT, Oxford and Tokyo University. In accordance with the key research areas of the SIP, Nissan developed a dynamic map prototype that was launched in 2015.[81] A dynamic map is a database with layered structure built on graph network representation of road. The database is expected to be expanded to include much more detailed description of road structure and surrounding environment and to be dynamically linked to real-time data from integrated on-board sensing systems and semi-real-time data from V2X communications. Nagoya University, also involved in SIP-ADUS, undertakes research, too.

The World Expo 2005 near the city of Nagoya in the Aichi Prefecture served as an incubator for two promising technologies. First, Linimo, a magnetic levitation train, was presented as the world's first unmanned commercial Urban Maglev and Japan's first commercial maglev to use the High Speed Surface Transport (HSST) type technology. It now operates to serve the local community and covers 9 km with a top speed of 100 km/h.[82] Second, an automated platoon bus system was put into real operation for passenger services. The system carried about 2 million visitors in 6 months. However, it was never deployed for permanent operation. Additionally, between 2010 and 2015 Japan's Energy ITS project has been developing and testing platooning of three fully automated trucks. The project was funded by METI through its New Energy Technology Development Organization (NEDO) with about USD 12 million per year for five years. The project is co-ordinated and managed by the Japan Automobile Research Institute (JARI) and involves a multitude of different universities and only indirectly truck manufacturers. The primary goal is to attain energy savings through the reduction of aerodynamic drag by operating trucks in an electronically coupled platoon at shorter-than-normal gaps. The reduction in aerodynamic drag for following vehicles, and build-up of pressure behind the lead vehicle yields impressive fuel efficiencies, with various tests reporting convoy savings of between 5% and 10% with most fleet operators attributing some 30 to 40% of their operating costs to fuel expenditure. Further objectives are the improvement of highway traffic flow and safety. The Japan market is expected to witness a notable number of factory-equipped truck platooning systems only by 2022, owing to the fact that the region remains low in terms of connected truck technology penetration.[83] But there is also development in the passenger sector, spearheaded by Toyota. The company develops and tests a platoon of three Lexus LS-460 passenger cars that follow each other closely to reduce fuel consumption.[84]

As for academia, the one university contributing most to the advancement of automation and connectivity is without doubt Tokyo University. A multitude of laboratories and institutes are working on these technologies including Shibasaki Laboratory, Center for Spatial Information Science, the Interfacial Transport Engineering Lab in the Institute of Industrial Science, the Oguchi & Iryo Laboratory in the Institute of Industrial Science, the Advanced Mobility Research Center, Institute of Industrial Science, the Future Generation Mobility Center in the Institute of Industrial Science, the Information and Robot Technology Research Initiative, and the School of Engineering. Other universities engaging in this

[77] Jordan, B., Wasson, C. and Roth-Lobo, H. (2015). Ethnographic Study Lifts the Hood on what REALLY Goes On inside that Car. Retrieved from https://www.epicpeople.org/ethnographic-study-lifts-the-hood

[78] Nissan Global (2016). Research with an Eye on the Trends That Will Impact the Automotive Future. Retrieved from http://www.nissan-global.com/EN/NRC/DOMAINS/#page1

[79] Nissan Global (2016). Research Fields. Transition of research fields. Retrieved from http://www.nissan-global.com/EN/NRC/FIELDS

[80] Joon-Sool, K. and Ji-Soo, L. (2016). Race is on to capture driverless car market. Retrieved from http://koreajoongangdaily.joins.com/news/article/article.aspx?aid=3014601&cloc=joongangdaily|home|newslist2

[81] Fukushima, M. (2014). Dynamic Map [Presentation]. Retrieved from http://www.its-jp.org/english/files/2014/07/SIP3_Fukushima.pdf

[82] *Yasuda, Y., Fujino, M., Tanaka, M., Ishimoto, S. (2004). The first HSST maglev commercial train in Japan. Proceedings of the 18th international conference on magnetically levitated systems and linear drives (MAGLEV 2004). Retrieved from* http://www.maglev.ir/eng/documents/papers/conferences/maglev2004/topic1/IMT_CP_M2004_T1_10.pdf

[83] Maida, J. (2016). Increased Acceptance of Connected Trucks in China, Japan, and Australia Labels APAC as the Fastest-growing Truck Platooning System Market Until 2020, Says Technavio. Retrieved from http://www.businesswire.com/news/home/20160704005076/en/Increased-Acceptance-Connected-Trucks-China-Japan-Australia

[84] Wang, B. (2015). 7.7 Million Truck Platoon Systems to Ship by 2025 and Japanese truck platooning research. Retrieved from http://nextbigfuture.com/2015/05/77-million-truck-platoon-systems-to.html

technology field are Aoyama Gakuin University, Kyoto Institute of Technology, Nagoya Institute of Technology, Nagoya University, Ochanomizu University, Osaka Institute of Technology, Tokyo Institute of Technology, and the National Institute of Informatics.

3.1.4.3 Industry

The automotive industry in Japan is organized in vertical "keiretsus". A keiretsu is typically centered on an OEM and ties together suppliers, manufacturers, and distributors of an industry[85] with interlocking shareholdings, joint R&D activities, technology transfers, primary or exclusive customer supplier relationships, etc. During Japan's decade of slow growth in the 1990s many corporations suffered from the rigid structures of the Keiretsu system. So, new Keiretsus were developed, e.g. by Toyota, that break from traditional keiretsus by also sourcing from the global market and encouraging suppliers to become involved in product development already at the planning stage.[86]

Nissan will be the first Japanese manufacturer to introduce autonomous driving technologies to control steering, brakes and throttle on highways. The system, called ProPILOT, is integrated in the 5th-generation Japan-only Serena minivan to be released in August 2016. In 2017 the system is expected to be introduced on the European market in the Qashqai. The system was designed for single-lane highway driving. According to the company, multi-lane autonomous driving will be introduced in 2018 and autonomous driving in urban contexts in 2020.[87] Nissan has also teamed up with NASA to further develop their automated driving systems and recently with the Department of Automotive Engineering at Tsinghua University to establish a joint research center for intelligent mobility to work on R&D of electric vehicle and autonomous drive technologies especially for the Chinese market.[88]

The Renault-Nissan alliance plans to launch 10 models with significant autonomous driving functionalities built into mainstream, mass-market cars at affordable prices in the US, Japan, Europe, and China through 2020.[89] On the short run the alliance will introduce a plethora of different technologies to increase the convenience such as an automotive app for mobile devices that allows for remote interaction with the car, an "Alliance Multimedia System", and a new Virtual Personal Assistant feature. The alliance has a R&D budget of USD 5 billion and several research centers all over the world.[90]

Mitsubishi has introduced the EMIRAI3 xAUTO, an automated concept car, in October 2015. Mitsubishi Electric Corp. plans to readjust their developed defense technology for use in autonomous vehicles. The company is expected to commercialize its technologies as of 2020.[91] In 2017, they will start offering superior lane-keeping and auto brake systems.[92]

Toyota is expected to invest USD 1 billion in autonomous vehicles, artificial intelligence (AI), and robotics in the next four years. The company together with Fanuc and Panasonic collaborates with Preferred Networks, a company developing machine learning technology, to apply AI to robots and au-

[85] Moffatt, M. (2015). An Economic Introduction to the Japanese Keiretsu System. The Definition, Significance, and History of Keiretsu in Japan. Retrieved from http://economics.about.com/od/termsbeginningwithk/g/keiretsu_system.htm

[86] Aoki, K. and Lennerfors, T. (2013). The New, Improved Keiretsu. Retrieved from https://hbr.org/2013/09/the-new-improved-keiretsu

[87] Collie, S. (2016). Nissan Serena will be the first Japanese vehicle with autonomous drive. Retrieved from http://newatlas.com/nissan-propilot-serena/44325/

[88] NissanNews (2016). Nissan Joint Research Center for Intelligent Mobility at Tsinghua University opens in Beijing. Retrieved from http://nissannews.com/en-US/nissan/usa/channels/us-nissan-technologies-autonomous-driving/releases/nissan-joint-research-center-for-intelligent-mobility-at-tsinghua-university-opens-in-beijing

[89] Adashek, J. (2016). People behind the ProPILOT: From NASA Mission Control to the driver's seat, scientist shapes future of autonomous driving. Retrieved from http://nissannews.com/en-US/nissan/usa/channels/us-nissan-technologies-autonomous-driving/releases/people-behind-the-propilot-from-nasa-mission-control-to-the-driver-s-seat-scientist-shapes-future-of-autonomous-driving

[90] NissanNews (2016). Renault-Nissan to launch more than 10 vehicles with autonomous drive technology over the next four years. Retrieved from http://nissannews.com/en-US/nissan/usa/channels/us-nissan-technologies-autonomous-driving/releases/renault-nissan-to-launch-more-than-10-vehicles-with-autonomous-drive-technology-over-the-next-four-years

[91] Mitsubishi Electric (2015). Mitsubishi Electric Introduces EMIRAI3 xAUTO Automated Driving Concept Car. Retrieved from http://www.mitsubishielectric.com/news/2015/1014-b.html

[92] 2025AD (2016). Mitsubishi redesigns weapon technology for driverless cars. Retrieved from https://www.2025ad.com/in-the-news/news/mitsubishi-boosts-driverless-cars/

tonomous driving systems. Sony has invested in ZMP, a start-up in robot cars, to develop self-driving vehicle technologies.[93]

Automotive suppliers put just as much effort into the advancement of automation and connectivity. For example Panasonic just shifted their motor business from to automotive and industrial appliances, paving the way in factory automation. In 2013, the company released new portable car navigation systems that are equipped with a drive camera function allowing to record the traffic situation in front of the vehicle and view the scenery of the drive in conjunction with the engine start-up. It uses GPS, gyro and Quasi-Zenith Satellite – Japan's continuously developing domestic positioning system – precision positioning technologies.[94]

Nippon Ceramic Co. Ltd. (Nicera), a tier-2 supplier mainly supplying Denso and Panasonic, is developing ultrasonic sensors for less than USD 0.92[95] that help autonomous vehicles avoid crashes and fit into tight parking spaces. The company's global market share in ultrasonic sensors is about 50%. Ultrasonic sensors can detect objects and obstacles within a 5-meter range. NEC Corp., Hitachi Automotive Systems Ltd. also produce sensors.[96] NEC is very strong in image recognition technology and V2X communication technology.[97] However, Japanese car parts makers lag behind German suppliers such as Bosch or Continental in sensor technology.

In 2014, METI signed an agreement with Japan Automobile Research Institute (JARI) worth JPY 1 billion to develop autonomous driving software in collaboration with NEC, Pioneer and ZMP that is expected to be put in practical use within five years.[98]

NEC, Denso, eSol formed a joint venture, named Aubass, to develop basic software that can support high-speed data communication, high-quality security, and high-performance microcomputers for in-vehicle systems mainly used for automated driving.[99]

Denso started testing advanced driving support technologies in 2014 on public roads. The company also owns a test course that has been in use.[100] In 2016 the company which specializes on communication-based vehicle control and in-vehicle communication devices has partnered with NTT DOCOMOCO, Inc., Japans biggest mobile phone operator with expertise in LTE and 5G networks, to jointly develop vehicle control systems for automated driving systems.[101]

Hitachi Automotive Systems has defined their business along three different domains, two of which tackle automation and connectivity. Whereas automation is mainly addressed within the field "safety" where different drive control systems are developed, the field "information" focuses on connectivity by developing cloud information network services as well as on-board information equipment.[102]

Fujitsu already runs intelligent traffic systems and intelligent parking solutions.[103] In Europe the company is developing multi-modal route planning linking multiple transportation networks including road, air, sea, and rail. In a joint collaboration with the MIT, Fujitsu Laboratories the company develops a

[93] Inagaki, K. (2016). Google and IBM overshadow Japanese tech groups in global AI race. Retrieved from http://www.ft.com/cms/s/0/c33eabe6-bea7-11e5-9fdb-87b8d15baec2.html#axzz4HaZVxXoz
[94] Telematics Wire (n.d.). Japan: Panasonic to release car navigation unit – Gorilla Eye. Retrieved from http://telematicswire.net/japan-panasonic-to-release-car-navigation-unit-gorilla-eye/
[95] Curry, D. (2016). Who's the Japanese firm with half of the self-driving car market?. Retrieved from http://readwrite.com/2016/04/15/nippon-ceramic-self-driving-car-japanese-tl4/
[96] Horie, M., Jie, M. (2016). 92-Cent Crash Avoidance Sensor Drives Nippon Ceramic's Gains. Retrieved from http://www.bloomberg.com/news/articles/2016-04-10/a-92-cent-chip-for-driverless-cars-is-a-windfall-for-japan-maker
[97] Arai, S., Hayakawa, A., Katou, M. et al. (2015). NEC's Commitment to Smart Mobility. In: NEC Technical Journal Vol. 10, Number 1. Retrieved from http://www.nec.com/en/global/techrep/journal/g15/n01/pdf/150112.pdf
[98] Nikkei (2014). Japan Trade Ministry, companies team up on self-driving tech. Retrieved from http://asia.nikkei.com/Tech-Science/Tech/Japan-Trade-Ministry-companies-team-up-on-self-driving-tech
[99] Edwards, D. (2016). Denso, eSol, and NEC form joint venture for connected cars. Retrieved from http://roboticsandautomationnews.com/2016/04/27/denso-esol-and-nec-form-joint-venture-for-connected-cars/4235/
[100] Denso (2014). DENSO Tests Advanced Driving Support Technology on a Public Road in Japan. Retrieved from http://www.globaldenso.com/en/newsreleases/140714-01.html
[101] NTT Docomo (2016). DENSO and NTT DOCOMO Agree to Develop Technologies for Advanced Driver Assistance and Automated Driving Systems. Retrieved from https://www.nttdocomo.co.jp/english/info/media_center/pr/2016/0222_00.html
[102] Hitachi Automotive Systems (n.d.). Business Description. Retrieved from http://www.hitachi-automotive.co.jp/en/vision/vision_04/index.html
[103] Reger, J. (2016). Artificial Intelligence (AI) is not a new discipline. Retrieved from http://blog.ts.fujitsu.com/index.php/artificial-intelligence-ai-not-new-discipline/

demonstration project, called “triple-role vehicles” adapting the vehicle to the amount of users and their dispensary time. Fujitsu is not only advancing their camera and radar technologies but also works on connectivity and online solutions such as with their Intelligent Society Solution SPATIOWL that collects travel and sensor information. One application case is the provision of hydrogen station information for Toyota’s Mirai FCEV.[104]

In addition to the older analogue Automatic Train Control (ATC) Japan’s railway system partially relies on digital ATC (D-ATC or DS-ATC for Shinkansen trains) using train-based control (opposed to ground-based control of the analogue system) allowing for braking in dependence of the specific train’s ability. The technology, developed by Hitachi and successfully deployed since the early 2000s, was first limited to automatic braking. Later on the company enhanced the technology by extending the function from just braking to all phases of train operation (ATO).[105] In combination with the company’s Communication-Based Train Control (CBTC) system higher traffic densities and driverless operation is made possible. The latter is based on a general-purpose 2.4 GHz band which makes it suitable for many different countries and regions.[106]

Furthermore standards of the applications of maritime intelligent transport systems have been presented including maritime Management and Information Systems, sea environment and interactive data on-line networks, ship integrated decision support systems, Advanced maritime navigation services, automatic identification, tracking and monitoring of vessels, as well as safety purposes.[107]

3.1.4.4 Market

As can be seen in Figure 5 and Figure 6, according to the White Paper on Transportation published in 2015[108] 15.9% would like to use and 38.7% would consider using autonomous vehicles (n=2,000). This adds up to more than half of the interviewed to be in favor of developments towards autonomous driving. Interestingly, when taking a closer look on the difference between the age of respondents, the ones most in favor (“would like to use”) are 20 or younger (18.3%), 30 to 39 (17.8%) and 60 or older (16.8%). This reflects the technological affinity of the younger generation and the diminishing vitality of the elderly who seek assistance in automated systems. This becomes even clearer by including the ones who tend to perceive developments positively. 42.5% of 50 to 59-year olds and 41.0% of 60 or more year old respondents “would consider using” autonomous vehicles. Overall only 14.6% would not want to use an autonomous vehicles, divided by age the majority of negative answers is spread between age groups 30 to 39, 40 to 49 and 50 to 59 (15.8%).

All in all, there is a clear tendency towards a public acceptance of autonomous cars, whatever the reasons behind might look like.

[104] Fujitsu (2015). Smart Automobiles and Next-Generation Transportation Systems. Retrieved from http://journal.jp.fujitsu.com/en/2015/06/15/02/

[105] Hitachi Rail (n.d.). ATO (Automatic Train Operation) System. Retrieved from: http://www.hitachi-rail.com/products/signalling/ato/

[106] Hitachi Rail (n.d.). Communication Based Train Control (CBTC). Retrieved from http://www.hitachi-rail.com/products/signalling/cbtc/

[107] Nowacki, G. (2012). Development and Standardization of Intelligent Transport Systems. In: TransNav – International Journal on Marine Navigation and Safety of Sea Transportation, Vol.6 (03)

[108] Ministry of Internal Affairs and Communications (2015), White Paper on Information and Communications in Japan. Retrieved from http://www.soumu.go.jp/johotsusintokei/whitepaper/eng/WP2015/2015-index.html

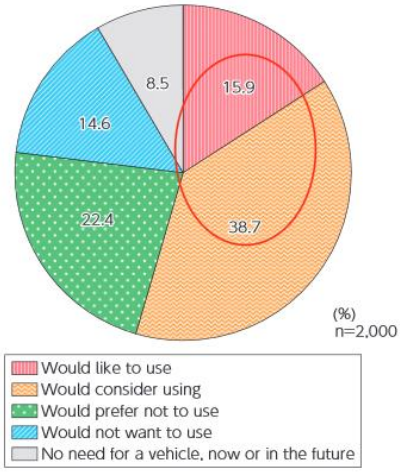


Figure 5: Japanese people's Intention to use autonomous vehicles[109]

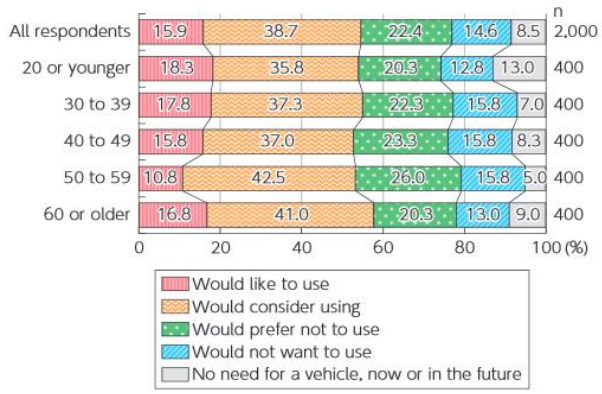


Figure 6: Japanese people's intention to use autonomous vehicles by age[110]

To reach the goal of transport automation and connectivity, the government is pushing the IT industry and IT-related research. Therefore, different strategies and plans have been issued. One of them, the ICT Growth Strategy II aims at realizing the world's most advanced ICT environment. Based on the vision "creating new innovation through connecting various things and services by ICT" three priority projects have been defined: (1) local revitalization including smart cities and smart agriculture, (2) solving social problems including transportation, and (3) Tokyo 2020 Olympic & Paralympic Games. To be able to attain the goal and put the vision into action the government invests in a common platform, the necessary infrastructure, and environmental improvement. [111]

[109] Ministry of Internal Affairs and Communication (2015). Study Report on People's Attitudes toward New ICT Services and Technologies that Resolve Social Issues,. Retrieved from http://www.soumu.go.jp/johotsusintokei/whitepaper/eng/WP2015/chapter-4.pdf

[110] Ministry of Internal Affairs and Communication (2015). Study Report on People's Attitudes toward New ICT Services and Technologies that Resolve Social Issues,. Retrieved from http://www.soumu.go.jp/johotsusintokei/whitepaper/eng/WP2015/chapter-4.pdf

[111] Ministry of Internal Affairs and Communications (2014). Smart Japan ICT Strategy. Retrieved from http://www.soumu.go.jp/main_content/000301884.pdf

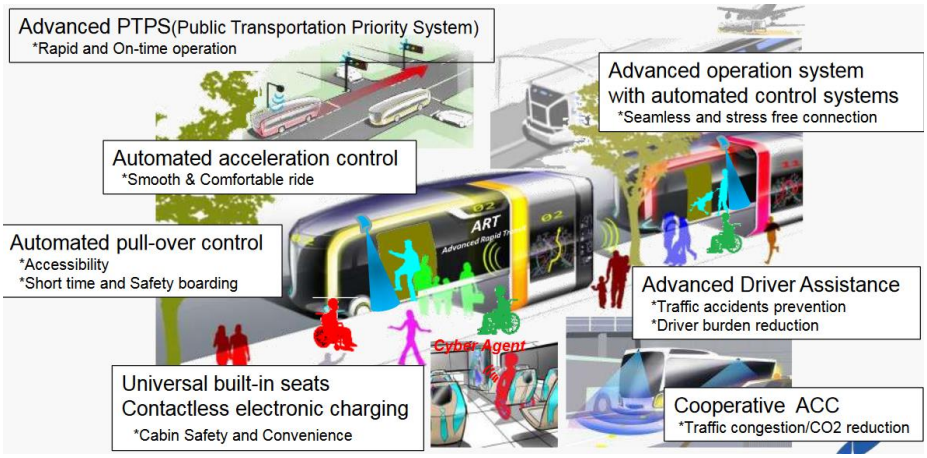


Figure 7: Advanced Rapid Transit Concept developed in SIP-ADUS[112]

In cities with high-density travel demand, such as Tokyo and Osaka, a pedestrian-centered multimodal transportation network is promising an efficient and sustainable alternative to conventional mobility. Therefore, innovative transit system with automated driving technologies and on-demand operation are developed that will not only reduce travel time and greenhouse gas emissions but also increase the comfort for passengers and enhance the efficiency for operators. Figure 7 shows different technologies to be deployed within the Next Generation Urban Transportation Systems – Advanced Rapid Transit (ART). It was created in the Cross-ministerial Strategic Innovation Promotion Program (SIP-ADUS). [113] They include Advanced Public Transport Priority Systems, Automated Acceleration Control, Automated Pull-Over Control, Contactless Electronic Charging, etc.

Figure 8 shows how the Next Generation Urban Transportation Systems is embedded within the Automated Driving theme. It can be seen that is perceived as a way to evoke a modal shift away from passenger cars, to push an advanced regional traffic management and to develop traffic infrastructure and control and thus, increase safety by encouraging accident prevention activities. Right now it is still in R&D phase but soon to be implemented. The plan is to have field tests between 2017 and 2018 before going in business operation in 2019.[114]

The plan to realize comprehensive ITS deployment lies on advances in navigation systems, electronic toll collection systems, assistance for safe driving, optimization of traffic management, increasing efficiency in road management, support for public transport, increasing efficiency of commercial vehicle operations, support for pedestrians, and support for emergency vehicle operations. ITS Initiatives in Japan.[115]

The technological affinity of the Japanese has led to an early and widespread use of Variable Message Signs (VMS) and Dynamic Message Signs (DMS) on roads to facilitate traffic. This holds also true for aviation: Tokyo International Airport (RJTT, Haneda Airport) was the first Japanese airport to introduce the Variable Message Sign (VMS) and Runway Status Lights (RWSL) in 2012. The system consists of LCD panel boards on one or both sides of the runway which light up to indicate how the pilot should proceed. It is a system where Runway Entrance Lights (REL) or Take-off Hold Lights (THL) are illuminated or extinguished, automatically and independent of air traffic control instructions based on dynamic surveillance capabilities (multilateration) which measures the aircraft position by the

[112] Kawamoto, M. (2014). An Approach to the Next Generation Transportation Systems. Retrieved from http://www.its-jp.org/english/files/2014/07/SIP7_Kawamoto.pdf
[113] Kawamoto, M. (2014). An Approach to the Next Generation Transportation Systems. Retrieved from http://www.its-jp.org/english/files/2014/07/SIP7_Kawamoto.pdf
[114] Kawamoto, M. (2014). An Approach to the Next Generation Transportation Systems. Retrieved from http://www.its-jp.org/english/files/2014/07/SIP7_Kawamoto.pdf
[115] Ministry of Land, Infrastructure, Transport and Tourism (2012). ITS initiatives in Japan. Retrieved from http://www.mlit.go.jp/road/ITS/pdf/ITSinitiativesinJapan.pdf

time difference of signals transmitted from the aircraft transponder and received. Other airports such as Osaka, New Chitose and Fukuoka soon followed suit.[116] [117]

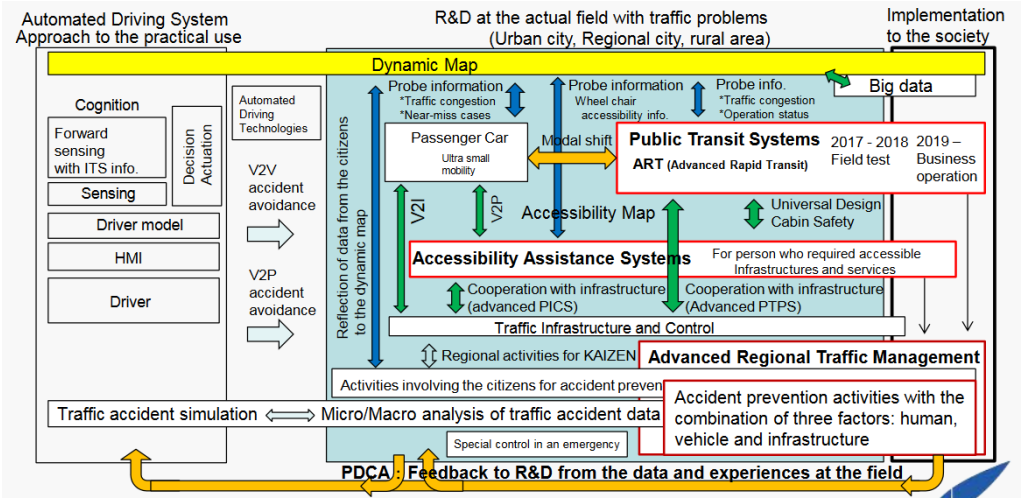


Figure 8: The Next Urban Transportation System in the context of automated driving[118]

Following the incident of a drone landing on the Prime Minister's office in April 2015, the Japanese legislation was fast to amend the Civil Aeronautics Act and Ordinance in light of unmanned aerial vehicles that took effect on 10 December 2015. The amended Act introduced restrictions on areas of flight and operation. It is prohibited for a drone to be used in airspace because of its likelihood to affect the safe operation of aircraft, meaning above airports and their vicinity and airspace which is above densely populated areas based on national census (> 5,000 per km^2). Its use is limited to daytime with a certain operating distance (30 meters) to other people and properties (among others).[119]

For rail, JR Systems is using computer-aided traffic control (COMTRAC) that allows around-the-clock status monitoring of all Shinkansen trains currently in operation. The core of the system is a Man-Machine Advanced Processor (MAP), Programmed Route Control (PRC), and Electronic Data Processing (EDP). They are also using Centralized Traffic Control (CTC), Automatic Train Control (ATC), Passenger Information Control (PIC) including automatic announcement systems, etc. Automatic Train Stop (ATS), a system for automatically applying brakes in situations where the risks overrunning, was introduced on all lines including conventional lines.[120]

[116] The International Federation of Air Line Pilots' Associations (2012). Variable Message Sign installed at Tokyo International Airport. Retrieved from http://www.ifalpa.org/store/13AGEBL03%20-%20Variable%20Message%20Sign%20installed%20at%20Tokyo%20Int'l%20Airport.pdf

[117] Ministry of Land, Infrastructure, Transport and Tourism (2015). Runway Status Lights (RWSL) in Japan. Retrieved from http://www.icao.int/APAC/Meetings/2015%20VisualAids/RWSL%20JAPAN.pdf

[118] Kawamoto, M. (2014). An Approach to the Next Generation Transportation Systems. Retrieved from http://www.its-jp.org/english/files/2014/07/SIP7_Kawamoto.pdf

[119] International Comperative Legal Guides (2016). Japan. Aviation Law 2016. Retrieved from http://www.iclg.co.uk/practice-areas/aviation-law/aviation-law-2016/japan

[120] Central Japan Railway Company (2012). Data Book 2012. Retrieved from http://english.jr-central.co.jp/company/company/others/data-book/_pdf/2012.pdf

3.1.4.5 SWOT analysis

Strengths	Weaknesses
• Multitude of academic institutions and universities putting effort into R&D for automation and connectivity • Strong industrial R&D&I by manufacturers and suppliers • Strong domestic ITS corporation • Long experience and market lead in ICT-related research and industry • Widespread use of state-of-the-art technologies • Strong governmental support through different programs and initiatives (e.g. SIP-ADUS): automated driving 1 of 10 prioritized themes	• Despite developments towards more flexibility traditional Keiretsu systems of value chain cooperation are still slow to react to crisis situations/changes • Tendency to develop island solutions with their own standards that are not deployed nation-wide, let alone internationally
Opportunities	**Threats**
• Demographic change, scarcity of resources and the necessity to establish a resilient transport system are strong drivers for development • 2020 Olympic Games are a major milestones that push investments in related industries • High technological affinity by society, especially for automated driving (>50 % in favour of developments towards autonomous driving), affinity to quality • Japanese companies setting up business in other countries such as USA	• Export opportunities are not used sufficiently

3.1.5 South Korea

3.1.5.1 General Information

One of the main drivers to push autonomous vehicle technologies is the South Korean's government's goal to attain their accident reduction target of road accident fatalities to 4,000 by 2017, and the number of fatalities per 10,000 motor vehicles down to 1.64 during the five-years of the current administration (2013-2017).[121] To reach this goal the government has invested KRW 295.5 billion for converging industries covering IT and automotive technologies (see Focus Area 3).[122] The main actors are The Korea Transport Institute (KOTI), Korean Automobile Manufacturers Association (KAMA), Korea Auto Industries Cooperation Associatioin (KAICA).

Even though the government has pushed software development a lot in the past, there has hardly been any funding for software development recently. Here, South Korea misses out on the opportunity to become a world leader in automation technologies, especially in light of the high education rate (> 80% of the population own a Bachelor degree).

[121] Hwang, S. and Kim, G. (2014). 50 Praxes for Better Transport in Korea, The Korea Transport Institute, Gyeonggi-do, 411-701, Republic of Korea, p. 86.
[122] Jeong Eun Ha (2015). Autonomous Vehicle industry in Korea, p. 1-2.

3.1.5.2 Research, Development & Innovation

Hyundai is putting a lot of effort in developing fully autonomous cars.[123] Their plan is to set aside KRW 2 trillion to commercialize fully autonomous vehicles by 2030. In its Uiwang Choongang Laboratory, its central research center, and in its Namyang R&D Center in Hwaseong, Gyeonggi, different autonomous car technologies are being tested. The company has received the approval for testing its autonomous road vehicle prototype in Nevada, United States. [124] However, it is perceived as a late comer when it comes to automation.[125] Hyundai plans to invest KRW 2 trillion on the development of smart cars by 2018. Together with their smaller affiliate Kia Motors Corp. they are planning to unveil self-driving vehicles in 2020.[126] The company announced to invest USD 9.75 billion over five years including USD 2 billion on R&D to Kia Motors over three years.[127]

Hyundai Mobis, a car part manufacturer affiliated with the OEM, has received a temporary license plate from the Ministry of Land, Infrastructure, and Transport to test its self-driving car on a 41 kilometer freeway from Seoul to Hobeop Junction in Gyeonggi. The license is effective for five years. In addition the company is building its own test roads designed just for the autonomous cars inside a large-scale testing ground including technology for simulation of emergency situations. It is scheduled to be constructed by October 2016 in Seosan, South Chungcheong.[128] Another applicant to the automated driving license plate is Kookmin University's Kookmin Unmanned Vehicle Laboratory (KUL). The research laboratory is working on unmanned vehicles since 1997.[129]

The main actor is the Korea Transport Institute. Their (research) activities span across eleven different areas, including Intelligent Transport Systems: Highway, Aviation, Transport economics, Urban transport, Railway, Logistics, ITS, Traffic safety and disaster prevention, Government-project, Means of transportation, National strategy.

Seoul National University has introduced a demonstration project called Snuber (SNU + Uber) at the university campus testing different technologies in its autonomous vehicle prototype.

3.1.5.3 Industry

Hyundai Motor, as Korea's biggest car manufacturer, introduced the first partially automated demonstration car in 2010.[130] Their updated plans foresee a commercialization of driverless vehicles by 2020. After receiving a test license for US highways, the company has recently also received a license from the Ministry of Land, Infrastructure and Transport for testing its autonomous Genesis sedan prototype on local roads in real-traffic conditions. The company is continuously improving their driver assistance systems.[131]

Apart from Hyundai, the main industrial company working on autonomous vehicle technologies in Korea is Unmanned Solution. The company, based in Seoul, specializes in unmanned transportation and is run by a former researcher at Kookmin University. It has successfully manufactured test cars for autonomous driving.[132]

[123] Lavars, N. (2015). Hyundai unleashes fully-autonomous Tucson Fuel Cell vehicles on US roads. Retrieved from http://www.gizmag.com/hyundai-autonomous-fuel-cell-us-roads/40935
[124] Jin-hai, P. (2015). Hyundai to test autonomous cars in U.S. Retrieved from http://www.koreatimes.co.kr/www/news/biz/2016/03/388_193175.html
[125] Airrang.co.kr. (2016): S. Korea transport ministry issues first license plate to an autonomous vehicle http://www.arirang.co.kr/News/News_View.asp?nseq=188922
[126] Safe Car News (2015). South Korea: Hyundai plans self-driving Genesis. Retrieved from http://safecarnews.com/south-korea-hyundai-plans-self-driving-genesis_n693
[127] Iglauer, P. (2015). Hyundai to develop fully autonomous cars by 2030. Retrieved from http://www.zdnet.com/article/hyundai-to-develop-fully-autonomous-cars-by-2030
[128] Eun-Soo, J. (2016). Mobis' self-driving car advances. Retrieved from http://koreajoongangdaily.joins.com/news/article/article.aspx?aid=3019829&cloc=joongangdaily|home|newslist1
[129] Kookmin Unmanned Vehicle Laboratory. Retrieved from http://kul.kookmin.ac.kr
[130] López, J. (2015). Hyundai Self Driving Car 2030 Plan. Retrieved from http://thekoreancarblog.com/2015/04/07/hyundai-self-driving-car-2030-plan
[131] Hyo-sik, L. (2016). Hyundai Motor to test self-driving car on local roads. Retrieved from http://www.koreatimes.co.kr/www/news/biz/2016/03/123_199840.html
[132] Joon-Sool, K. and Ji-Soo, L. (2016). Race is on to capture driverless car market. Retrieved from http://koreajoongangdaily.joins.com/news/article/article.aspx?aid=3014601&cloc=joongangdaily|home|newslist2

The Incheon Airport-Maglev rail line began commercial operation in February 2016. Two more stages of 9.7 km and 37.4 km are planned, which, once completed, will form a circular line. These lines make up a core project that the Korea Rail Network Authority managed. Hyundai Rotem has supplied four driverless trains, each with capacity for 230 passengers.[133]

Suncheon SkyCube PRT is one of the handful personal rapid transit (PRT) systems in the world and the only PRT in Asia.[134] The 4.64-kilometer-long railway connects Suncheon's Dream Bridge with Suncheon's Literature Center in 10 minutes. In opposition to the rather generic automated guideway transit (AGT) and the more specific automated people mover (APM) – both for mass-transit – Sky Cube has a total of 40 railcars, with each one being able to accommodate six to nine passengers. Passengers can only get on and get off at the arrival and destination stations (no stops in between) and tickets cost KRW 5,000.[135] System installation costs about 1/10th of the cost it takes to build subway systems. They are also one third the cost of light rail train systems and capacity is about the same. Because operation of PRT is automatic, cost efficiency is high and costs can be further reduced if cars are not operated when there are no passengers. PRT is an advantageous solution for development of new cities or new routes or advancements to existing routes.[136]

3.1.5.4 Market

The South Korean government has set a concrete strategy for technology development related to drones and autonomous vehicles which they have implemented in 2015. After requests for deregulations, the Ministry of Land, Infrastructure and Transport revised the Automobile Management Act, making it possible for self-driving vehicles to be tested on a total of 320 km on six designated routes on five national highways, including Suwon, Hwaseong and Yongin and a 41-kilometer section on the Gyeongbu Expressway from Seoul to Busan as well as the Incheon-Gangneung expressways.[137] [138] The license requires two drivers in the car at all times. Both license and plate are valid for five years.

K-Water, the governmental agency for comprehensive water resource development and management, introduced the ICT-based Smart Water Management Initiative that provides integrated water resource management services over the whole process of water cycle. Through the system a variety of different information shall be retrieved: real-time hydrological information, weather/rainfall prediction, flood analysis, real-time operation and control of dams and weirs.[139]

With respect to high-altitude unmanned aerial vehicles, the government has designated four locations of air space, along with 15 key developers, which will be allowed to use the designated air space to test their new products.[140]

[133] Railway Gazette (2016). Incheon Airport maglev starts passenger services. Retrieved from http://www.railwaygazette.com/news/news/asia/single-view/view/incheon-airport-maglev-starts-passenger-services.html
[134] Nikola (2015). Suncheon SkyCube PRT Ride . Retrieved from http://kojects.com/2015/07/20/suncheon-skycube-prt-ride
[135] Imagine your Korea (2014). Suncheon Bay's eco-friendly 'Sky Cube' train opens April 20. Retrieved from http://english.visitkorea.or.kr/enu/AKR/FU_EN_15.jsp?cid=1917408
[136] Posco.com (2014). Korea's First Personal Rapid Transit (PRT), SkyCube. Retrieved from http://globalblog.posco.com/koreas-first-personal-rapid-transit-prt-skycube
[137] Joon-Sool, K. and Ji-Soo, L. (2016). Race is on to capture driverless car market. Retrieved from http://koreajoongangdaily.joins.com/news/article/article.aspx?aid=3014601&cloc=joongangdaily|home|newslist2
[138] Korea Bizwire (2015). S. Korea to Begin Road Test of Self-Driving Cars in Feb. Retrieved from http://koreabizwire.com/s-korea-to-begin-road-test-of-self-driving-cars-in-feb/44678
[139] K-water (2016). K-water will open the future of water management with its own smart technologies. Retrieved from http://english.kwater.or.kr/eng/busi/SWMIPage.do?s_mid=1552
[140] K-water (2016). K-water will open the future of water management with its own smart technologies. Retrieved from http://english.kwater.or.kr/eng/busi/SWMIPage.do?s_mid=1552

3.1.5.5 SWOT Analysis

Strengths	Weaknesses
• State-of-the-art technologies already deployed • Export-oriented commercialization activities • Strong government push through financing programmes for IT and automotive technologies; however, in the last 5 years support reduced in comparison with other technologies • Government puts focus on funding SMEs (rather than big Chaebols) • In ICT-related industries synergies are built between government, research and industry • Legislation has been eased: roads have been opened for testing of automated driving, four locations of air space for high-altitude unmanned vehicles	• Lagging behind other countries in car automation; South Korea's technology level is at about 70-80% of global automation status-quo because there is no core technology developed (as e.g. in Germany and Japan) • Despite research and commercialization activities by single companies there is a lack of innovation culture and industrial activies • Economy is organized along business conglomerates • Lack of IT-related expertise/knowledge in comparison to other countries (e.g. USA, India, China, Japan)
Opportunities	**Threats**
• Demographic change, urbanization and reduction of traffic fatalities are huge drivers of automation and connectivity • Citizens demand more mobility options • Individual mobility stronger than public transportation	• Because users are concerned about privacy with Korean products they opt for foreign services • Lowest birth rate in the world

3.1.6 United States of America

3.1.6.1 General Information

Most stakeholders in the US consider autonomous vehicles to be a major part of the transportation sector future and the automotive industry. In this context of development and investment in the sector of autonomous driving, a classification system has also been created with six levels of vehicle automation, ranging from "no automation" up to "full automation".[141]

The rapid development of the autonomous vehicles technology forces state and municipal governments to find ways to ensure that potential challenges impacts can be tackled in a timely manner. In this context, 16 states have already introduced legislation concerning autonomous vehicles in 2015, more than 12 states in 2014, 10 states (including D.C) in 2013 and 6 states in 2012.[142] The no ratification of the Vienna Convention by the USA allows for favorable legislation of testing and uptake, while in the opposite side is the Federal structure that often leads to poor harmonization between states.

3.1.6.2 Research, Development & Innovation

The development of vehicle automation is evolving very quickly, with many OEMs mainly manufacturers' suppliers developing and testing prototype technologies, with high number of innovative SMEs providing the necessary sensor solutions, with well-established industrial collaboration between automobile manufacturing companies and technology companies, both being power horses of the U.S. economy**,** and with venture capital companies putting money into automation and connectivity tech-

[141] SAE International (2014). Automated Driving Levels of Driving Automation Are Defined in new SAE International Standard J3016. Retrieved from: http://www.sae.org/misc/pdfs/automated_driving.pdf
[142] National Conference of State Legislatures (2016). Autonomous | Self-Driving Vehicles Legislation. Retrieved from: http://www.ncsl.org/research/transportation/autonomous-vehicles-legislation.aspx

nologies. Many U.S. based IT companies are global market leaders in big data analysis required for higher level automation in complex environments, such as cities.

The ITS Joint Program Joint Program Office (ITS JPO) of the USDoT, is the basic sponsor of the Connected Vehicle program. Connected Vehicle focuses on localized Vehicle-to-Vehicle (V2V), Vehicle-to-Infrastructure (V2I) and Vehicle-to-Device Systems (V2X) to support safety, mobility and environmental applications using vehicle Dedicated Short Range Communications (DSRC)\ Wireless Access for Vehicular Environments (WAVE). This program has support from most of OEMs and a number of state departments of transportation.

The ITS America Connected Vehicle Task Force in cooperation with other organizations (i.e. Transportation Research Board, Institute of Transportation Engineers, American Association of State Highway and Transportation Officials, International Road Federation, etc.) have tried to respond to the Middle Class Tax Relief and Job Creation Act[143], while the USDoT has developed a Connected Vehicle Reference Architecture[144] regarding the components deployment by road operators, equipment manufacturers, service providers, etc. USDoT intends to implement test beds at several different locations in the US, in an effort to help and promote the deployment on highways[145], as well as face the problem of lack of telecommunication infrastructure, especially in rural regions.

Furthermore, the Virginia Automated Corridors (VAC) is a new initiative aiming to provide an automation-friendly environment in which government agencies, equipment manufacturers and suppliers could test and certify their systems. The VAC will offer great advantages and assets in on-road safety research for efficient solutions to automated-vehicle testing.[146] Figure 9 presents the routes included in the VAC initiative.

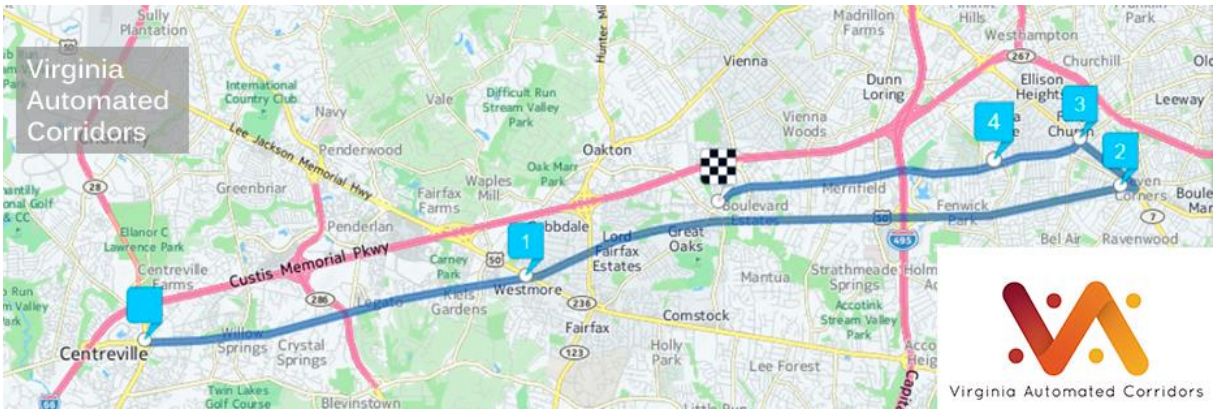


Figure 9: Routes of the Virginia Automated Corridors initiative[147]

The Tri-Lateral Working Group (WG), which has been created by the VRA (Vehicle and Road Automation) FP7 Project in 2013, focuses also on autonomous driving, involving all road users within a connected environment for broad information sharing and collaboration across the regions, in an effort to achieve the maximum benefits in terms of safety, mobility and environmental impact. The Trilateral WG is composed of EU, US and Japanese representatives, as well as experts to support the discussions. From the European side, VRA provides the support to the EU officials.[148]

[143] ITS America (n.d). The Connected Vehicle - Next Generation ITS. Retrieved from: http://www.itsa.org/industryforums/connectedvehicle

[144] CVRIA (2016). Connected Vehicle Reference Implementation Architecture. Retrieved from http://www.iteris.com/cvria/index.html

[145] ITS America (n.d). The Connected Vehicle - Next Generation ITS. Retrieved from: http://www.itsa.org/industryforums/connectedvehicle

[146] VAC (2015). Providing real-world testing environments for the development and deployment of automated vehicles: Retrieved from http://www.vtti.vt.edu/PDFs/VAC.pdf

[147] Virginia Tech Transportation Institute (2015). Virginia Tech Transportation Institute and Partners Unveil Virginia Automated Corridors. Retrieved from: http://www.vtti.vt.edu/featured/?p=260

[148] VRA Networking in Automation (2014). Trilateral Automation WG on Road Vehicle Automation. Retrieved from: http://vra-net.eu/event-archive/trilateral-automation-wg-on-road-vehicle-automation/

The Tampa, Florida Expressway Authority recently conducted a SWOT analysis of the role of "Automated Vehicles to Reduced Fuel Consumption and Air Pollution".[149]

The Florida SWOT analysis considered two scales—a single automated vehicle and the whole traffic system. Automated vehicles (AVs) provide significant safety benefits, may improve urban areas by reducing the need for parking and enhance fuel reduction, while offering synergies with alternative fuel vehicles. A reduction of fuel consumption of 20% to 50% seems to be feasible.

The SWOT study revealed that the Automated Vehicles have the potential to contribute to the goal of reducing fuel consumption. One weakness of the Tampa Hillsborough Expressway Authority SWOT analysis is that it did not include an evaluation of the type of fuel being consumed with Autonomous Vehicle technology. If the SWOT considered alternative fuels, it is conceivable that the results would have directly favoured the implementation of connected driving[150].

Also, the University of Kentucky recently completed a SWOT analysis of Self-Driving Cars for ICT 300.[151] Threats posed by self-driving vehicles identified through the SWOT analysis include the potential for injury or death via unforeseen/un-programmed accident avoidance situations and the dramatic increase in threats to privacy through the operation of networks that track your location on a 24-hour basis.

Opportunities included the need to develop new manufacturing processes and facilities and a transition from vehicle ownership to pay-as-you-go. Strengths included the ability to centralize the control of traffic flows which should reduce congestion. Weaknesses ranged from the time it takes to develop a supporting infrastructure to building appropriate regulatory and liability-management frameworks to establishing globally-accepted standards.

On September 14th, 2015, the USDoT announced the selection of sites for the Connected Vehicle (CV) Pilot Deployment Program[152]. The CV Pilots Deployment Program seeks to combine connected vehicle and mobile device technologies in innovative and cost-effective ways to improve traveller mobility and system productivity, while reducing environmental impacts and enhancing safety. The selected three pilot sites, where a broad spectrum of applications enabled by connected vehicle technologies driven by site-specific needs, will be evaluated. It will further advance the proof of concept and move towards the deployment and operations phases.

These three pilot sites, which were selected in order to represent different needs and applications, include the use of connected vehicle technologies to improve safe and efficient truck movement (southern Wyoming), the exploitation of V2V and intersection communications to improve vehicle flow and pedestrian safety (New York), as well as deployment of multiple safety and mobility applications on and in proximity to reversible freeway lanes (Tampa, Florida).[153]

The three pilot sites will work together and also co-operate with the USDOT, and additional stakeholders and team members, in order to enhance program productivity. This model of co-operation is expected to benefit the current effort but also the second wave of pilot deployment sites that are going to be identified later in the program.[154]

As more and more automated and connected vehicles are manufactured and more and more enabling infrastructure is being built, the country's legal framework is developed to go hand in hand with this progress.

[149] Eckart, J. and Vairavamoorthy, K. (2013). Contribution of Automated Vehicles to Reduce Fuel Consumption and Air Pollution. Retrieved from: http://www.automatedvehicleinstitute.org/pdf/TAVI_9-FuelAirQualityEckart.pdf
[150] Eckart, J. and Vairavamoorthy, K. (2013). Contribution of Automated Vehicles to Reduce Fuel Consumption and Air Pollution. Retrieved from: http://www.automatedvehicleinstitute.org/pdf/TAVI_9-FuelAirQualityEckart.pdf
[151] Self Driving Car (2016). The Future. Retrieved from https://selfdrivingcarproject.wordpress.com/
[152] USDoT – Intelligent Transportation Systems Joint Program Office (2016). Connected Vehicle Pilot Deployment Program. Retrieved from: http://www.its.dot.gov/pilots/
[153] USDoT – Intelligent Transportation Systems Joint Program Office (2016). Connected Vehicle Pilot Deployment Program. Retrieved from: http://www.its.dot.gov/pilots/
[154] USDoT – Intelligent Transportation Systems Joint Program Office (2016). Connected Vehicle Pilot Deployment Program. Retrieved from: http://www.its.dot.gov/pilots/

Congress has suggested but not introduced new legislation yet, mainly due to the opposition from car manufacturers and technology companies. On July of 2015, Senators Edward Markey and Richard Blumenthal proposed legislation requiring the Department of Transportation's National Highway Traffic Safety Administration (NHTSA) to cooperate with the Federal Trade Commission (FTC) for the establishment of consumer data privacy and car computer network security rules ("f Car Act").

The SPY Car Act was based on a report by Senator Markey, who had surveyed OEMs about cyber threats to safety and the collection and storage of driving data (i.e. location, driving history, and user data). According to the report, almost every car on the market has wireless technologies and has also identified several weaknesses in the security of connected features in cars.

The SPY Car Act would require collaboration between the NHTSA and the FTC to implement cybersecurity standards for vehicle system and driving data security.[155] More information is presented in the "Standardization & Interoperability focus area, in section 3.4.6.2.

UC Berkeley PATH has been created of the Berkeley DeepDrive (BDD) Industry Consortium that will facilitate linkages between innovations in information technology to innovations in car manufacturing for connected vehicles. This research alliance will investigate state-of-the-art technologies in computer vision and machine learning for automotive application. The Center's inaugural private industry partners are: Audi/VW of America, Bosch, Ford, Honda, NVIDIA, Samsung, Panasonic, Qualcomm, and Toyota.[156]

Another area that is examined by the US Government for the use of autonomous vehicles, is the planned emergency procedures. More specifically, the U.S. Department of Transportation has been examining how car-to-car communications, which is a critical piece of the anticipated self-driving future, could enhance and improve evacuation procedures. The recent federal policy guidance highlights the need for auto makers to consider how autonomous vehicles could respond in emergency situations[157].

The U.S. Department of Transportation is officially entering into this self-driving area, issuing a policy guidance on regulating the emerging technology nationwide. This equates to a federal endorsement of full autonomy.

In more details, with the guidance, DoT aims to lay a foundation for the safe testing and deployment of autonomous vehicles. It also includes a 15-point "Safety Assessment" to guide carmakers through the development phase, encompassing cases, such as how vehicles should react if autonomous technology fails, and how the manufacturers intend to share the driving data gathered by their vehicles. It describes a "model policy" for states, trying to ease the current patchwork of state laws, into something more consistent with national policy. And it discusses ways that the National Highway Traffic Safety Administration could apply current safety regulations regarding autonomous cars, as well as the potential for new standards and testing protocols that might be necessary as technology evolves. However, as was pointed out by the DoT officials, this guidance is just a guidance and not a statement of rule-making.[158]

The USDOT has also issued the Smart City Challenge, announcing to fund one city with USD 40 million, in order to support it in evolving to become the country's first Smart City by fully integrating innovative technologies, like self-driving cars, connected vehicles and smart sensors into their transportation network.[159] 78 cities participated in this initiative, giving great emphasis on automated vehicles. In more details, 82% of the participants included significant vehicle automation concepts, as part of their Smart City vision. Many applicants identified opportunities for leveraging

[155] Markey, S. and Edward, J. [D-MA] (2015). Security and Privacy in Your Car Act of 2015 or the SPY Car Act of 2015. Retrieved from: https://www.congress.gov/bill/114th-congress/senate-bill/1806/all-info

[156] Ingrassia P. and White J. (2016). Automakers, not Silicon Valley, lead in driverless car patents: study. Retrieved from: http://www.reuters.com/article/us-tech-ces-autos-idUSKBN0UJ1UD20160105

[157] Bliss L. (2016). Could Self-Driving Cars Speed Hurricane Evacuations?. Retrieved from: http://www.theatlantic.com/technology/archive/2016/10/self-driving-cars-evacuations/504131/

[158] Bliss L. (2016). The U.S DOT Officially Puts a Car in the Self-Driving Race. Retrieved from: http://www.citylab.com/commute/2016/09/the-us-dot-officially-puts-a-car-in-the-self-driving-race/500744/

[159] US Department of Transportation (2016). Smart City Challenge. Retrieved from: https://www.transportation.gov/smartcity.

automated vehicles to connect disadvantaged communities, while significant interest was also shown in electric propulsion (i.e. electric automated vehicles), as well as low speed automated vehicles supporting first mile / last mile connections, automated / semi-automated transit vehicles, automated truck demonstration and truck platooning.[160]

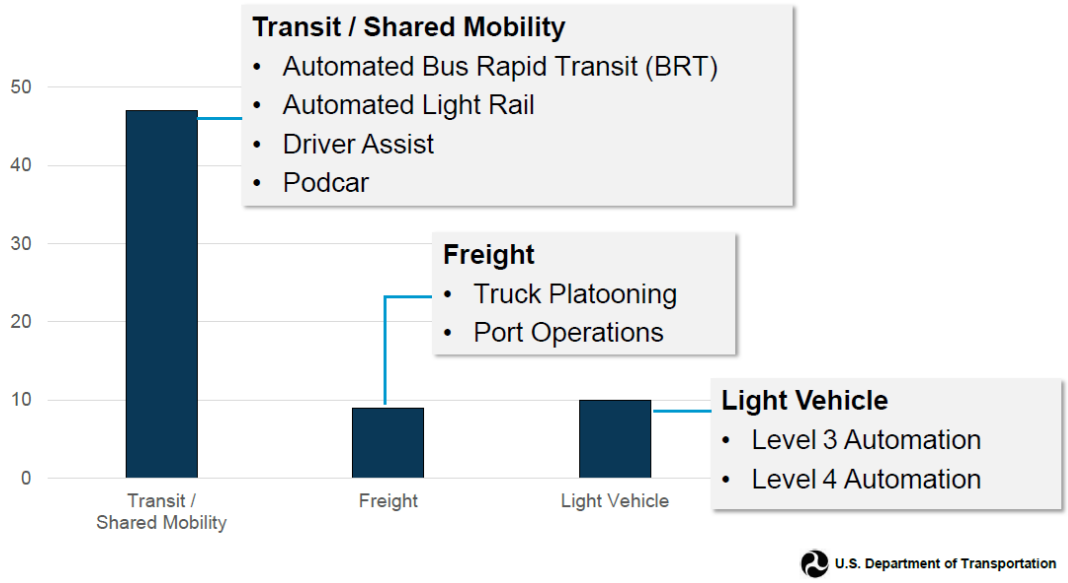


Figure 10: Urban Automation: 78 Cities Analysis in Smart City Challenge

Regarding the air sector, the Unmanned Aircraft Systems (widely known as drones) are widespread in USA, especially for military use. United States drone laws are continuously changing and evolving, following the technological developments. The NEW Small UAS Rule (Part 107), including all pilot and operating rules, will be effective on August 29, 2016.[161]

However, up until now, United States Drone laws allow drones to only be used for recreational use. Recently the Federal Aviation Administration (FAA), which was trying to enforce drone registration and education for years, has announced that all drones and quadcopters that weigh more than 250 grams should be registered. The registration can be done on internet through a web form. The reason is that there are a lot of safety and privacy concerns. One is that drone airspace could interfere with the airspace of other aircrafts and this is why the FAA has declared that drones are prohibited within five miles around airports and national parks, as well as, in certain areas where it might be considered that drones could be a threat.

It is also forbidden for drones to fly above the height of 400 feet and without the sight of operator. This limitation of up BVLS (Beyond Visual Line of Sight) is the greater inhibitor to commercial use of drones for transport application and logistics. Other safety concerns stem from the fact that almost everything can be attached to the drone – there have been incidents of people attaching guns and flamethrowers. With registration, it is easier to trace and recognize the violations.[162]

3.1.6.3 Industry

NHTSA is expected to propose best-practice guidance to industry for setting principles regarding the safe operation of fully automated vehicles. NHTSA plans to work with industry and other stakeholders aiming at guidance for the safe deployment and operation of autonomous vehicles, providing a con-

[160] Cronin B. (2016). Beyond Traffic: The Smart City Challenge - Automation in the Smart City.
[161] Federal Aviation Administration (2016). Summary of small unmanned aircraft rule (part 207). Retrieved from: https://www.faa.gov/uas/media/Part_107_Summary.pdf
[162] Thomas Foster (2015). New Drone Regulation in USA – What Changes? Retrieved from: https://www.cinema5d.com/new-drone-regulation-in-usa-what-changes/

sensus concerning the performance characteristics necessary for fully autonomous vehicles, as well as the testing and analysis methods for their assessment.[163]

The ITS America Connected Vehicle Task Force is also in dialogue with industry and public sector members about the challenges of public-private partnerships and business models that are going to make deployment attractive for both sides, ensuring long term technical support and implementation and assisting USDoT, the FCC, as well as state and local authorities in establishing leadership where needed[164].

Perhaps the most typical example of autonomous driving development is USA is the Google Self-Driving Car Project. Google Self-Driving Car is an initiative, as part of Google's project to develop technology for electric cars. The software installed in Google's cars is named Google Chauffeur[165]. The team has equipped a number of different types of cars (i.e. Toyota Prius, Audi TT, and Lexus RX450h) with self-driving equipment, while has also developed its own custom vehicle, assembled by Roush Enterprises and using equipment from Bosch, ZF Lenksysteme, LG and Continental.[166]

Figure 11: Google's in-house driverless car design[167]

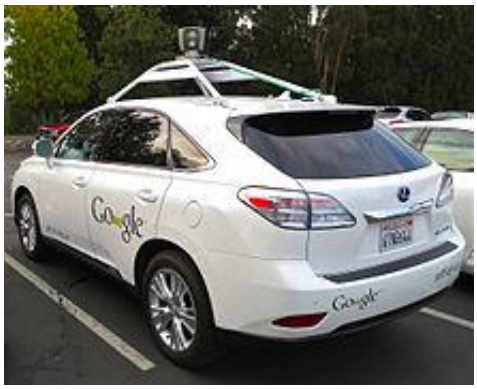


Figure 12: A Lexus RX450h retrofitted by Google for its driverless car fleet[168]

Google's cars have about USD 150,000 in equipment, including a USD 70,000 LIDAR system. The range finder mounted on the top is a Velodyne 64-beam laser, which allows the car create a detailed 3D map of its environment. The car then uses these maps, combines them with world high-resolution

[163] National Highway Traffic Safety Administration (2016). Secretary Foxx unveils President Obama's FY17 budget proposal of nearly USD 4 billion for automated vehicles and announces DOT initiatives to accelerate vehicle safety innovations . Retrieved from: http://www.nhtsa.gov/About+NHTSA/Press+Releases/dot-initiatives-accelerating-vehicle-safety-innovations-01142016

[164] ITS America (2016). The Connected Vehicle - Next Generation ITS. Retrieved from: http://www.itsa.org/industryforums/connectedvehicle

[165] Fisher, Adam (2013). Inside Google's Quest To Popularize Self-Driving Cars. Retrieved from: http://www.popsci.com/cars/article/2013-09/google-self-driving-car.

[166] Nelson, G. (2015). Google in talks with OEMs, suppliers to build self-driving cars. Retrieved from: http://www.autonews.com/article/20150114/OEM09/150119815/google-in-talks-with-oems-suppliers-to-build-self-driving-cars

[167] WIKIPEDIA (2016), Google self-driving car. Retrieved from https://en.wikipedia.org/wiki/Google_self-driving_car#cite_note-19

[168] WIKIPEDIA (2016), Google self-driving car. Retrieved from https://en.wikipedia.org/wiki/Google_self-driving_car#cite_note-19

maps and produce different types of data models that allow it to drive itself. As of June 2014, the system works with a very high definition inch-precision map of the area the vehicle is expected to use. As of June 2016, Google had test driven their fleet of vehicles, in autonomous mode, a total of 2,777,585 km.[169]

Tesla is another OEM that is active in the area of autonomous cars, making semi-autonomous cars. Tesla's strength is propulsion and storage technology, notably batteries. The vehicles are equipped with new instrument panels, app windows and take up more of the 17-inch touchscreen. Drivers are getting information about what their cars are doing when they are in Autopilot, while they can also lock and unlock their car from the status bar.[170]The Tesla Model S finds its way by the use of two tracking systems, either by locking onto the car ahead or sighting the lane marks. In case of difficulties in detecting the road, a “Hold Steering Wheel” advisory is being used. , while if lane keeping is interrupted, a black wheel gripped by red hands and a “Take Over Immediately” message appear on the dash.[171] Tesla's strength is propulsion and storage technology, notably batteries.

Figure 13: The Tesla Model S P85D[172]

Since 2015 there are also various reports that Apple is also working on an autonomous car project. The iCar project it will probably be released on 2020.[173] Another proof of the company’s turn in the autonomous cars field is that Apple has invested USD 1 billion in the Chinese ride-sharing company Didi Chuxing.[174] Apple's advantage is in electronic navigation and communication systems.

BMW, Intel and Mobileye's partnership is also another significant milestone for the automotive industry. Mobileye's technology enables BMW to be the first OEM to succeed series production of fully autonomous vehicles by 2021.[175]

[169] Madrigal, A.C. (2014). The Trick That Makes Google's Self-Driving Cars Work. Retrieved from: http://www.theatlantic.com/technology/archive/2014/05/all-the-world-a-track-the-trick-that-makes-googles-self-driving-cars-work/370871/

[170] Mc Hugh, M. (2015). Tesla’s Cars Now Drive Themselves, Kinda. Retrieved from: http://www.wired.com/2015/10/tesla-self-driving-over-air-update-live/

[171] Sherman, D. (2016). 2015 Tesla Model S P85D. Retrieved from: http://www.caranddriver.com/features/semi-autonomous-cars-compared-tesla-vs-bmw-mercedes-and-infiniti-feature-2015-tesla-model-s-p85d-page-5

[172] Sherman, D. (2016). 2015 Tesla Model S P85D. Retrieved from: http://www.caranddriver.com/features/semi-autonomous-cars-compared-tesla-vs-bmw-mercedes-and-infiniti-feature-2015-tesla-model-s-p85d-page-5

[173] Lewis Painter (2016). iCar release date rumours, features and images: Apple has tripled its R&D budget to USD 10bn suggesting something big is being developed | Project Titan to roll-out in 2021. Retrieved from: http://www.macworld.co.uk/news/apple/will-apple-make-icar-project-titan-rumour-roundup-ford-tesla-budget-date-3425394/#launch

[174] Daisuke Wakabayashi and Douglas McMillan (2014). Apple’s Latest USD 1 Billion Bet Is on the Future of Cars. Retrieved from: http://www.wsj.com/articles/apples-1-billion-didi-investment-revs-up-autonomous-car-push-1463154162

[175] http://www.mobileye.com/

However, the United States is not the current leader in the generation of connected driving intellectual property. According to a report by the Intellectual Property and Science Division of Thomson Reuters[176], Toyota is considered to be the global leader in the area of self-driving car patents. Toyota is followed by Germany's Robert Bosch GmbH, Japan's Denso Corp, Korea's Hyundai Motor Company, and the U.S. General Motors Company. Google ranks only 26th on the number of patents list.[177]

Toyota is investing over a billion dollars in U.S. based research centers to access the information technology and robotics talent of Silicon Valley, California, Ann Arbor Michigan, and the Boston Massachusetts area. USA is also an additional attraction for many other OEMs involved in the research concerning automated driving and which make their research centres in the USA, such as Baidu from China, or Volvo from Sweden.[178]

Partnerships between U.S. OEMs are also being forged with lesser known Silicon Valley technology companies that have interesting but relatively untested technologies. General Motors is investing USD 500 million in Lyft, Inc. to initiate a Detroit-Silicon Valley partnership with the ride-sharing technology company to develop an "on-demand" network of self-driving cars.[179]

While most experts predict that fully self-driving vehicles are unlikely to be on highways in large numbers for many years, there are many incremental opportunities to introduce elements of "semi-autonomous" driving systems that can handle tedious or complicated driving situations and/or improve information and data services.

As far as drones are considered, the UAV and drones industry is being flourished, especially during the last years. There are many drones' manufactures in USA, developing some of the most advanced systems, such as 3D Robotics, Parrot, Matternet, etc.

3.1.6.4 Market

In January 2016, the U.S. Transportation Secretary presented a new policy updating the National Highway Traffic Safety Administration's (NHTSA) 2013 preliminary policy statement about autonomous vehicles. An investment of nearly 10 years and USD 4 billion to stimulate the development and adoption of safe vehicle automation through real-world pilots has been also announced. The new policy is designed to promote the development of technologies with the potential to save lives.[180]

The ITS America Connected Vehicle Task Force explores opportunities for the deployment of short range vehicle-to-X safety, mobility applications and related wireless communications-based intelligent transportation systems. Issues examined concern technical risks, institutional risks (i.e. Liability and privacy issues), meeting stakeholder needs, as well as ensuring system sustainability.

A 2014 Survey of Public Opinion about Autonomous and Self-Driving Vehicles in the U.S., the U.K., and Australia, conducted by The University of Michigan Transportation Research Institute (UMTRI) is illuminating as to public opinion on autonomous mobility in three English-speaking countries.[181] The main findings applicable to USA indicated that although the majority of respondents had previously heard of autonomous or self-driving vehicles, had a positive initial opinion of the technology, and had high expectations about the benefits of the technology, most of them also had high levels of concern mainly about security issues and riding in self-driving vehicles. Female responders expressed higher

[176] Jen Breen and David Russell (2016). Toyota, Bosch, Denso, Hyundai, GM & Nissan Lead the World in Self-Driving Auto Innovation. Retrieved from: http://thomsonreuters.com/en/press-releases/2016/january/toyota-bosh-denso-hundai-gm-nissan-auto-innovation.html

[177] Paul Ingrassia (2016). Automakers, not Silicon Valley, lead in driverless car patents: study. Retrieved from: http://www.reuters.com/article/us-tech-ces-autos-idUSKBN0UJ1UD20160105

[178] Markoff, J. (2015). Toyota Invests USD 1 Billion in Artificial Intelligence in U.S. Retrieved from: http://www.nytimes.com/2015/11/06/technology/toyota-silicon-valley-artificial-intelligence-research-center.html?_r=0

[179] Trousdale, S. (2016). GM invests USD 500 million in Lyft, sets out self-driving car partnership. Retrieved from: http://www.reuters.com/article/us-gm-lyft-investment-idUSKBN0UI1A820160104

[180] National Highway Traffic Safety Administration (2016). Secretary Foxx unveils President Obama's FY17 budget proposal of nearly USD 4 billion for automated vehicles and announces DOT initiatives to accelerate vehicle safety innovations. Retrieved from: http://www.nhtsa.gov/About+NHTSA/Press+Releases/dot-initiatives-accelerating-vehicle-safety-innovations-01142016

[181] Schoettle, B. and Sivak, M. (2014). A Survey of Public Opinion about Autonomous and Self-Driving Vehicles in the U.S., the U.K., and Australia." Report No. UMTRI-2014-21. Retrieved from: https://deepblue.lib.umich.edu/bitstream/handle/2027.42/108384/103024.pdf

levels of concern with self-driving vehicles than did males and they were more cautious about their expectations concerning the benefits from using self-driving vehicles.[182]

With the globalization of the auto-industry and research programs in other countries, the ITS America Connected Vehicle Task Force also seeks cooperation through international partnerships with associations such as ITS Japan, ITS Canada, Europe's ERTICO, and their stakeholders.[183]

Despite the assurances of the USDoT, there is also a general trend towards tracking the driving behavior of drivers. Considerably strong was the reaction of the public, in a proposed rule by the National Highway Traffic Safety Administration (NHTSA), regarding the placing of event data recorder to all cars, concerned about privacy issues.[184]

The use of telematics data can be a privacy issue. In 2013, a relevant issue had occurred, when during a New York Times' reporter, contesting of the battery life of a Model S car, Tesla managed to have data showing that he was draining the battery on purpose. Although, the reporter argued that he was just facing problems finding a charging station in the dark, the main issues raised from this was that the use of the data at face value exposed some major privacy problems. Is this level of data gathering happening to everyone? Are car companies unnecessarily tracking drivers without their knowledge?

The Consumers Union says that having EDRs in all cars is an important step toward improving auto safety. But it also says that car owners should own the data and that the privacy concerns of consumers should be respected.[185]

Thus, although the US with the endless driving distances and the long highways along states offers the obvious entry market for autonomous cars; public acceptance might be the highest obstacle and stake.

On National level, the U.S. Department of Transportation (USDoT), as a matter of policy (not law), states that it is committed to secure that connected vehicle technology preserves personal privacy and the system protects from unauthorized access. The vehicle information communicated does not identify the driver or vehicle and technical controls have been put in place to help the prevention of vehicle tracking and distortion with the system. It is already working closely with stakeholders to address such challenges, as well as develop technology and systems to ensure the safety of automated vehicles.[186]

According to the USDoT, the safety applications of connected vehicles require that the wireless devices send and receive a basic safety message (BSM) about vehicle position, speed and more information related to vehicle status and projected route. However, these BSMs, contain no personally information and is transmitted in a very limited geographical range, usually less than 1km.[187] Nearby motor vehicles are going to use such information to warn drivers of dangerous situations.[188]

[182] Schoettle, B. and Sivak, M. (2014). A Survey of Public Opinion about Autonomous and Self-Driving Vehicles in the U.S., the U.K., and Australia." Report No. UMTRI-2014-21. Retrieved from: https://deepblue.lib.umich.edu/bitstream/handle/2027.42/108384/103024.pdf

[183] ITS America (n.d). The Connected Vehicle - Next Generation ITS. Retrieved from: http://www.itsa.org/industryforums/connectedvehicle

[184] The Buffalo News (2014). Amid 'black box debate,' cellphones in cars already compromise privacy. Retrieved from: http://www.buffalonews.com/business/consumer-reports/amid-black-box-debate-cellphones-in-cars-already-compromise-privacy-20140929

[185] ConsumerReports (2014). How your car's black box is tracking you. You're trading personal information for safety and convenience. Retrieved from: http://www.consumerreports.org/cro/magazine/2014/09/how-your-car-is-tracking-you/index.htm

[186] U.S. Department of Transportation (2014). ITS Strategic Plan 2015–2019 Automation. Retrieved from: http://www.its.dot.gov/factsheets/pdf/FactSheet_AutomatedVehicles.pdf

[187] USDoT – Intelligent Transportation Systems Joint Program Office (n.d). Connected Vehicles and Your Privacy. Retrieved from: http://www.its.dot.gov/factsheets/privacy.htm

[188] USDoT – Intelligent Transportation Systems Joint Program Office (n.d). Connected Vehicles and Your Privacy. Retrieved from: http://www.its.dot.gov/factsheets/privacy.htm

3.1.6.5 SWOT Analysis

Strengths	**Weaknesses**
• Strong government support for combination of connected and automated driving • U.S. based IT companies are global market leaders in big data analysis required for higher level automation in complex environments, such as cities • High number of innovative SMEs providing the necessary sensor solutions • Well-established industrial collaboration between automobile manufacturing companies and technology companies • Venture capital companies putting money into automation and connectivity technologies. • Abundance of test-beds	• Federal structure leads to poor harmonization between states • Lack of IT infrastructure, especially in rural regions • No investment for deployment • Lack of knowhow in automotive-related technologies (e.g. sensors)
Opportunities	**Threats**
• International collaboration e.g. through participation of relevant government agencies in the Trilateral group with Europe and Japan • While the deployment of a totally-automated vehicles may be years off, incremental advancements in automated vehicle technology are already being implemented by various automobile manufacturers • No ratification of Vienna Convention allows for favorable legislation of testing and uptake • Energy and traffic efficiency gains are expected to lead to benefits beyond road safety, e.g. better climate protection, air quality, productivity • Fertile ground due to systemic linking of IT, automotive and energy developments, both being power horses of the U.S. economy	• Recent malfunctions may increase public reluctance to purchase automated vehicles • Growing political and public opposition to “free trade” agreements could slow the international deployment of connected vehicle technologies in the U.S. • Increasing sell-out to China due to bigger market and cheaper production possibilities • Ongoing concerns regarding automation and robot ethics impede uptake of automation technologies • Potential increase of traffic volume based on automatization may create rebound effects, hampering overall benefits • Threat in terms of cybersecurity

3.2 Focus Area 2 – Transformation of Infrastructure

3.2.1 Brazil

3.2.1.1 General Information

Brazil has a national plan to improve urban mobility through infrastructure improvements and reducing reliance on personal vehicles that aim to reduce GHG emissions from passenger road transport by a total of 19.5 million tons CO_2 by 2020 relative to business as usual. Brazil has already developed a program for improving urban mobility that would reduce GHG emissions by reducing dependence on personal vehicles.[189] The Brazilian Federal Government intends to introduce high speed rail as an alternative solution to other transport modes including road and airports, but currently it seems to be expensive. Metro systems exist in eight Brazilian cities, including São Paulo, Rio de Janeiro and Belo Horizonte. Brazil's air transport infrastructure is relatively well developed. Road transport is the primary means for passengers and for freight purposes in Brazil. Keeping that in mind, this focus area for Brazil focuses on the transformation of road infrastructure.

In terms of infrastructure adequacy, Brazil still needs to improve in many parts of its cities. Based on the survey on overall infrastructure quality by World Economic Forum in 2014, Brazil ranked 120 out of 144 countries, with particularly poor results for roads and air transport quality.[190] Though financial support through the government to improve infrastructure is less, it is attracting private investment in roads, railways and airports.[191] However, the transformation of infrastructure for public transport and Non-Motorised Transport (NMT) is in rise in Brazil. For infrastructural transformations, the National Policy on Urban Mobility was established in 2012, under the law 12.587/2012. The Mobility Law, as it is known, brings to attention some new elements, perspectives and requirements that will positively influence the energy efficiency of public transport. The law promotes non-motorized and prioritizes public over private motorized transport. In addition, the law states that cities can use methods and tools for monitoring and controlling local pollutants and GHG emissions from the transport system. Although adopting tools for reducing emissions is strongly recommended, it is not mandatory.

No specific information could be found on Research, Development & Innovation or Industry activities regarding transformation of infrastructure in Brazil.

3.2.1.2 Market

In order to improve road infrastructure in Brazil, the Institute for Transportation and Development Policy (ITDP) provides technical assistance to the cities (such as WRI Brasil) investment in bus rapid transit (BRT) lanes, which are relatively low cost and have a short lead time. ITDP also supports the requirements for integrating large transport systems like subways or trains with BRT lanes and the promotion of cycling and walking.[192] Between 2009 and 2012, Rio created 152 km of new cycling pathways along the beachfront and connected the city's lake to the bustling Botafogo neighbourhood.[193]

Also, the southern city of Curitiba pioneered BRT systems with high-quality stations, overland bus transport and real-time information systems, as well as dedicated lanes for buses and high-capacity vehicles.[194] Curitiba's BRT has made a huge impact on a modal shift from automobile travel to bus

[189] Kahn, S., & Brandao, I. (2015). The contribution of low-carbon cities to Brazil's greenhouse gas emissions reduction goals: Briefing on urban energy use and greenhouse gas emissions. Stockholm Environment Institute.
[190] Garcia-Escribano, M., Goes, C., & Karpowicz, I. (2015). Filling the Gap: Infrastructure Investment in Brazil. International Monetary Fund.
[191] The Economist. (2015). Brazilian infrastructure: Delays ahead. Retrieved from http://www.economist.com/news/americas/21653949-government-getting-serious-about-attracting-private-investment-roads-railways-and-airports
[192] Frayssinet, F. (2013). Needed in Brazil: Integrated Urban Transport System. Retrieved from IPS-Inter Press Service: Retrieved from http://www.ipsnews.net/2013/07/needed-in-brazil-integrated-urban-transport-system/
[193] Colin, B. (2015). 4 Inspirations for Sustainable Transport from Rio de Janeiro. Retrieved from http://www.wri.org/blog/2015/03/4-inspirations-sustainable-transport-rio-de-janeiro
[194] Frayssinet, F. (2013). Needed in Brazil: Integrated Urban Transport System. Retrieved from http://www.ipsnews.net/2013/07/needed-in-brazil-integrated-urban-transport-system/

travel. The result of traveller survey in 1991 estimated that the introduction of the BRT had caused a reduction of about 27 million auto trips per year, saving about 27 million litres of fuel annually.[195] In advance of the Olympic Games 2016, the length of mass transit systems in Rio, mostly Bus Rapid Transit (BRT) and metro extension, were increased from 76 to 156 km and 4 to 16 km respectively.[196]

Moreover, the development bank of Latin America (Corporacion Andina de Fomento (CAF) – Banco de Desarrollo de América Latina in Portugues) principally supports the road and logistics sector, the development of tourism and sports infrastructure, the environmental sector and the response to natural disasters.[197]

In Brazil, there is no direct link between federal policy and what states and cities plan and implement, and no direct financing mechanism providing priority to sustainable urban transport developments. One of the major strategies from the Brazilian Federal Government is the investment on urban infrastructure through financing programs such as the Program for Accelerated Growth (also known as PAC (Programa de Aceleração do Crescimento)) and the national housing program (also known as MCMV (Minha Casa Minha Vida). Considering urban mobility only, PAC is providing € 40 billion in loans to 88 cities with more than 250 thousand residents to foster the implementation of structuring transport infrastructure projects. It is administered by the Ministry of Cities and funds mass transit projects, including BRT, Light Rail Transit (LRT) and metro in large cities (see the table in the following for PAC planning and implementation activitities). Although Federal Government is making available of financial resources, several cities lack good quality project designs that induce transport integration and a comprehensive idea of sustainability.

The maximum national funding share is 95%, with a minimum local participation of 5 percent.[198] The Brazilian government is trying to attract private investment in roads, railways and airports through concessions to redevelop and operate. The government plans to shrink the role of the ailing public railway and airport operators, and rely less on subsidized loans from BNDES, Brazil's overbearing development bank.[199] The Brazilian Federal Government launched the Investment Program in Logistics (PIL) in 2012 that includes projects that contribute to developing a modern and efficient transport system and will be carried out by means of strategic partnerships with the private sector, promoting a synergy between road, rail, river, sea and air transport systems.[200]

Summary of projects and stage of implementation by PAC (updated in 2014):

SUMMARY	PAC (implementation)	PAC (planning)	Other Multilaterals	Completed
BRT	19	27	1	1
busway	8	93	6	0
Metro/rail	8	18	9	5
LRT	3	16	0	0
Control	5	5	3	0
Infrastructure	9	7	4	2
Road	14	23	17	1
Cycling	1	4	8	0
Mobility planning	0	4	18	0

[195] Burgess, C., & Ordiz, S. (2010). Exploring the BRT Systems of Curitiba and Bogota. California Polytechnic State University.
[196] Lindau, T., & Felin, B. (2016). Rio Olympics' Legacy: Urban Mobility. Retrieved from http://www.wri.org/blog/2016/08/rio-olympics-legacy-urban-mobility
[197] CAF Development Bank of Latin America (2016). Brazil: Our action. Retrieved from https://www.caf.com/en/countries/brazil/our-action/
[198] Owen, B., Carrigan, A., & Hidalgo, D. (2012). Evaluate, Enable, Engage: Principles to Support Effective Decision Making in Mass Transit Investment Programs. EMBARQ.
[199] The Economist. (2015). Brazilian infrastructure: Delays ahead. Retrieved from http://www.economist.com/news/americas/21653949-government-getting-serious-about-attracting-private-investment-roads-railways-and-airports
[200] Logistics Brazil. (2015). Logistics Investments Program. Retrieved from http://www.logisticsbrazil.gov.br/highways

SUMMARY	PAC (implementation)	PAC (planning)	Other Multilaterals	Completed
Others	6	19	19	1
	73	**216**	**85**	**10**

3.2.1.3 SWOT Analysis

Strengths • National plan to improve urban mobility through infrastructure improvements • Involvement of private investment to improve and redevelop road, railways and airport infrastructure • Transformation of infrastructure for public transport and Non-Motorised Transport is on the rise	**Weaknesses** • Government budget deficit for infrastructure investment • A large part of Brazilian infrastructures still require improvement • A lack of modal choice is a big obstacle to evoke a modal shift • The political and economic environment is not ideal for investments
Opportunities • Government initiatives for infrastructure financing by the private creates many business opportunities • Support from the banks • General awareness of the opportunities related to sustainable modes of transport in cities by the national government • Considering the size of the Brazilian transport system, there is a big market opportunity	**Threats** • Hardly any infrastructure to realize/implement new technologies (e.g. tracking technologies) • Elementary infrastructure is not existent • International investors increasingly participate in funding competitions

3.2.2 China

3.2.2.1 General Information

Over half of the population in China now lives in urban areas and the United Nations estimates that the proportion of urban citizens will reach 75% by 2050. Of course, it is not known if the pace of urbanization will continue as expected over the next 30 to 40 years, however it is likely that there will be continuing demand for more and better infrastructure as new urban areas develop and existing cities expand.

China's highway transported 36 billion passengers, while the volume of freight consigned through highway in China reached 32 billion tonnes in 2012. As far as rail transport is concerned, 1,893 million passengers used China's railway system and up to 3.9 billion tonnes of freight were dispatched by railway during 2012. Respectively, 258 million passenger and 4.6 billion tonnes of freight were transported through China's waterway during 2012, while the port of Shanghai ranked first in the world and 8 out of the 20 world's top ports were located in China (see Figure 14).[201]

[201] Fung Business Intelligence Centre (2013). Transport Infrastructure Development in China. Retrieved from: http://www.funggroup.com/eng/knowledge/research/china_dis_issue116.pdf

Rank in 2011	Rank in 2012	Port	2012 (million TEU)	Annual growth (%)
1	1	Shanghai*	32.6	2.6
2	2	Singapore	31.7	5.7
3	3	Hong Kong	23.1	-5.3
4	4	Shenzhen*	22.9	1.6
5	5	Busan	17.0	5.3
6	6	Ningbo-Zhoushan*	16.8	14.3
7	7	Guangzhou*	14.7	3.4
8	8	Qingdao*	14.5	11.4
9	9	Dubai	13.3	2.1
11	10	Tianjin*	12.3	6.0
10	11	Rotterdam,	11.9	-0.1
13	12	Port Kelang	10.0	4.3
12	13	Kaohsiung	9.8	1.5
14	14	Hamburg	8.9	-1.5
15	15	Antwerp	8.6	-0.2
16	16	Los Angeles	8.1	1.6
20	17	Dalian*	8.0	25.0
18	18	Tanjung Pelepas	7.7	2.9
19	19	Xiamen*	7.2	11.1
-	20	Bremen	6.3	6.1

Figure 14: Global ranking of port (2012) (*Source: The Ministry of Transport and World Shipping Council*)
** Ports in the Mainland China*

Regarding the air transport in China, the total air passenger traffic reached 319 million passengers and 5.5 million tonnes, with the top four passenger airports (in Beijing Capital, Guangzhou, Shanghai Pudong and Shanghai Hongqiao) accounted for 31% of the total passenger air transport in China.

The Beijing Capital International Airport was declared the 2nd busiest passenger airport in the world in 2012, transferring 81.9 million passengers and the Shanghai Pudong International Airport was the 3rd busiest cargo airport in the world, transferring 2.94 million tonnes.[202]

Figure 15: Accelerating development in transport infrastructure in China (Source: China Statistical Yearbook (Abstract) 2013)[203]

[202] Fung Business Intelligence Centre (2013). Transport Infrastructure Development in China. Retrieved from: http://www.funggroup.com/eng/knowledge/research/china_dis_issue116.pdf

According to the 12th Five-Year Development Plan (FYP), the main goals of the Chinese government to accelerate the development of transport infrastructure are: the increase of the length of railway and highway in operation, the promotion and development of electrification, the increase of number of civil airports, and the increase of coastal deep-water berths.[204]

In order to go along with rapid urban growth, many cities in China now have BRT operations or have BRT projects being planned or constructed. Guangzhou's BRT system, for example, began to operate in February 2010 and it is now the world second largest BRT system, the first being TransMilenio in Bogota of Colombia. Approximately 800,000 passengers are moved around by the BRT system per day. A number of initiatives of the system are breaking many passenger records in China or in the world.[205]

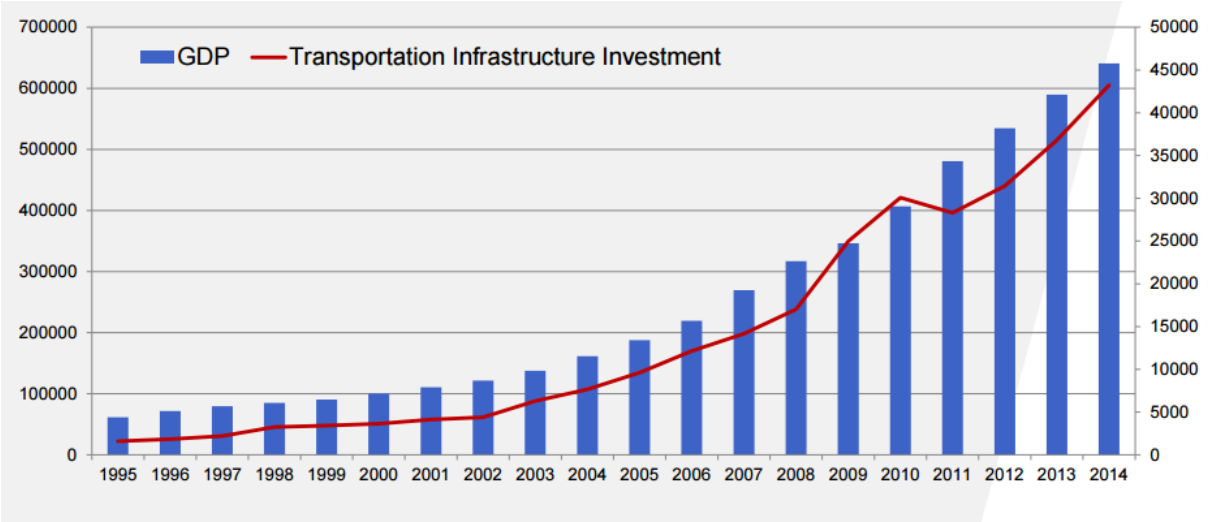


Figure 16: China's GDP and transport infrastructure investment trend during 1995-2014 (Source: CIECC Research Centre)[206]

In 2014, the National Development and Reform Commission (NDRC) announced the investment of CNY 34 billion (USD 5.56 billion) for transportation infrastructure, including railways, roads, airports and waterways. Although China had more than 110,000 kilometers of railways by the end of 2014 of which 15,800 kilometers were high speed rail (HSR), making it the HSR world leader, the NDRC stated that more railway lines (mainly in the central and western regions), will be put into operation during 2015, while also declared that will continue to support and encourage social capital through preferential measures, in order to attract investment in major transportation infrastructure.[207]

By investing heavily in transport infrastructure, the Chinese Government has provided its cities strong foundations for their development. Projects, such as the transport-oriented development in the Shanghai suburb of Xinzhuang, place mobility at the centre of urban development. Another example of the investment of the Chinese government in transport infrastructure is the construction of the infrastructure for the Maglev Train. The Shanghai Maglev Train or Shanghai Transrapid is a magnetic levitation train that operates in Shanghai, China. The line is the first commercially operated high-speed magnetic levitation line in the world and has a length of 153 metres, a width of 3.7 metres, a height of 4.2

[203] Fung Business Intelligence Centre (2013). Transport Infrastructure Development in China. Retrieved from: http://www.funggroup.com/eng/knowledge/research/china_dis_issue116.pdf
[204] Fung Business Intelligence Centre (2013). Transport Infrastructure Development in China. Retrieved from: http://www.funggroup.com/eng/knowledge/research/china_dis_issue116.pdf
[205] Division for Sustainable Development -United Nations -Department of Economic and Social Affairs (2012). Local Policies and Best Practices on "Greening" Urban Transport in Chinese Cities. Retrieved from: https://sustainabledevelopment.un.org/content/documents/booklet-greeningchina.pdf
[206] Kaimeng, L. (2016). A Brief Introduction to China's PPP Application in Transport and Logistics Sectors. Retrieved from: https://www.unece.org/fileadmin/DAM/ceci/documents/2016/PPP/Forum_PPP-SDGs/Presentations/Kaimeng_LI-UNECE_PPP_Forum_March_2016_A_Brief_Introduction_to_China%E2%80%99s_PPP_Application_in_Transport_and_Logistics_Sectors.pdf
[207] ChinaDaily USA (2016). China to step up construction on major transport infrastructure. Retrieved from: http://usa.chinadaily.com.cn/business/2015-02/22/content_19634000.htm

metres and a three-class, 574-passenger configuration. The Shanghai Transrapid project took CNY 10 billion (USD 1.33 billion) and two and a half years to complete.[208]

Additionally, in 2016 the Changsha Maglev, or Changsha Maglev Express has been also open to the public. It is a medium-low speed magnetic levitation, or maglev line in the city of Changsha. It is the first one fully developed and produced within the country, while the mid-low speed maglev track is also the longest one of its kind in the world, and has been operational for test runs since 26th December 2015.[209] The line stretches over 18.55 kilometers and runs between Changsha Huanghua International Airport, Langli station and the high-speed railway station Changsha South Railway Station. While its rolling stock is designed for a speed of up to 120 km/h, its current maximum speed is 100 km/h and it takes 19.5 minutes to complete the whole journey[210], which is around 40 minutes quicker than taking the airport shuttle bus and around 20 minutes quicker than taking a taxi.[211]

The Beijing–Shanghai High-Speed Railway (or Jinghu High-Speed Railway from its Chinese name) is also a 1,318-kilometre long high-speed railway that connects two major economic zones in China, the Bohai Economic Rim and the Yangtze River Delta. The line opened to the public for commercial service on June 30, 2011 and it's the world's longest high-speed line ever constructed in a single phase.[212]

Nevertheless, the Chinese government can't finance infrastructure forever. This is why China has introduced some sort of public-private partnership model. It will also need to introduce more competition to focus operators on improving efficiency and service quality.

3.2.2.2 Research, Development & Innovation

Transport infrastructure is a key factor to China's urban development and it concerns the whole country, involving a big range of cities, from developing industrial centres, like Wuxi, to already developed urban areas, such as Shanghai.[213]

To boost economic growth, China has focused in transport infrastructure in recent years in the four major modes of transportation (road, railway, water and air). Investments amounted to CNY 2,200 billion in 2011 (≈ USD 304 million). Highway accounted for more than half of the total fixed assets, indicating the importance of road transportation in the development of transport infrastructure in China.

Since 2000 the infrastructure investment priority has gradually shifted from roadway building to public transportation, especially in large cities. The Chinese government is planning to invest almost CNY 5 trillion (nearly USD 750 billion) into transport infrastructure over the next three years. CNY 5 trillion is equivalent to 6.9% of China's 2015 gross domestic product.[214]

For example, more than 60 inland airports are under expansion and more 30 new regional airports are being under construction. According to government's source, China's airports will increase to 240 by 2020 from around 200 today, while USD 80 billion would be invested in aviation projects during 2015, according to the Civil Aviation Administration of China (CAAC).[215]

The Chinese government has been also encouraging the private sector to invest in state projects and the NDRC has already published a list of infrastructure projects, where the private sector is encour-

[208] Wikipedia (2016). Schanghai Maglev Train. Retrieved from https://en.wikipedia.org/wiki/Shanghai_Maglev_Train#cite_note-3
[209] Wilkinson B.(2016). CHANGSHA'S 'MAGLEV' STARTS ON 6TH MAY! . Retrieved from: http://www.wnichangsha.com/changsha-maglev-opens.php
[210] Wikipedia (2016. Changscha Maglev. Retrieved from https://en.wikipedia.org/wiki/Changsha_Maglev
[211] Wilkinson B. (2016). CHANGSHA'S 'MAGLEV' STARTS ON 6TH MAY! . Retrieved from: http://www.wnichangsha.com/changsha-maglev-opens.php
[212] Wikipedia (2016). Retrieved from https://en.wikipedia.org/wiki/Beijing%E2%80%93Shanghai_High-Speed_Railway
[213] Kwok, M. (2014). How is China transforming its cities? Retrieved from: http://thoughts.arup.com/post/mobiledetails/391/how-is-china-transforming-its-cities?
[214] Lockett, H. and Hornby, L. (2016). China routes CNY 5 trillion into transport infrastructure. Retrieved from: https://next.ft.com/content/14926948-172b-11e6-b197-a4af20d5575e
[215] Gray, D. (2015). China's aviation boom drives airport building frenzy. Retrieved from: http://www.reuters.com/article/us-china-aviation-idUSKBN0P60F220150626

aged to invest. Transportation, ICT infrastructure, clean energy, and gas transportation are some of them.[216]

In November 2014, the Ministry of Finance, the Ministry of Science and Technology, the Ministry of Industry and Information Technology and the National Development and Reform Commission of China cooperated for the publication of the "Notice Regarding Incentive for Construction of New Energy Vehicle Charging Facilities". In order to promote the construction of charging facilities of new energy vehicles, have set central finance plans for the construction of charging facilities in new energy vehicle promotion cities or cluster of cities.

On October 2015, the Government of China has also adopted a draft for the 13th Five-Year Plan for 2016-2020, setting out the goals and principles of China's development within the next 5 years. Among the targets of the 13th Five-Year Plan, is the increase of the country's urbanization pace and, respectively, the development of infrastructure[217], as well as the enhancement of the private sector participation.

Another action presenting the China's efforts to boost global infrastructure investment, is also the creation of the Asian Infrastructure Investment Bank (AIIB). During 2015, 21 Asian countries signed memorandum of understanding for the establishment of AIIB with an expected initial capital of USD 50 billion.[218] This initiative has been proposed by the government of China.[219] The capital of the bank is currently USD 100 billion, equivalent to 2⁄3 of the capital of the Asian Development Bank and about half that of the World Bank.[220]

Additionally, the One Belt, One Road (OBOR) Initiative is a development strategy and framework that focuses on connectivity and cooperation among countries primarily between the People's Republic of China and the rest of Eurasia, which consists of two main components, the land-based "Silk Road Economic Belt" (SREB) and ocean-based "Maritime Silk Road" (MSR). This strategy emphasizes on China's effort to have a bigger role in global affairs, and the need for priority capacity cooperation in areas, like steel manufacturing.[221] China's "One Belt, One Road" (OBOR) encompasses 65 countries along the land and maritime Silk Road routes and highlights China's economic and strategic objectives. One of the main reasons that the OBOR initiative has been developed is to face the country's overcapacity domestically. In general, China's leaders have put forward a long-term vision through investing in infrastructure development in OBOR countries, China aims to promote the flow of capital, goods and merchandise across the region. According to the Li Daokui from the Tsinghua University in Beijing, if the plan is successful over the coming decades, the countries in the region "will form a highly effective, efficient and socially developed region like the EU".[222]

3.2.2.3 Industry

The urban infrastructure's prompt implementation has also been proven a driver of China's economic growth supporting in parallel the development of industry growth of Chinese cities, while the involvement of the private sector has made industry see strategic opportunities

For all transportation modes, the governmental administration involves the ministries such as ministry of transport, ministry of finance, National Development and Reform Commission, etc. Initial construction of infrastructure is mainly conducted by state-owned big contractors, such as China Railway Construction Corporation. In terms of infrastructure operation, originally, transportation commission of local government, special bureau of the central government (e.g. former ministry of railway, currently China

[216] Atkinson, R. (2014). ICT Innovation Policy in China: A Review. Retrieved from: http://www2.itif.org/2014-china-ict.pdf
[217] Lyn, F. and Wu, D. (2015). Prosperity for the masses by 2020. Retrieved from: http://www.pwchk.com/home/eng/prosperity_masses_2020.html
[218] ChinaDaily USA (2016). China to step up construction on major transport infrastructure. Retrieved from: http://usa.chinadaily.com.cn/business/2015-02/22/content_19634000.htm
[219] Xinhuanet (2014). 21 Asian countries sign MOU on establishing Asian Infrastructure Investment Bank. Retrieved from: http://news.xinhuanet.com/english/business/2014-10/24/c_133740149.htm
[220] The Economist (2015). The economist explains. Retrieved from: http://www.economist.com/blogs/economist-explains/2014/11/economist-explains-6
[221] Wikipedia (2016). One Belt, One Road. Retrieved from https://en.wikipedia.org/wiki/One_Belt,_One_Road
[222] Fon Mathuros (2016), One Belt, One Road Initiative Signals China's Economic and Strategic Objectives.

Railways Corporation) or some BOT (Built-Operate-Transfer) private partners are in charge of operations of infrastructure.

Transport infrastructure is the most important area in PPP application in China. Until now, 6,997 PPP projects have been listed into the PPP information system of the Ministry of Transport reaching an investment of 8.13 trillion CNY. PPP models have been used by 19 industries in China, including energy, transport, ecological construction and environmental protection, regional development, agriculture, science and technology, etc. The number of running transport infrastructure projects based on PPP in China of 2016 is 761, while the investment on the PPP projects in transport sector is about 2.23tn CNY.[223]

Now the private partners (in China, most are essentially state-owned enterprises) are involved in the process of the infrastructure development in the context of urbanization and they invest instead of government. The government repays the cost through a long term in which performance measurement is heavily depended on. Thus, the efficiency and effectiveness of infrastructure is largely improved. It is the local practice of commonly used performance based contracting.

There is an increasingly active secondary market, such as domestic construction companies looking to invest in new highway and other infrastructure projects, while opportunities may also appear if the government allowing private participation in the toll-road concession projects as well.[224]

3.2.2.4 Market

There is already a lively and dynamic presence by European and American companies, especially in big coastal cities of China, including Beijing and Shanghai but very few of them are active in secondary markets such as Chengdu, Sichuan and Hunan. However, there is a turn of these foreign investors in inland, since wages and costs have increased in the coastal areas and since the inland cities also ask for investments in infrastructure.

Foreign investors and companies being active in China also have to deal with several challenges mainly relating to the comprehension of the local market. There is definitely a need of any new, foreign business to China to be partnered with a local company or employ professional consultants and this is an effective way to find and understand differences in the regulatory system, tax laws, corporate culture, business negotiations, employment practices, etc.[225]

Transit-oriented development (TOD) is a very important factor in the development of Chinese cities. Many cities adapt their zoning codes, after subway construction, to allow development around transit stops. At least 13 Chinese cities currently have one or more subway lines under operation, while another 76 lines are under construction. The target is 40 subways systems by 2020. TOD is expected to make a big difference in the long-term sustainability of urban living, focusing also on energy efficiency.[226]

China is also focusing on Bus Rapid Transit (BRT), which complements walking and biking. BRT is an effective and inexpensive approach for the transfer of people in urban areas. China is building thousands of miles of subway lines but due tunnelling, they are expensive and slow to build and that's the reason why BRT is an excellent complement.[227]

[223] Kaimeng, L. (2016). A Brief Introduction to China's PPP Application in Transport and Logistics Sectors. Retrieved from: https://www.unece.org/fileadmin/DAM/ceci/documents/2016/PPP/Forum_PPP-SDGs/Presentations/Kaimeng_LI-UNECE_PPP_Forum_March_2016_A_Brief_Introduction_to_China%E2%80%99s_PPP_Application_in_Transport_and_Logistics_Sectors.pdf

[224] KPMG (2009). Infrastructure in China: Foundation for growth. Retrieved from: https://kpmg.de/docs/Infrastructure_in_China.pdf

[225] Atkins, M. (2013) Infrastructure investment in China. Retrieved from: http://www.financierworldwide.com/infrastructure-investment-in-china/#.V5nHqvmLSUl

[226] Bachmann, J. and Burnett, J. (2012). Infrastructure and the Environment in Chinese Cities: Prospects for Improvement. Retrieved from: http://www.chinabusinessreview.com/infrastructure-and-the-environment-in-chinese-cities-prospects-for-improvement/

[227] Harvey, H. and Busch, C. (2012). GETTING CITIES RIGHT IN CHINA: Urban design, smart transportation and institutional reform. Retrieved from: http://energyinnovation.org/wp-content/uploads/2014/06/gettingcitiesrightinchina-final.pdf

In March 2014 the government released its new urbanization plan. Targets in the plan include an urbanization rate of 60% by 2020, representing roughly 100 million new urban residents[228]. Facing limited investment capacity from local governments, the Ministry of Finance (MoF) has been pushing for PPPs, which are seen as a way to invest considerable private capital into the public sector.

Public–private partnership (PPP) is a relatively approach for the provision of public infrastructure in current China that changes the paradigm of infrastructure performance measurement. In the past, government invested in infrastructure mainly directly through its own debt but the most noticeable issue concerning this practice is the low efficiency, low quality, and failure to control the long term quality.

Although Public-Private Partnerships (PPPs) have made their appearance in China since the 1980s, a boost in their development didn't happen until 2014, when the Chinese government published several important documents promoting private investment in public services and infrastructure. Figure 17 depicts the sectors, where private participation is mainly involved.

The MoF set up a PPP-leading group and also established a PPP center, whose target is to undertake policy research, training, statistics gathering and international cooperation. The MoF is planning has also build a proper environment by establishing more effectively related standards and norms by helping the implementation of relevant projects. In this context, in December 2014, the MoF announced 30 pilot PPP projects of a total CNY 180 billion investment. These projects concern water and heat supply, waste management, transport, new energy vehicles, environmental restoration, medical treatment, etc.[229]

In the future, a new law on Infrastructure and Public Utilities Franchises is going to be published, concerning the promotion of PPP.[230]

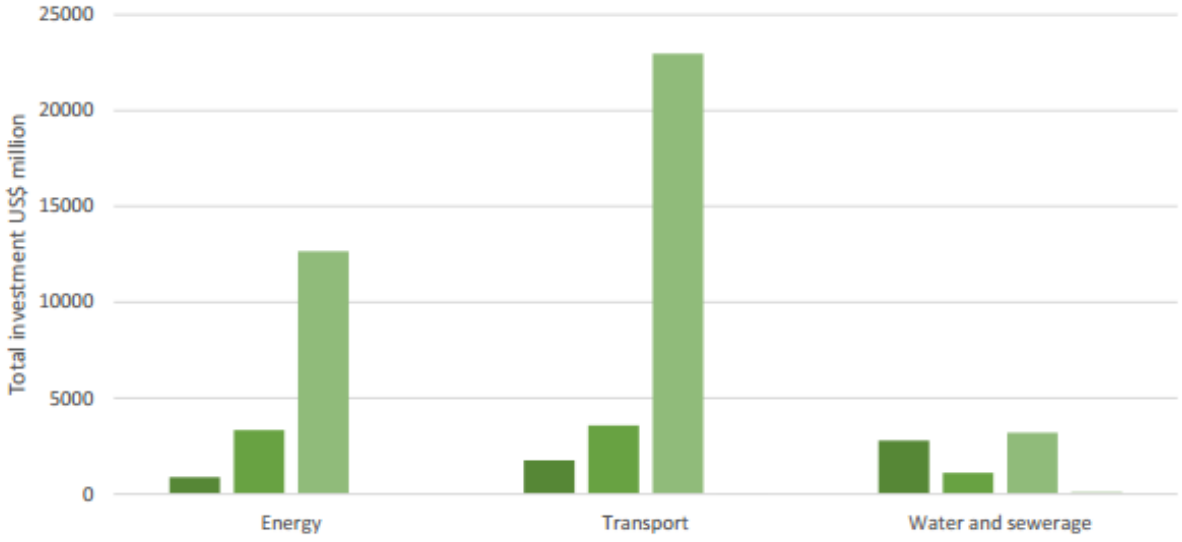


Figure 17: Type of private participation in different sectors for the period 2004–2013 (World Bank, 2014).

[228] Xinhuanet (2014). China's urbanization level to reach 60 pct by 2020. Retrieved from: http://news.xinhuanet.com/english/china/2014-03/16/c_133190605.htm

[229] Thieriot, H. and Dominguez, C. (2015). PUBLIC-PRIVATE PARTNERSHIPS IN CHINA On 2014 as a landmark year, with past and future challenges. Retrieved from: https://www.iisd.org/sites/default/files/publications/public-private-partnerships-china.pdf

[230] Buchanan, K. (2014). China: Guidelines on Public-Private Partnerships Issued. Retrieved from: http://www.loc.gov/law/foreign-news/article/china-guidelines-on-public-private-partnerships-issued/

3.2.2.5 SWOT Analysis

Strengths	Weaknesses
• Massive investment of China's government in transport infrastructure • Development of PPP schemes and promotion by the Chinese government • Fast realization of infrastructure projects due to political structure and cheap labour • China is continuously improving in technology development; quality level is increasing	• Poor quality of initial construction of roads in general, with the exception of big cities • Coordination issues among various stakeholders: Coordination among different jurisdictions is currently still a major obstacle in the system development • Lack of charging infrastructure for EVs.
Opportunities	**Threats**
• Because of fast implementation, China's flexibility to adapt to different needs and changes is very high • Emerging active secondary market, such as domestic construction companies looking to invest in infrastructure projects, while opportunities may also appear if the government allows private participation in the toll road concession projects as well • A variety of additional financing available, both domestically and internationally (FDI) • "Cooling down" of Chinese economy development may promote further investments	• Faulty planning and forecasting leads to the problem of "ghost cities"/"ghost infrastructure" (= unused infrastructure) • Local governments default on PPP Projects payment

3.2.3 India

3.2.3.1 General Information

In order to respond the rapid momentum in India, it is necessary to strengthen transportation infrastructure facilities such as rail, roads, port and airport that connects the domestic economy effectively and improving overall competitiveness, thereby lowering trade and transaction cost. Aviation Industry in India is growing very fast and has undergone a rapid transformation. It is desired in this important mode of transport infrastructure, mostly within growing middle income population that has shifted using air transport than road.[231] Industry estimates that the Indian aviation market is expected to become the third largest across the globe by 2020. Indian port sector infrastructure is also seen a great progress in the years to come.[232]

India has the second largest road network in the world, that is stretched a total of 4.87 million kilometers. Indian roads transport accounts for over 60% of all goods and 85% of total passenger traffic.[233] As road transport is also the primary means for passengers and for freight purposes in India, this section focuses on the transformation of road infrastructure. Major domestic freight transfers in India are conducted through road, although another mode such as inland waterways is more cost efficient in tonne-km per litre of fuel than roadways but comparatively not well developed.[234]

India has an infrastructure gap in terms of new construction and improvement, which indicates big infrastructure business opportunities for national and international investors. Indian road and highway infrastructure need to be improved to channel the burgeoning traffic into less congested routes. Major metropolitan cities are continually addressing this issue by building flyovers and subways, widening

[231] Sahoo, P. (2011). Transport Infrastructure in India: Development, Challenges and Lessons from Japan.
[232] IBEF(2016). Infrastructure sector in India. Retrieved from http://www.ibef.org/pages/infrastructure-snapshot
[233] IBEF(2016). Road and Infrastructure Industry Analysis. Retrieved from http://www.ibef.org/industry/roads-presentation
[234] JLL (2015). Indian logistics - Taking giant leaps forward. Jones Lang LaSalle.

roads and designating one-way roads during peak hours. But an important approach to ITS is to advance public transportation as a competitive alternative to private transport. Public transport remains the predominant mode of transport in India. Buses are not enough in the cities, and also due to congestion, two-wheelers and cars are preferred in India. People still uses and prefer NMT in India (except dense metropolitan cities), but bicycle lanes are not well addressed. Rail services are available in seven metropolitan cities of Mumbai, Delhi, Chennai, Kolkotta, Bengaluru, Hydrabad and Pune. Also, the modal shift from automobile travel to BRT and NMT is in progress and has started in major cities. BRTs projects are running in Pune, Delhi, Ahmedabad, Indore, Mumbai, Hyderabad, Bangalore, Chennai, Coimbatore, Jaipur, Madurai, Nagpur, Vijayawada, Visakhapatnam.

Though specific information on Research, Development & Innovation activities regarding transformation of infrastructure in India is not easily available, infrastructure teams at Indian Institutes of Management (IIMs), civil and transport departments at Indian Institute of Science (IISC) and Indian Institutes of Technology (IIT) and Centre for Environmental Planning and Technology University (CEPT University) are actively working on this front.

3.2.3.2 Industry

Some of the Infrastructure companies that are active in infrastructure construction are:[235]

- Gammon India Ltd. It is involved in highways, public utilities, environmental engineering and marine structures. It has built the longest fly-over bridge in Mumbai, the first elevated road over road in Maharastra and India's first cable stayed bridge at Akkar, Sikkim etc.
- PNC Infratech. Its major infrastructure projects include highways, bridges, flyovers, power transmission lines, airport runways and industrial area development etc.
- Reliance Infrastructure Ltd (Rinfra). Its road projects are operative in urban high traffic growth corridors of Delhi, Bangalore, Jaipur, Gurgaon, Agra and Pune. It is the first private player in India to execute and operate metro rail projects.
- L&T Infrastructure Development Projects Limited (L&T IDPL). It is a pioneer of the Public-Private-Partnership (PPP) model of development in India, in which infrastructure projects are developed in partnership with the Central and State Governments and private sector players.
- GMR Group. It is a major player in the infrastructure sector, with world class projects in India and abroad. Using the public-private partnership (PPP) model, the Group has successfully implemented several iconic infrastructure projects in India. It operates India's busiest airport, the Indira Gandhi International Airport (IGIA) in New Delhi.

3.2.3.3 Market

In order to create an adequate road network and to cater to the increased traffic and movement of goods, the Indian government has assigned 20% of the USD 1-trillion investment to infrastructure during the 12th Five-Year Plan (2012-17) to develop the country's roads. The Government of India is investing Rs 10 trillion (USD 148.24 billion) in highways and shipping sector by 2019. Some of the recent developments are[236] :

- The National Highways Authority of India (NHAI) has prepared a plan of connecting 27 vertical and horizontal highways in the form of an interconnected grid, which is one of the basic practices of highway planning for a smooth and uninterrupted access across various regions of India.
- The Government of India plans to award 100 highway projects under the Public-Private Partnership (PPP) mode in 2016. As of August 2015, India constitutes 112 completed and 144 ongoing PPP projects for roads and highways.[237]

[235] IBEF(2013). *Road Sector India*. Retrieved from http://www.ibef.org/industry/roads-india/showcase
[236] IBEF(2016). Road Infrastructure in India. Retrieved from www.ibef.org/industry/roads-india.aspx
[237] IBEF(2015). Road and Infrastructure Industry Growth - Infographic. Retrieved from http://www.ibef.org/industry/roads-india/infographic

- The Ministry of Road Transport and Highways plans to build extra five greenfield expressways across the country, which are expected to reduce travel time and accelerate economic growth.
- The Ministry of Urban Development under the government of India is developing Smart Cities mission and Atal Mission for Rejuvenation and Urban Transformation (AMRUT) mission.

The Ministry of Urban development has set up a Smart Cities mission under the Government of India. Its objective is to promote cities that provide core infrastructure and give a decent quality of life to its citizens, a clean and sustainable environment and application of 'Smart' Solutions. The focus is to achieve sustainable and inclusive development, looking at compact areas and create a replicable model which will act like a light house to other aspiring cities. One of the core infrastructure elements in the smart city is 'efficient urban mobility and public transport'. Some typical features of comprehensive development in Smart Cities include: creating walkable localities, reduce congestion, air pollution and resource depletion, boost local economy, promote interactions and ensure security. The road network is created or refurbished not only for vehicles and public transport, but also for pedestrians and cyclists, and necessary administrative services are offered within walking or cycling distance, promoting a variety of transport options. The network is further enhanced through transit-oriented development (TOD), public transport and last mile para-transport connectivity as well as the application of smart solutions to infrastructure and services in area-based development. As a result areas become less vulnerable to disasters, use fewer resources, and can provide cheaper services.[238] Through India Smart cities challenge, 33 cities have been selected, out of the100 cities competing to receive funds.[239]

Atal Mission for Rejuvenation and Urban Transformation (AMRUT) has also been introduced by the Ministry of Urban Development (MoUD) under the Government of India. Among the components of the AMRUT, urban transport and development of green spaces and parks are emphasised. One of its goals is to increase the amenity value of cities by developing greenery and well maintained open spaces (e.g. parks) while reducing pollution by switching to public transport or constructing facilities for non-motorized transport (e.g. walking and cycling). All these outcomes are valued by citizens, particularly women, and indicators and standards have been prescribed by the Ministry of Urban Development in the form of Service Level Benchmarks (SLBs). Previously, the MoUD used to give project-by-project sanctions. But in the AMRUT, project approval is given by the State Annual Action Plan once a year. This makes States equal partners in planning and implementation of projects, thus actualizing the spirit of co-operative federalism. AMRUT Mission focuses on 500 target cities/ULBs.[240]

Under the Jawaharlal Nehru National Urban Renewal Mission (JNNURM), Nanded Waghala City Municipal Corporation (NWCMC) in Maharashtra developed 28 km of cycle tracks and achieved the aim of segregation of slow and fast moving traffic. This segregated traffic resulted in increased travel speeds for both NMT and motorised vehicles, and reduced major accidents.[241]

Beside the government initiative to address the infrastructure gap, India witnesses a significant interest from national and international investors in its infrastructure development. Some of them are:[242]

- Spanish companies are intersted to collaborate with India on infrastructure, high speed trains, renewable energy and developing smart cities.
- Silver Spring Capital Management, a Hong Kong-based equity hedge fund, plans to invest over Rs 2,000 crore (USD 306 million) in Hyderabad-based infrastructure developer Transstroy India Ltd, for constructing highways in the country.
- Airports Authority of India (AAI) plans to develop city-side infrastructure at 13 regional airports across India, with help from private investors for building of hotels, car parks and other facilities, and thereby boost its non-aeronautical revenues.
- Support from the Asian Development Bank (ADB) and the World Bank.

[238] Smart Cities Mission. (n.d.). Smart City Features. Retrieved from http://smartcities.gov.in/writereaddata/Smart%20City%20Features.pdf
[239] Sarkari Yojana (2016). Smart Cities List 2016 – 33 Cities Selected so Far. Retrieved from http://www.sarkariyojna.co.in/smart-cities-list-2016-33-cities-selected-far/
[240] AMRUT. (2015). Atal Mission for Rejuvenation and Urban Transformation. Retrieved from http://amrut.gov.in
[241] NIUA. (2015). Urban Transportation in Indian Cities.
[242] IBEF(2016). Infrastructure sector in India. Retrieved from http://www.ibef.org/pages/infrastructure-snapshot

The World Bank supports ten projects in its transport portfolio which include seven state road projects and one each for national highway, rural road and urban transport (1). ADB Loan is also available to improve about 430 kilometers (km) of major district roads (MDRs) in the state of Uttar Pradesh, in line with the Strategic Core Road Network Master Plan for Uttar Pradesh. The activities include reconstruction, widening and strengthening of culverts and bridges; and maintenance of the improved road assets, conducting a road safety audit of the MDRs on the core road network (CRN) and initiating remedial measures at identified critical locations.[243]

3.2.3.4 SWOT Analysis

Strengths • Government and international initiatives/investment in infrastructure improvement	**Weaknesses** • Demand of public transport and non-motorised transportation exceeds supply and growth of the transport infrastructure system even though they remain the predominant mode of transport in India, e.g. rail infrastructure • Reduced transit possibilities and interfaces between different modes • Federal system decreases possibility of building a working infrastructure • Rate of growth of demand does not match the increase in the public transport system
Opportunities • Business opportunities for international investors due to infrastructure gap, e.g. for the refurbishment of the transport system for new modes of transport • Multilaterial organisations such as the World Bank and ADB are supporting infrastructure improvement • Fast-growing Indian aviation market has undergone a rapid transformation • Business opportunities for international investors due to infrastructure gap on road refurbishment (e.g. footpath) or infrastructure for new mode of transport (e.g. BRT)	**Threats** • If the supporting infrastructure is not built in the right way, there are only limited possibilities for transformation towards more sustainable transport

3.2.4 Japan

3.2.4.1 General Information

Japan is a long, narrow island country. The remarkably high proportion of coastline, which spans over 34,600 km, with a total land area of 380,000 km^2, has generated an extremely large number of ports. Approximately 42% of the entire population of Japan lives near a harbor. Ports are the mainstay for 99% of Japan's foreign trade and 42% of its domestic distribution.[244] Japanese aviation comprises the world's third largest domestic market, about 5.5% of global traffic and 11% of global industry revenues. Aviation has a significant footprint in the Japanese economy, supporting 0.7 % of GDP (JPY 3,135 trillion) and 0.7% of the Japanese workforce (429,000 jobs). Including aviation's contribution to tourism, the figures rise to 1% of GDP (JPY 4,501 trillion) and 1% of the workforce (620,000 jobs).[245]

[243] ADB (2016). India: Uttar Pradesh Major District Roads Improvement Project. Retrieved from http://www.adb.org/projects/43574-025/main

[244] Ministry of Land, Infrastructrue, Transport and Tourism (2016). Ports and Harbours in Japan. Retrieved from http://www.mlit.go.jp/kowan/english/index.html

[245] The International Air Transport Association (2012). Strengthening Japan's Aviation Competitiveness - Reducing Cost of Infrastructure. Retrieved from http://www.iata.org/pressroom/pr/Pages/2012-09-19-01.aspx

Along with the governmental decentralization that started in the past 50 years to foster regional economic development, the transport system began to decentralize as well in order to better meet the citizens' differing needs. The main authorities in charge of the transport system in each region are regional offices of the Ministry of Economy, Trade and Industry (METI). It can be seen that recently there has been a general shift from supply-centric policies towards demand-centric policies taking travel behaviour into consideration. Travel behaviour includes indicators such as trip frequency, activity choice/trip purpose, destination choice, travel mode choice, departure time choice, route choice, trip duration (choice), trip balance (relationship between public and private travel modes).

It could also be shown that one of the most prominent factors determining travel mode and destination choice in Japan is the age of travellers.[246] As an answer to the rising age of the Japanese population, more and more importance is put on paratransit mobility. This type of transportation refers to demand-responsive door-to-door transport services (e.g. minibuses) that act as gap fillers between public buses and private automobiles.[247]

Apart from the aging society, major drivers of a transforming infrastructure are Japan's scarcity of resources, an efficient industry and industrial cooperation and the need for resilient infrastructures that has increased since the Great East Japan Earthquake (GEJE). To be better suited for future disasters, Japan introduced a disaster risk management (DRM) system after that, roads are increasingly developed to serve as a damage mitigation by acting as secondary barriers or dikes and thus prevent debris from flowing into inland urban areas.[248] The catastrophe has made Japan a world leader in building resilience in critical energy, water, transport and other lifeline infrastructures.

3.2.4.2 Research, Development & Innovation

As an answer to the aging population and to further push a modal shift so-called compact cities are promoted. A unique example is Toyama City. Centered on public transportation, the city's main pillar in becoming a compact city is a light-rail transit system with lower-floored cars, barrier-free station platforms, and less noise. The overall goal is to increase urban sustainability in a three-fold way including environmental, social and economic aspects. Major characteristics are shorter intra-urban travel distances, less automobile dependency, more district-wide energy utilization and local energy generation, optimum use of land resources and more opportunities for urban-rural linkage, more efficient public service delivery, and better access to a diversity of local services and jobs. Through this approach pollution shall be reduced, workers' productivity shall be increased, and infrastructure investments costs shall be reduced. Another important aspect is the improvement of quality of life and health by offering facilities for recreation.[249]

The superconducting Maglev (SCMaglev), developed by JR Central, is a magnetic levitation railway system based on magnetic repulsion between the track and the cars. In 2011, JR Central received the permission to operate the SCMaglev on their planned Chuo-Shinkansen linking Tokyo and Nagoya by 2027, and to Osaka by 2045. The technology has been tested on the 18 km long Ymananashi Test Line (YMTL) since 1997. In 2011 the line was closed for a JPY 23 billion update that includes an extension to 42.8 km and an upgrade to commercial specification. SCMaglev has reached 603 km/h and thus, broke its own record of 590 km/h. It is expected that normal passenger trains will travel with 500 km/h. [250] [251] However, it is not the first Maglev to be developed in Japan (see Focus Area 1) but of course this scale is unprecedented. The main developing institution behind the Maglev program is the

[246] Hatzinger, R. and Maxanec J. (2007). Measuring the part worth of the mode of transport in a trip package: An extended Bradley-Terry model for paired-comparison conjoint data. In: Journal of Business Research, Vol. 60(12), pp 1290-1302.
[247] Zhang et al. (2013). Paratransit-Adaptive Transportation Policies for Transition to Sustainability in Developing Countries. In: Sustainable Transport Studies in Asia, pp.137-166
[248] Ranghieri, F. and Ishiwatari, M. (2014). Learning from Megadisasters: Lessons from the Great East Japan Earthquake. Retrieved from https://openknowledge.worldbank.org/handle/10986/18864
[249] Mory, M. (2013). Toyama's Unique Compact City Management Strategy. Creating a Compact City by Reimagining and Restructuring Public Transportation. Retrieved from http://www.uncrd.or.jp/content/documents/7EST-Keynote2.pdf
[250] International Transport Forum (2010). The Future for Interurban Passenger Transport. Bringing Citizens Closer Together. Retrieved from http://www.keepeek.com/Digital-Asset-Management/oecd/transport/the-future-for-interurban-passenger-transport_9789282102688-en#page168
[251] Zeit Online (2015). Japans Magnetbahn fährt Rekordgeschwindigkeit. Retrieved from http://www.zeit.de/wissen/2015-04/maglev-weltrekord-japan-geschwindigkeit

Railway Technical Research Institute (RTRI), funded by the government and the JR Group. It conducts research about trains, railways and their operation and develops new technology. Other current research streams deal with variable gauge systems allowing Shinkansen trains that run on more narrow trails to use trails of the original rail network.[252]

3.2.4.3 Industry

Private-sector National Resilience spending was mainly undertaken for earthquake-proofing of building and equipment, reinforcement of transport systems (roads and railroads), disaster-relief robotics, communications resilience, and training of specialist leadership. With respect to transport systems most money is spent on road development, electric vehicles, and the linear bullet train (Maglev) which is currently under construction. The government's rationale for including the Maglev in its National Resilience Plan is that it "encourages the distribution of people and facilities away from the undeniably excessive over-concentration of population and core business and government functions in Metropolitan Tokyo." Besides infrastructural development, most of the rest of the investment is spent on non-natural disaster events and patent threats (such as cyber-attack or supply shocks of energy and other materials). [253]

TAMA Industrial Activation Association Inc. [254] was established by private companies, mainly product developing small and medium-sized enterprises, universities and other education and research organizations, industry associations, and local governments in the western Tokyo metropolitan area. It acts as an intermediation of industry-academic and inter-corporate collaboration and is viewed as a leading project of the Industrial Cluster Plan throughout the nation.

On Honshu island, following general economic decentralization the Japanese National Railway (JNR) was restructured into three different companies in 1987 into JR East, JR Central, and JR West. Together with JR Hokkaido, JR Shikoku, and JR Kyushu there are six passenger railway organizations. Besides, there is JR Freight, Railway Technical Research Institute (RTRI) and Railway Information System (JR Systems).[255] [256]

Transport services have been provided by train companies competing with each other in the private sector, but were subject to strict government control of fares. As a result, they had to diversify their business in order to find other ways on how to make profit. This is why they introduced other services linked to train operation, such as (1) motor vehicle services, (2) suburban residential development and (3) retail centres and department stores.[257]

In light of the enormous infrastructural developments in road and rail and the strength of Japan's automotive and maritime industry, its aviation industry lags behind. However, Mitsubishi Aircraft Corp. is aiming to change that with Japan's first new passenger plane in more than four decades.[258]

3.2.4.4 Market

As of 1990 the Japanese government conducts the interregional net passenger traffic survey every five years and aggregates data into interregional OD (origin-destination) tables. The survey covers all transportation modes across all regions in Japan and captures different travel characteristics, such as origin and destination of each transportation mode on the entire route.[259] Due to the early develop-

[252] Soejima, H. (2003). Railway Technologies in Japan – Challenges and Strategies. In: Japan Railway & Transport Review, Vol. 36. Retrieved from http://www.jrtr.net/jrtr36/pdf/f04_soe.pdf
[253] DeWit, A. (2016). Japan's "National Resilience" and the Legacy of 3-11. Retrieved from http://apjjf.org/2016/06/DeWit.html
[254] Kodama, T. (2002). Industry-Academic and Inter-corporate Collaboration in TAMA (Technology Advanced Metropolitan Area). Retrieved from http://www.rieti.go.jp/en/publications/summary/02120003.html
[255] Goto, K. (2000). Passenger Service Technologies. In: Japan Railway & Transport Review 24, Wako, K. (eds.). Retrieved from http://www.ejrcf.or.jp/jrtr/jrtr24/pdf/f50_tec.pdf
[256] Central Japan Railway Company (2012). Data Book 2012. Retrieved from http://english.jr-central.co.jp/company/company/others/data-book/_pdf/2012.pdf
[257] Aveline, N. (2002). Mobility in Japan—A Model for French Transportation Policies?. In: Japan Railway & Transport Review, Vol. 31, pp 42–43. Retrieved from http://www.jrtr.net/jrtr31/ap42_ave.html
[258] Cooper, C. (2015). Japan Aims to Crack the Aviation Market With Its First New Passenger Plane in Four Decades. Retrieved from http://www.bloomberg.com/news/articles/2015-08-31/japan-set-for-first-flight-of-regional-jet-in-late-october
[259] Tsukai, M. and Okumura, M. (2013). Interregional Tourism Demand and Destination Management. In: Sustainable Transport Studies in Asia, pp 113-135.

ments in high-speed trains, the Japanese are eager users of the train network. However, in recent decades the number of local airports has increased, leading to an improvement in transportation services. Especially, in OD-pairs (origin-destination) over 500 km, air transportation has become competitive as there is an advantage in speed and cost.[260]

Japan's National Resilience ("Kokudo Kyoujinka") strategy, including both public and private sector spending, totalled over JPY 24 trillion (USD 210 billion) in 2013 and expected to grow enormously until 2020.[261] It is deeply institutionalized, mainly by the newly established Association for Resilience Japan which is far more advanced than its counterpart initiatives in North America, the EU and elsewhere. It is assumed that most of the money will be spent on concrete-intensive infrastructure programs such as road development.[262]

Generally, infrastructure in urban areas, especially transit networks, are centered on rail infrastructure. This is due to the early development of high-speed trains (Shinkansen). Not only because of the primary role of rail but also because transit networks have relied on the private sector for a long time, there is a high level of integration between various transportation modes and a close link between transportation and urban infrastructure. As a result urban transport systems, especially road infrastructure, is very underdeveloped leading to frequent congestion. In combination with smooth public transfer possibilities this has boosted urban sprawl. Private ownership and management of residential zones has led to the government taking a more pro-active role in urban planning. One successful transit-oriented development project is the Shibuya Hikarie area centred around railway lines. The goal is to build an "urban core" integrating culture, commerce, transportation, work, housing.[263] [264]

The private vehicle market is already saturated in Japan. Therefore, there has been hardly any growth in vehicle sales over recent decades. In addition, Tokyo has introduced a unique set of parking policies that includes the proof-of-parking rules which requires car-buyers to first secure a night-time parking space before registering a car. As parking is scarce and costly (rates are commercially priced) it is generally hard for people to meet the proof-of-parking rule and thus, own a car.[265]

Tokyo's subway system is run by two different operators – the Tokyo Metro (run by Tokyo Metro Co., Ltd.) and the Toei Subway (run by the Bureau of Transportation of the Tokyo Metropolitan Government). Even though they are closely integrated in a unified system of line colours, line codes and station numbers, the separate administration has led to some inefficiencies and inconveniences. Firstly, for single rides across the two systems, a special transfer ticket is required. Secondly, the visualization of the Tokyo subway network is different in stations, trains and customer information diagrams.[266]

With respect to ports, Japan's port system is very deconcentrated in comparison to its neighbouring countries China and Korea. It does not have megaports but five medium-sized ports and a large number of small local container ports. This is mainly due to its different geographical shape (long coastline) and its focus on industrial decentralization.[267] As for port development, the construction of two international physical distribution terminals was commenced, one at Onahana Port, which had been selected to be the nation's first designated bulk import port (coal) and one at Kushiro Port.[268]

Japan Civil Aviation Bureau is the civil aviation authority of Japan and a division of the Ministry of Land, Infrastructure, Transport and Tourism (MLIT). Apart from a few exceptions, airports in Japan

[260] Tsukai, M. and Okumura, M. (2013). Interregional Tourism Demand and Destination Management. In: Sustainable Transport Studies in Asia, pp 113-135.
[261] DeWit, A. (2016). Japan's "National Resilience" and the Legacy of 3-11. Retrieved from http://apjjf.org/2016/06/DeWit.html
[262] DeWit, A. (2014). Japan's "National Resilience Plan". Its Promise and Perils in the Wake of the Election. In: The Asia-Pacific Journal, Vol. 12(51), No. 1. Retrieved from http://apjjf.org/2014/12/51/Andrew-DeWit/4240.html on 25 July 2016
[263] Aveline, N. (2002). Mobility in Japan—A Model for French Transportation Policies?. In: Japan Railway & Transport Review, Vol. 31, pp 42–43. Retrieved from http://www.jrtr.net/jrtr31/ap42_ave.html
[264] Nikken (n.d.). Practicing and Propagating TOD to the World. Retrieved from http://www.nikken.co.jp/en/solutions/tod.html
[265] Choi, C. and Loh, N. (2013). Transport Policies and Patterns: A Comparison of Five Asian Cities. Retrieved from http://www.lta.gov.sg/ltaacademy/doc/13Sep069-Loh_ComparisonOfFiveAsianCities.pdf
[266] Toi (n.d.). How to Ride the Toei Subways. Retrieved from http://www.kotsu.metro.tokyo.jp/eng/services/sub_ride.html
[267] Le, Y. and Ieda, H. (2010). Evolution Dynamics of Container Port Systems with a Geo-Economic Concentration Index: A Comparison of Japan, China and Korea. In: Asian Transport Studies, Vol. 1(1), pp 46-61. Retrieved from https://www.jstage.jst.go.jp/article/eastsats/1/1/1_1_46/_pdf
[268] Ministry of Land, Infrastructure, Transport and Tourism. (2014): White Paper n Land, Infrastructure, Transport And Tourism In Japan.

were constructed and are owned and managed directly by either the national government or local governments. Since April 2015 airports in Japan are classified either as national airports established and managed by the national government (19), or as special regional airports established by the national government but managed by local governments (5), or as incorporated airports established and managed by corporations under special laws (4), or as regional airports established and managed by local governments (54), or as airports for joint use managed by either the Japan Self Defence Forces or the US forces stationed in Japan jointly with the national government (8), and other minor airports.

3.2.4.5 SWOT Analysis

Strengths • Decentralized transport system and governance structure allows better adaptation to citizens' differing needs and leads to improved transportation services • High modal share of rail due to early investment in rail infrastructure • Smooth transfer possibilities between modes • Mix between private & public: huge infrastructure development through privatization, but still under governmental control • Strong expertise in technological applications due to early deployment (e.g. smart infrastructure)	**Weaknesses** • Developments in road infrastructure suffers from heavy congestion due to focus on and early establishment of rail infrastructure • Tokyo's subway system is not well integrated because it is run by two different providers • Unplanned events are difficult to manage • Slow decision-making processes hamper the development towards a resilient infrastructure
Opportunities • Main drivers for further infrastructure improvement are demographic change, scarcity of resources, and need for resilience • Fit-for-purpose urban planning decreases the likelihood of misplanning • Demographic change drives transformation of infrastructure towards demand-responsive door-to-door services • Move towards "compact cities" and holistic transit-oriented development around existing railway stations integrating culture, entertainment, commerce, transportation, work and housing • Tightening of the private vehicle market (saturation and tight parking situation) triggers changing consumer behavior • High acceptance of new technologies (e.g. Scmaglev)	**Threats** • Due to geographical position, Japan is prone to natural disasters • Threat of know-how loss in (international) business co-operations • Restrictive system decreases implementation and scalability of infrastructure projects • Even though there is a high system stability, the magnitude of failure increases with the degree of system integration

3.2.5 South Korea

3.2.5.1 General Information

Many factors contributed to the rapid economic growth of South Korea. It is said that the decisive factor was the construction and systematic operation of transportation logistics facilities.[269]

Recently, there has been a policy shift from supply-based to user-based infrastructure development

[269] Hwang, S. Kim, G. (2014). 50 Praxes for Better Transport in Korea.

that is centrally planned, organized and managed by government who acts as the main supporter of transport funding.[270]

Like in many other countries, urban sprawl is becoming a big problem. As more people move to the outlying suburban areas due to high housing prices within cities, Seoul plans to extend its metro lines into the metropolitan area. Koreans have the longest commute among OECD countries. However, commuting is about 25% faster compared to 1990 due to the improved infrastructure.[271]

Korea is aiming at transforming their infrastructure towards a green transportation system based on electric cars, a cloud-based intermodal transport system, and mobile traffic schedule services using smartphones. To spearhead the global development towards a sustainable transport system, the country has set itself the goal of defining the related hardware and software systems. At the same time it seeks to engage in international standardization and regulation setting in order to guarantee the mutual operability, compatibility and suitability of related services.[272]

Because South Korea is cut off from the rest of Asia due to its on-going disputes with North Korea, it has developed one of the world's largest shipbuilding industries and the necessary infrastructure covering about 1,609 km of navigable waterways in South Korea.

3.2.5.2 Research, Development & Innovation

In order to push intelligent and sustainable transportation, a number of new technologies in public transportation have been introduced. The Ministry of Land, Transport and Maritime Affairs has designated bimodal trams and magnet-embedded tracks as new transportation technologies. Bimodal trams are built by applying railway technologies into buses. Thus, they combine the flexibility of buses and the periodicity of trains. The trams are controlled electronically, provide a smoother ride for passengers, and can be automatically operated on dedicated tracks with magnets embedded in them. They are eco-friendly systems that could be an alternative to light rail vehicles.[273]

Currently there are several innovative rail technologies being tested by the Korean Rail Research Institute (KRRI). The institute is developing a 350-km/h high-speed rail (HSR-350x), a light-rail transit (K-AGT), and a tilting train (TTX) for passenger transport and an ultra-high-speed train reaching speeds of up to 400 km/h.[274]

3.2.5.3 Industry

The major innovation in recent years with respect to infrastructure is definitely the Korea Train eXpress (KTX), Korea's high-speed train, run by Korail. While the first generation was based on French TGVs, the second generation (KTX II) was developed by the company itself as a result of heavy R&D investments. The technology now ranks fourth after France, Germany, and Japan. The trains were developed by Korea Railroad Research Institute (KRRI) and manufactured by Hyundai Rotem, part of Hyundai Motor Group.[275]

3.2.5.4 Market

In 2010 trips made by bus and rail accounted for 64.3% of all trips, public transport in total made up 71.5%. In Seoul the vast majority of rides in 2015 was done by public transport or taxi: 37% by subway, 28% by bus and 7% by taxi.[276] According to South Korea's Green Growth strategy green transportation and mass transportation shall be increased. The share of passenger transportation by rail shall increase from 18% in 2009 and 22% in 2013 to 26% in 2020. The overall share of the mass

[270] Choi, C. and Loh, N. (2013). Transport Policies and Patterns: A Comparison of Five Asian Cities. Retrieved from http://www.lta.gov.sg/ltaacademy/doc/13Sep069-Loh_ComparisonOfFiveAsianCities.pdf
[207] OECD (2014). OECD Green Growth Studies. Retrieved from http://dx.doi.org/10.1787/9789264225503-en
[272] Moon, Y., Kim, S. (2013). International Standardization Strategies for Green Transport System. In: KOTI World Brief Vol.5 (45) Retrieved from: http://www.koti.re.kr/mail/pdf2/world13-45/Focus.pdf
[273] Nikola (2013). New Generation of Trams. Retrieved from http://kojects.com/2013/03/20/new-generation-of-trams
[274] Railway Research (n.d.). Korean Rail Research Institute (KRRI). Retrieved from: http://www.railway-research.org/Korean Rail-Research-Institute
[275] Choon, C. (2016). South Korea eyes global high-speed rail market. Retrieved from http://www.straitstimes.com/asia/east-asia/south-korea-eyes-global-high-speed-rail-market
[276] Kojects (2016). General Information. Retrieved from http://kojects.com/general-information

transit shall be increased from 50% in 2009 and 55% in 2013 to 65% by 2020. The share of bicycle transport shall increase from 1.5% of the total passenger transport volume in 2009 and 5% in 2013 to 10% by 2020.[277]

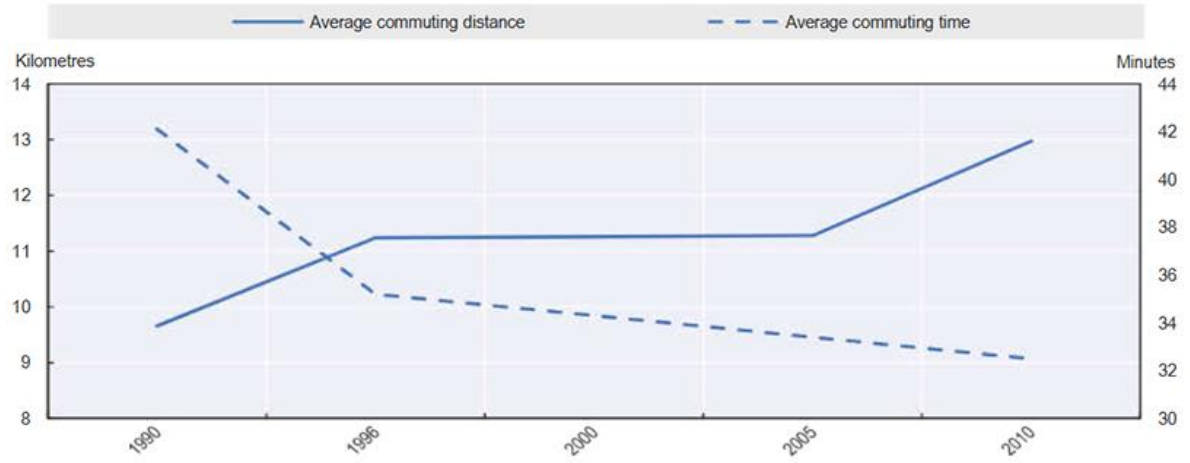


Figure 18: Average commuting distance and commuting time of Koreans

Whereas subways in Seoul are operated by the public, bus operators are usually private companies. Due to Korea's relatively small geographic area, the share of bus in long-distance travel is comparatively high. However, in order to reduce emissions, recent plans foresee a national railway system built by 2025 that can link Seoul with most cities in two hours.

Supply policies include bus rapid transit (BRT), exclusive median bus lane, urban bus reform, transit facility expansion, BIS/Bus Management System (BMS), business taxi, bicycle revitalization, pedestrian priority zone. Restriction policies include a parking cap, parking fare policy, resident priority parking, weekly no driving day program, TDM in private sector and congestion-free transportation.[278]

The National Transportation Network Plan (2000-2019)[279] aims at establishing a cost-reduction logistics system and a high-efficiency multi-modal transport system. In the Second Amendment to the National Transportation Network Plan (2001-2020), published in December 2010, the expansion of transport infrastructure – including roads, railways, airport and ports – foresees the establishment of an integrated network for the installation of interconnected and effective national comprehensive transport systems. Additional goals are the reduction of socio-economic costs caused by transport logistics activities and realization of sustainable green growth.[280]

The 4th Comprehensive National Territorial Plan Corrective Plan's (2011-2020) long-term goals are to promote international cooperation for establishing railway transport and logistics system to enable expanding into Asia and Europe and for connecting the missing link in Asian Highway, through connecting Korean Peninsula Railway Network with Trans-Siberian Railway (TSR) and Trans-China Railway (TCR).

The Urban Traffic Improvement Promotion Act issued in 2010 sets goals of ensuring smooth traffic and to promote convenience in urban areas, improving traffic facilities and increasing efficiency. The act states that anyone who intends to undertake any project within an urban traffic improvement district or within a traffic zone of an urban traffic improvement district shall formulate a traffic impact analysis and improvement plan.[281] If projects exceed a certain size such plans have to include a Traffic

[277] Green Growth Knowledge Platform (2010). Road to Our Future Green Growth: National Strategy and the Five-Year Plan (2009-2013). Retrieved from http://www.greengrowthknowledge.org/resource/road-our-future-green-growth-national-strategy-and-five-year-plan-2009-2013

[278] Lee, S. (2009). Environmentally Sustainable Transport Policies in Korea. Retrieved from http://www.uncrd.or.jp/content/documents/4EST-B1G201.pdf

[279] Hwang, S. Kim, G. (2014). 50 Praxes for Better Transport in Korea, The Korea Transport Institute, Gyeonggi-do, pp. 91-93

[280] The Ministry of Land, Infrastructure and Transport (2010). The Second Amendment to the National Transportation Network Plan 2001-2020.

[281] Ministry of Land, Infrastructure and Transport (2010). Urban Traffic Improvement Promotion Act ACT. Retrieved from http://elaw.klri.re.kr/kor_service/lawView.do?hseq=18768&lang=ENG

Impact Assessment (TIA) that is conducted to analyze various traffic facilities and the traffic volume in anticipation of expected transportation needs within one, five and ten years. Through this assessment secure, smooth, pleasant and safe urban travel can be guaranteed based on appropriate traffic measures and an improved transportation environment.[282] The number of TIA reached about 400 in the first four years after its introduction in 1987 and increased to 700 in the late 1990s.

In May the Ministry of Land, Infrastructure and Transport (MOLIT) appointed Seoul's city center as Korea's first Green Transport Promotion Zone. It covers parts of the two heavy-traffic districts Jongno-gu and Jung-gu. Measures include the establishment of pedestrian zones, bicycle infrastructure (paths, racks and bicycle parking) and better facilities for public transport users. The Seoul Metropolitan Government developed measures according to the principles of A (Accident-Free), B (Barrier-Free), C (Congestion-Free), D (Disorder-Free) and E (Emission-Free). In total there are 29 measures. Based on 2015-levels, goals for 2018 and 2030 have been set respectively: [283]

	2015	2018	2030
Space for green transport (km^2)	0.43 (31.2%)	0.58	0.87
Modal share of green transport (%)	68.3 (2013)	70	75
Modal share of cars (10.000/day)	80 (2013)	74	56
Air pollution (ton/year)	5,036 (2012)	4,532	3,198
Traffic fatalities (people/year)	8 (2014)	5	0

In the Seoul Transportation Vision 2030 the plan to build a sustainable transportation system that centres on pedestrians was articulated. Its aim is to expand its urban railroad network so that subway stations are located no more than ten minutes away from anywhere on foot. This entails providing safe, convenient transportation for the disabled, a pedestrian-oriented transportation environment, and low-cost, high efficiency operation systems.

Like in other Asian countries, such as Japan, the Korean government has also articulated efforts towards Transit-oriented Development in its Public Transport Reform. One urban project is centred around the Multi-Mode-COEX-Station that is integrating different transport modes. In the past, two-dimensional road planning for surface roads or raised highways was more emphasized, but recently the focus has been put on three-dimensional urban planning reducing transfer congestion by adding underground and high-rise walkways.

Due to the fact that local governments in agriculture and fishing areas cannot afford to subsidize bus companies, two demand-responsive transport services have been introduced: Hope Taxi in Seocheon County and Majung Bus in Asan City both in Chungchungnam Province. Hope Taxi is currently operated in five towns and townships and 22 villages.[284]

The Public Transport Reform in 2004 has introduced the Bus Management Sytem (BMS) that divided the bus network in four different types, easily recognizable by four different colors. The goal is to ease the usability for users.

[282] Hwang, S. and Kim, G. (2014). 50 Praxes for Better Transport in Korea, The Korea Transport Institute, Gyeonggi-do, pp. 31
[283] Medimorec, N. (2016). Seoul Becomes Korea's First Green Transport Promotion Zone. Retrieved from http://kojects.com/2016/06/13/seoul-becomes-koreas-first-green-transport-promotion-zone
[284] Hwang, S. and Kim, G. (2014). 50 Praxes for Better Transport in Korea, The Korea Transport Institute, Gyeonggi-do, pp 70

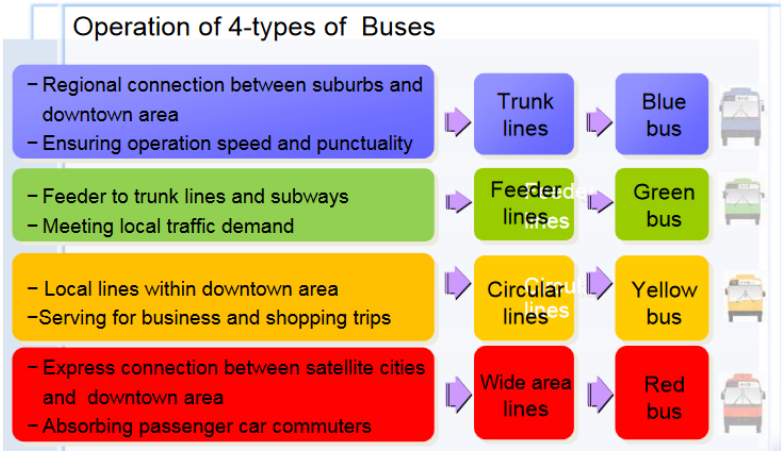


Figure 19: New 4-type Bus Management System in Korea

The exclusive 141 km High-Occupancy Vehicle (HOV) Lane of Gyeongbu Expressway, a main arterial road, aimed to grant exclusive use to public transportation.[285]

With respect to rail transport, a multitude of different technologies are developed: Continental Railroad Connection (TKR), Great Train eXpress (GTX), Light Rail Transit (LRT) and the Korean Train eXpress (KTX). In the 3rd National Railroad Development Plan, the Ministry of Land, Infrastructure and Transport aims to upgrade existing rail lines so they can accommodate high-speed trains and open new railroads that can handle semi-high speed rolling stock. [286] Korea Rail Network Authority, a public corporation, oversees rail development.

The primary goal of North-South Railroad Connection Project is to establish the Trans-Korea Railway (TKR) on the Korean Peninsula, but the final goal is to induce Korean railroads to go beyond the Korean Peninsula and connect to Eurasian railroads including the Trans-Siberian Railway (TSR), Trans-China Railway (TCR), Trans-Mongolian Railway (TMGR) and Trans-Manchurian Railway (TMR).

The Gyeongbu High Speed Railway Project in the Honam axis is being constructed to become another central axis in Korea. In this project, which has entered the second phase, a high-speed railway is constructed on new train tracks in order to further narrow regional differences. A further railroad constructed at the moment in the capital area will link Suseo and Pyeongtaek.[287]

Along the Seoul-Busan axis, the KTX (Korea Train eXpress) has been built. Numbers show that since the introduction of this high-speed train connection, 49% of commuters between the two cities switched from airborne transportation to KTX followed by users of passenger cars and express buses. In particular, the number of flights from Seoul to Daegu decreased from 36 to 4 per day, down 90%.[288] As a result of the continuous development of the KTX infrastructure about 70% of the nation is now reachable within 3 hours from any other point in the country.[289] About 150,000 people use the KTX every day, doubling the 71,000 figure when it started operating. In the same time, the daily number of airline passengers dropped from 21,341 before the opening of KTX to 10,934. The government's plan is to phase in more high-speed trains once all existing major conventional railway lines are electrified. By increasing the KTX transport share up to 35% of overall transportation, Korail is pushing to establish strategies to increase the Korean Customer Satisfaction Index (KCSI) up to the level of airlines. The organisation is also adopting a market-oriented rate system to overcome the limitations of the

[285] Hwang, S. and Kim, G. (2014). 50 Praxes for Better Transport in Korea, The Korea Transport Institute, Gyeonggi-do, pp. 90
[286] Yonhapnews (2016). S. Korea eyes quasi-high-speed railway system. Retrieved from http://english.yonhapnews.co.kr/news/2016/02/03/0200000000AEN20160203007100320.html
[287] Hwang, S. and Kim, G. (2014). 50 Praxes for Better Transport in Korea, The Korea Transport Institute, Gyeonggi-do, pp. 140.
[288] Hwang, S. and Kim, G. (2014). 50 Praxes for Better Transport in Korea, The Korea Transport Institute, Gyeonggi-do,p p. 138.
[289] Chun-Hwan (2005). Transportation Revolution: The Korean High-speed Railway. In: Japan Railway & Transport Review, Vol. 40. Retrieved from http://www.ejrcf.or.jp/jrtr/jrtr40/pdf/f08_kim.pdf

current fixed rate system and become more competitive than other transportation modes.[290] In addition, nine lines of Light Rail Transit (LRT) have been constructed to cover areas that are not covered by existing rail system. The Ui LRT line (11,4km), first of the nine LRT lines to be constructed was opened in 2014.

To further evoke a modal change, the Gyeongin Ara Waterway Project was initiated by K-Water. The 19 km long and 80 km wide waterway connects the Han River and the West Sea and enables transportation of 250 containers in one shipping and thus, reducing environmental costs compared to road and railway. The project further aims to prevent the Gulpo River from flooding and to create leisure space for local residents.[291] This shall be achieved by involving experts of tourism and culture from the planning stage. Eight spectacular waterfront sceneries are being created and the entire 19-km Ara Waterway will become a bicycle road, inline road and pedestrian walk.[292]

Rapid growth in Korea's export and import volumes has led to an expansion of the nation's ports. The pace of port expansion, however, was slower than the growth of trade: this led to congestion at gateway ports such as Busan, Gwangyang, and Incheon, which handled the majority of the Republic of Korea's foreign trade. In response, in 1980, the government initiated a policy to develop inland logistics centers, also known as dry ports. Dry ports are logistics facilities that can carry out inter-modal transportation among roads, rails, ports and airports. Inland logistics bases are divided into multimodal logistics terminals and inland container bases. One such multimodal logistics terminal was built in each of the country's five districts. The Gunpo Multimodal Logistics Terminal that serves as the center of logistics for the Seoul Metropolitan Area contributes to cutting down logistics costs by significantly reducing transport costs and time through bulk cargo transportation via different railway lines.[293] Another such dry port is the Uiwang Inland Container Depot (ICD), which is located 25 km from Seoul, was developed in 1993 by a public–private partnership (PPP), by the Korean Railroad Company and private transportation companies. In 2006, more than 2 million TEU containers were handled at Uiwang ICD. Further, the road mode share was approximately 75%, except for a drop in 2008. The rail mode share of throughput handled by the ICD was about 25% in 2010, even though the ICD was running over capacity. This use of railways for transport from the ICD to seaports has helped ease road traffic congestion and reduce vehicle emissions. An expansion of the ICD's capacity would further enhance the environmental benefits, as would an increase in the rail mode share of freight. The Ministry of Land, Transport and Maritime Affairs (MLTM) is the regulatory authority responsible for the planning, construction, and management of dry ports in the Republic of Korea. MLTM encourages private sector investment in the development of dry ports and logistics centers. Large-scale infrastructure project proposals from the private sector are reviewed by the Public and Private Infrastructure Investment Management Center (PIMAC) to determine whether they are consistent with the government's long-term plans and investment priorities. The government provides some support for the development of dry ports by assuming part of the land acquisition and project costs. [294]

Considering airborne transportation, in total there are 15 airports in South Korea, six only for civilian use and nine for joint use between military & civilians. In 2006, the Construction & Transportation R&D Innovation Roadmap (2nd mid- to long-term (2013-2017) was issued. In 2007 the Aviation Advancement Project, which was renamed into Aviation Technology Research Project in 2013 was issued.[295]

The aviation sector contributes KRW 8,347 billion (0.8%) to Korean GDP and supported around 140,000 jobs in 2011. Airlines registered in Korea directly employ 29,000 people locally, and support through their supply chains a further 29,000 jobs. Shippers pay airlines KRW 12,028 billion annually to

[290] Chun-Hwan (2005). Transportation Revolution: The Korean High-speed Railway. In: Japan Railway & Transport Review, Vol. 40. Retrieved from http://www.ejrcf.or.jp/jrtr/jrtr40/pdf/f08_kim.pdf on 25 July 2016.
[291] K-water (n.d.). GyeongIn Ara Waterway Projects. Retrieved from http://english.kwater.or.kr/eng/busi/project01Page.do?s_mid=1190
[292] Ji-hyun, L. (2012). K-water to develop Ara Waterway. Retrieved from http://koreajoongangdaily.joins.com/news/article/Article.aspx?aid=2950390
[293] Hwang, S. and Kim, G. (2014). 50 Praxes for Better Transport in Korea, The Korea Transport Institute, Gyeonggi-do.
[294] Hanaoka, S. (2011). Promoting intermodal freight transport through the development of dry ports in Asia: An environmental perspective [Article]. In: IATSS Research, Vol. 35(1), pp 16-23. Retrieved from http://www.sciencedirect.com/science/article/pii/S0386111211000148
[295] Hwang, S. Kim, G. (2014). 50 Praxes for Better Transport in Korea, The Korea Transport Institute, Gyeonggi-do, pp. 225-231.

carry 2.6 million tonnes of freight to, from and within Korea. The benefit to shippers, in excess of this expenditure, is estimated as KRW 5,012 billion. Domestically, more than 134,700 flights make over 22.5 million seats available to passengers, destined to 14 airports Passengers spent KRW 48,765 billion (inclusive of tax) on air travel in 2009 and shippers spent KRW 12,028 billion on the transportation of air cargo.[296]

3.2.5.5 SWOT Analysis

Strengths • Systematic approach towards construction of transportation logistics • Early development of inland distribution centers (dry ports) • 71.5% of all trips made with public transport (64.3% by bus & rail) • Pro-active urban planning including Transit-oriented Development (e.g. Multi-Mode CO-EX station, BRT), Traffic Impact Assessment) in anticipation of expected transportation needs within 1, 5 and 10 years), and three-dimensional urban planning	**Weaknesses** • Koreans have the longest commutes among OECD countries. However, 25% faster than in 1990 due to improved infrastructure • Subways are operated by the public, bus operators are usually private companies • Most long-distance travel within Korea made by bus; however, the government plans to establish a rail network to reduce GHG emissions • Railway system developed only on north-south axis; no tracks from east to west
Opportunities • Shift from supply-based to user-based infrastructure development • Many business opportunities in infrastructure-related industries • Synergies between the government & industry • Green Growth Strategy to increase share of public mass transport: 65% by 2020 • National railway system further developed: infrastructure to be built by 2025 that can link Seoul with most cities in two hours • Gyeongin Ara Waterway Project pushes modal shift and takes holistic approach by including pedestrian and bicycle lanes • The modal share of green transport shall reach 75% (compared to 68.3% in 2013) by 2030 and the modal share of cars reduced to 56% (compared to 80% in 2013) • Development of long-distance buses running on natural gas • COP21 is a big driver; high commitments were given that shape governmental strategy. Goal: 1 million electric vehicles and 3.000 stations until 2020; reduce GHG emissions by 34% until 2030 • The Winter Olympic Games 2018 act as a further driver	**Threats** • Urban sprawl is becoming an increasing problem • Threat from North Korea might decrease the realization of infrastructure projects • Big need for resilient systems

[296] Oxford Economics (OECD (2014), Compact City Policies: Korea. Towards Sustainable and Inclusive Growth, OECD Green Growth Studies, OECD Publishing, Paris, Retrieved from http://www.iata.org/policy/Documents/Benefits-of-Aviation-Republic%20of%20Korea-2011

3.2.6 United States of America

3.2.6.1 General Information

U.S. transportation fell from 5th place in the World Economic Forum's rankings in 2002 to 24th in 2011. This decline could be ascribed to a general trend of inadequate investment in the sector of transport infrastructure. According to the American Society of Civil Engineers (ASCE), the U.S. infrastructure has been awarded with D or D+ from 1998 to 2013.[297] The award criteria used cover different aspects, including (but not limited to):

- provision of an assessment of the infrastructure's capacity to meet current and future needs;
- the infrastructure's existing or near future physical condition;
- the current level of funding compared to the funding need;
- the evaluation of the necessary cost for the improvement of infrastructure and determination of whether future funding perspectives will be enough;
- the owner's ability to operate and maintain the infrastructure properly and whether the infrastructure is in compliance with the government's regulations;
- the level at which the safety of the public could be endangered by the condition of the infrastructure;
- the evaluation of the infrastructure system's capability to prevent or protect against various threats; and
- the ability to rapidly recover with minimum damage, as well as the use of innovative techniques.[298]

In all these areas there is potential for improvement all across the country. Current infrastructure requires more investment – for instance, one in nine U.S. bridges are structurally deficient—while new projects are needed to address issues such as road congestion and airport delays.[299]

3.2.6.2 Research, Development & Innovation

According to the U.S. Transportation Secretary, USD 500 million are going to available for transportation projects in the US under the 8th round of Transportation Investment Generating Economic Recovery (TIGER) program. The 2016 TIGER program will be used to fund capital investments in surface transportation infrastructure and is going to be provided for projects which will be deemed to have a major impact on the nation (i.e. that generate economic development, improve access etc.). Since 2009, TIGER programs have already provided nearly USD 4.6 billion to 381 projects in all 50 states, the District of Columbia and Puerto Rico.[300]

Moreover, the Federal Highway Administration (FHWA), in an effort to develop an integrated multimodal network that will promote and enhance community objectives, like community development, greater accessibility, safer transportation systems, transportation system for all users, etc. is funding transportation related projects and activities, enabling citizen to have a better quality of life by reducing pollution, saving money, living closer to work, etc.

As part of the USDoT Livability Initiative, FHWA works within the HUD/DOT/EPA Interagency Partnership for Sustainable Communities, for the coordination and promotion of Federal housing, transportation and other infrastructure policies and investments.

[297] Markovich, S.J. (2014). Transportation Infrastructure: Moving America. Retrieved from: http://www.cfr.org/infrastructure/transportation-infrastructure-moving-america/p18611

[298] American Society of Civil Engineers (2013). Report Card for America's Infrastructure. Retrieved from: http://www.infrastructurereportcard.org/a/documents/2013-Report-Card.pdf

[299] Markovich, S.J. (2014). Transportation Infrastructure: Moving America. Retrieved from: http://www.cfr.org/infrastructure/transportation-infrastructure-moving-america/p18611

[300] The White House - Office of the Press Secretary (2014). FACT SHEET: President Obama Lays Out Vision for 21st Century Transportation Infrastructure. Retrieved from: https://www.whitehouse.gov/the-press-office/2014/02/26/fact-sheet-president-obama-lays-out-vision-21st-century-transportation-i

The Livability initiatives demand the consolidation of such Livability objectives throughout the process of the transportation planning and transportation decision making process.[301]

A project for the implementation of the Silicon Valley Smart Corridor in northern California was initiated in 2015. This Project coordinates both freeway and selected surface street traffic operations for multiple adjacent jurisdictions in the I-880/Route 17 corridor. A link to a planned transit management system is included. The involved jurisdictions and stakeholders are Caltrans (California Department of Transportation), the cities of San Jose, Milpitas, Santa Clara and Campbell, the Town of Los Gatos and Santa Clara County, and technical contractors. An interesting feature of the system is that it allows both monitoring and control of system facilities by all jurisdictions on a peer-to-peer basis.

The system enables real-time data exchange and control between all agencies, thus providing the ability for each agency to monitor corridor-wide traffic management decision making. The real time monitoring includes the ability to adjust traffic signals, electronic signs, and other devices across multiple jurisdictions to respond to traffic volume changes and/or incidents. The system provides a real-time status display map of the corridor at each agency. This will provide travellers with information about current conditions and options, to optimize use of the freeways, expressways, and transit systems, and to minimize travel on local streets. The system interfaces with TravInfo, the San Francisco Bay Area regional traveller information system.

The first three phases of the project had an overall schedule of 18 months and a total budget of USD 7.5M from California's Traffic Systems Management program.

Project elements included: vehicle sensors, CCTV cameras and variable message signs on both surface streets and freeways, traffic responsive signal coordination, upgrades to existing signal and freeway management systems, a wide area computer network, automated data exchange, a corridor-wide real-time display, incident management procedures and a link to TravInfo. The system enables staff in any of the involved jurisdictions' Traffic Management Centers to manage any part or all of the corridor as needed and agreed between the participants.[302]

Additionally, some of the biggest US Transportation Infrastructure Projects that are going to be developed during 2016 are the following.[303]

- Second Avenue subway line in New York City: the segment of the Second Avenue subway line that connects 96th Street to 63rd Street.
- Light Rail / Streetcar: the H Street and Benning Road streetcar line in Washington D.C.
- Expo light rail line in Los Angeles: the second segment of the Expo light rail line in Los Angeles, which extends the route from downtown to Santa Monica.
- Bus-Rapid Transit: Chicago's Loop Link BRT corridor is going to have a dedicated lane along Canal Street, and serve a new bus hub beside Union Station. Protected lanes and shorter crossings will also be provided for cyclists and pedestrians.
- Intercity Rail: The new Hudson River rail tunnel connecting New York and New Jersey, the first phase of the Moynihan Station, which expands the Amtrak concourse of the current Penn Station and the privately funded All Aboard Florida passenger rail line, which links Miami and Orlando.
- Highways and Bridges: The replacement of Seattle's Alaskan Way Viaduct is also expected to have a significant progress in 2016, while the first span of the new Tappan Zee Bridge is expected to open in 2016.
- Street Design: The transformation of Cleveland's Public Square. It is the transformation of a traffic hub into a walkable square surrounded by greenery and thus detached from great traffic.
- Freight: The Panama Canal expansion is also scheduled for completion during 2016.

[301] USDoT – Federal Highway Administration (2016). Livability Initiative – What is Livability? Retrieved from: http://www.fhwa.dot.gov/livability/

[302] Federal Transit Administration (2014). Annual Report on Funding Recommendations Fiscal Year 2015 Capital Investment Grant Program. Retrieved from: https://www.transit.dot.gov/sites/fta.dot.gov/files/FY15_Annual_Report_on_Funding_Recommendations.pdf

[303] Jaffe, E. (2015). The Big U.S. Transportation Infrastructure Projects to Watch in 2016. Retrieved from: http://www.citylab.com/commute/2015/12/us-infrastructure-projects-2016-transportation/421431/

- Airports: The proposed LaGuardia renovation, if approved, could present great progress also in 2016 (while many airports across the U.S. wait to get a touch of modernization in 2016). As part of its ambitious NextGen technology upgrade, the Federal Aviation Administration plans to deploy new data communications equipment at 56 airport towers by the end of next year.[304] [303]

Additionally to all the above, the Federal Highway Administration has launched discussions with state and local officials, in order to recommend routes in their areas where drivers could charge electric vehicles and refuel those that run on other alternative fuels. Initial nominations for corridor designations are going to the done, according to the FHWA, no later than August 2016.[305]

3.2.6.3 Industry

However, the explanation by the US government concerning the takeover of private highway and aviation infrastructure continues to raise reactions, but for some experts, what cannot discussed is that inefficient public policies that have significantly compromised the performance of those public facilities.

According to Clifford Winston[306], applied microeconomist and senior fellow in the Economic Studies program at the Brookings Institution, there are three ways that the private sector may be able to help. First, privatization, that is returning the public infrastructure into private hand, secondly with the adoption, by the public sector, of technological innovations, especially in information technology, developed by the private sector that would improve the performance of existing infrastructure. The third option is direct actions taken by the private sector for the improvement of existing transportation system.[307]

3.2.6.4 Market

Just for the trucking industry, the Federal Highway Administration estimates that highway bottlenecks are responsible for more than 243 million hours of delay each year, and a respective cost of USD 7.8 billion annually.[308]

Reinvesting in infrastructure is a great opportunity for the United States, as the economic benefits related to infrastructure investment can be sustainable. Increased infrastructure investment is expected to result to a wide range of reinforcing benefits.[309]

Transportation investments affect also the geographic distribution of economic activity together with the economy's level. This means that reducing transport costs in the past years enabled the development of US cities (for example Chicago, which became an important center because it served as a central hub between the mid-west and the markets of the northeast and Europe).

There are also several laws and incentives, concerning related to the electrification of transport that also give a boost to the US Transportation Infrastructure. For example, The Zero Emission Airport Vehicle and Infrastructure Pilot Program, which offers funding to airports (up to 50% of the cost), in order to get Zero Emission Vehicles, as well as acquire or modify supporting infrastructure for these vehicles. This funding must be used for airport-owned, on-road vehicles used only for airport purposes and they must meet the Federal Aviation Administration's Airport Improvement Program requirements. Moreover, the airport must be for public use.[310]

[304] Jaffe, E. (2015). The Big U.S. Transportation Infrastructure Projects to Watch in 2016. Retrieved from: http://www.citylab.com/commute/2015/12/us-infrastructure-projects-2016-transportation/421431/
[305] Nadeau, G. (2016). Signs of Things to Come. Retrieved from: https://www.transportation.gov/fastlane/signs-things-come
[306] Winston, C. (2014). How the private sector can improve public transportation infrastructure. Retrieved from: http://www.brookings.edu/~/media/research/files/papers/2014/07/improve_transportation_infrastructure_private_sector_winston/improve_transportation_infrastructure_private_sector_winston.pdf
[307] Winston, C. (2014). How the private sector can improve public transportation infrastructure. Retrieved from: http://www.brookings.edu/~/media/research/files/papers/2014/07/improve_transportation_infrastructure_private_sector_winston/improve_transportation_infrastructure_private_sector_winston.pdf
[308] The White House (2014). An Economic Analysis of Transportation Infrastructure Investment. Retrieved from: https://www.whitehouse.gov/sites/default/files/docs/economic_analysis_of_transportation_investments.pdf
[309] Business Roundtable (2015). Road to Growth. The Case for Investing in America's Transportation Infrastructure. Retrieved from: http://businessroundtable.org/sites/default/files/2015.09.16%20Infrastructure%20Report%20-%20Final.pdf
[310] US Department of Energy (n.d.). Federal Laws and Incentives for Electricity. Retrieved from: http://www.afdc.energy.gov/fuels/laws/ELEC/US

An efficient and well-performing transportation network is necessary for ensuring the US competitiveness in a global marketplace, as it has a crucial role in keeping jobs in America, allowing businesses to expand and managing their inventories making it more cost-effective for manufacturers to keep production in or move production to the United States.[311]

Increased investment in public infrastructure leads to significant economic benefits:

- Up to USD 320 billion would be generated in 2020 if U.S. infrastructure investment were boosted by 1% of GDP per year.
- 1.7 million jobs would be created over the first three years by an USD 83 billion infrastructure investment.
- Nearly USD 3 in economic activity is created by every USD 1 invested in infrastructure.[312]

3.2.6.5 SWOT Analysis

Strengths	**Weaknesses**
• Good record of establishing national standards for the safe and efficient operation of transportation infrastructure systems and modes • Local state alliances (i.e. West Coast). • Competition among State and local jurisdictions seeking limited federal resources to enhance connectivity could become an incentive for the deployment of connected vehicle systems through Public - Private Partnerships	• Decline of the U.S. transportation from 5th place in the World Economic Forum's rankings in 2002 to 24th in 2011.This decline could be ascribed to a general trend of inadequate investment in the sector of transport infrastructure • The government only plays a little role; thus, only economically profitable projects are realized and many stakeholders are involved and decrease efficiency • Major focus is on road development • Infrastructure for public transportation poorly developed: both short and long distances as well as transit between modes (no connection/integration)
Opportunities	**Threats**
• Promotion and enhancement of community objectives, like community development, greater accessibility, safer transportation systems, transportation system for all users, etc • Development and expansion of the Livability Initiative	

[311] The White House (2014). An Economic Analysis of Transportation Infrastructure Investment. Retrieved from: https://www.whitehouse.gov/sites/default/files/docs/economic_analysis_of_transportation_investments.pdf
[312] Atkinson, R. (2014). ICT Innovation Policy in China: A Review. Retrieved from: http://www2.itif.org/2014-china-ict.pdf

3.3 Focus Area 3 – Smart Mobility Services, Freight, And Logistics

3.3.1 Brazil

3.3.1.1 General Information

Several technologies and applications to address mobility issues are being developed in Brazil. The use of technologies for traffic management by Brazilians is fairly low, only 20% of the cities in Brazil with more than 200 thousand inhabitants use it. Some of the technologies are smart traffic lights, electronic signs, surveillance cameras and systems to manage public transportation. Among Brazilian cities, São Paulo and Rio de Janeiro use these technologies the most. In 2012, the federal government of Brazil published the Brazilian Policy of Urban Mobility, or Política Nacional de Mobilidade Urbana (PNMU) stating that every municipality with more than 20 thousand inhabitants must have a mobility plan by 2015. However, almost none of the cities have developed such a plan.[313]

Brazil has smart mobility services for vehicles tracking and freight management. Some mobile applications are available for car sharing, taxi calls and apps to ease Brazilian traffic system. Various companies in Brazil are providing smart mobility in logistic sectors within and outside the country. Additionally, Sao Paolo's airport has started the rollout of a real-time cargo-handling automation and monitoring system.[314]

No specific information could be found on Research, Development & Innovation activities regarding Smart Mobility Services, Freight and Logistics in Brazil.

3.3.1.2 Industry

Log-In Logistica Intermodal offer cabotage services (door to door transportation, logistical planning, coasting trade, port terminal and intermodal terminals) with entire process involving maritime movement, from planning to delivery. Through the controls, the safety of the mode of transport and the possibility of tracking cargo, it has been able to drastically reduce the number of accidents caused by the operations. This helps to lower CO2 emissions (energy efficiency), use of natural waterways (fewer trucks, fewer accidents), integrity of the cargo (security and savings), bulk carriers (sustainability and hydrodynamics).[315]

Companies in Brazil commonly use technologies such as satellite, radio frequency, cellular/ General Packet Radio Service (GPRS) + Global Positioning System (GPS) and cellular/GPRS + GPS + satellite in order to achieve precise and real time tracking of vehicles across the country's roads. Globalnaya navigatsionnaya sputnikovaya sistema (GLONASS), a Russian satellite navigation system, is also being used in the country. The tracking and telemetry devices must be approved by Agência Nacional de Telecomunicações (ANATEL) and certified by the Experimental and Road Security Center/Centro de Experimentação e Segurança Viária/Center (CESVI) or the National Association of Risk Management and Tracking and Management Technology Companies (GRISTEC). Some of the tracking technologies in Brazil are: [316]

- Omnilink: It has nationwide coverage and offers equipment for monitoring and fleet management, guaranteeing more control and security over freight services. It also works with telemetry and risk management. The combined systems allow more efficiency and savings on freight services.
- Autotrac: The vehicle systems use communication and tracking over GPRS and GPS helping control and manage the data collected from the car or motorcycle via web or mobile
- Positron: It is among the leaders in vehicle security, offering equipment and insurance services for clients.

[313] Boechat, L. (2015). Smart Technologies for Urban Mobility in Brazil. Retrieved from TechinBrazil.
[314] Dhingra, L. (2013). Sao Paolo Airport Cargo Transport Going Real-Time, Automated. Retrieved from http://insights.wired.com/profiles/blogs/gru-airport-to-lead-cargo-transport-and-facilitate-global-trade#axzz4CzbsLo00
[315] Login (n.d.). Sustainable Logistics Solutions. Retrieved from https://www.loginlogistica.com.br/sustainability/#graneleiros
[316] Boechat, L. (2015). Smart Technologies for Urban Mobility in Brazil. Retrieved from TechinBrazil.

For freight management, Guarulhos Sao Paolo Aeropuerto Internacional and NIIT Technologies Inc., a global IT solutions firm, are working together to revitalize and augment a Cargo Handling System. Cargo Operating System (COSYS), a product of NIIT's partner SATS, enables real-time automation and monitoring of processes related to the tracking, shipping and managing of cargo shipments.[317]

Some of the Brazilian companies such as DC Logistics Brazil, GAC Marine Logistics and Prompt Brazil are providing smart mobility in the logistic sector within the country and internationally, including online tools to follow up cargos. The A-Z freight group, an industry-leading site, provides a wide range of news, information and data products to the global air cargo community made up of 35,000 global air cargo companies, including 24,000 freight forwarders and 1,700 airports.[318]

3.3.1.3 Market

Brazil has Waze mobile navigation apps for easy commuting and providing information about driving and traffic conditions, as well as carpool services. Some of the taxi applications such as 99taxi and Easy taxi are also used by Brazilians.[319] Regarding car sharing, Brazilian cities are exploring car share programs as the possible alternatives to private car ownership. Some of the smart mobility services include websites, where available seats and destination are indicated for sharing. Carsharing is popular in the densely populated megacities of Brazil. The first Brazilian carsharing provider is Zazcar, started its services in São Paulo with about 2000 members, 60 vehicles and 45 stations. Vehicle access is via RFID smart card, and it has a comprehensive tariff structure for private and business customers as well as vehicle reservations via internet and telephone. It plans to extend its services in Rio de Janeiro and Curitiba.[320]

Brazil also has CarpoolWorld.com, a ride sharing facility available in various cities. The available seats in the car are indicated in the website along with the address and the interested one can approach and share the ride.[321] Uber apps is also active in 14 Brazilian cities, such as in Belo Horizonzte, Brasilia, São Paulo and Salvador.[322] Besides that, Brazil also has Uber for trucks apps, operated by CargoX. As it is reported that around 300,000 vehicles are running empty for 40 percent of the time, this apps aim to reduce the number of empty trucks in the highways and increase revenue for truckers and reduce costs for freight owners.[323]

Sao Paulo is the first city to regulate fees for shared mobility services, such as Uber. It controls road congestion by putting price on vehicle use. The municipality collects a fee based on how many kilometers shared mobility services (such as uber cars) are driving their passengers. This aims to regulate and manage the emerging services of shared and on-demand mobility.[324]

3.3.1.4 SWOT Analysis

Strengths	**Weaknesses**
• Systemic traffic management solutions for specific challenges available • Precise and real-time tracking technology deployed nationwide for security reasons • Freight tracking based on GPRS services (not only RFID) including risk management established	• The use of technologies for traffic management is fairly low except in São Paulo and Rio de Janeiro • Poor governmental support for the development of smart mobility solutions • Lack of coordinated process towards smart mobility services

[317] Dhingra, L. (31. December 2013). Sao Paolo Airport Cargo Transport Going Real-Time, Automated. Retrieved from http://insights.wired.com/profiles/blogs/gru-airport-to-lead-cargo-transport-and-facilitate-global-trade#axzz4CzbsLo00
[318] Logistics Brazil. (n.d.). Directory of Logistics and Transportation Companies. Retrieved from http://www.logisticsbrazil.com/Logistics_Brazil
[319] Boechat, L. (2015). Smart Technologies for Urban Mobility in Brazil. Retrieved from TechinBrazil.
[320] Jung, A. (2014). Carsharing Services in Emerging Economies. GIZ.
[321] CarpoolWorld. (n.d.). Retrieved from https://www.carpoolworld.com
[322] Uber Brazil (n.d.). Uber Brazil. Retrieved from http://uberestimator.com/country/brazil
[323] Ha, Anthony (2016). Goldman Sachs leads USD 10M investment in Brazilian trucking startup CargoX. Retrieved from https://techcrunch.com/2016/07/20/goldman-sachs-leads-10m-investment-in-brazilian-trucking-startup-cargox/
[324] Darido, G. (2016). Sao Paulo's Innovative Proposal to Regulate Shared Mobility by Pricing Vehicle Use. Retrieved from http://blogs.worldbank.org/transport/sao-paulo-s-innovative-proposal-regulate-shared-mobility-pricing-vehicle-use

• Brazil is a leader in some solutions (e.g. Uber for Trucks)	• Despite governmental efforts pushing cities to establish mobility plans almost no city has created one
Opportunities • Due to size and traffic issues of Brazilian cities there is a great potential for the development of smart mobility solutions • Increasing integration of modes undertaken	**Threats** • Slow development of smart mobility solutions cannot respond to exploding traffic volumes

3.3.2 China

3.3.2.1 General Information

China is focusing on the development of smart mobility solutions in order to meet the needs and demands of its rapidly growing population. This includes mobile applications, car and bicycle sharing, green vehicles, and transport-related devices. A smart and sustainable transportation system is a priority for the country, especially because of the high urbanisation rate that will increase even more until 2020.[325] Another key enabler for the deployment of such solutions is the fast infrastructure building.

The logistics industry in China is also expected to present rapid growth within the next 5 years, predicting major changes in the following five sections: express road freight, air freight, contract logistics, and international freight forwarding. However, China's logistics industry has not developed accordingly to its economy growth mainly due to its fragmentation. But at the present, many transportation and logistics companies in China are already adapting their strategies and focusing on more innovative business models, improving their networks and their cost structures[326], while a lot of opportunities for logistics/freight development exist due to well-established infrastructure and export-oriented economy. Currently, China has many logistics parks (clusters of logistics activities at well-defined locations). Due to the rapid growth in exports and the local manufacturing market, hundreds of such facilities have been created. Between 2006 and 2012, the number of logistics parks in China increased by 24% a year.[327]

3.3.2.2 Research, Development & Innovation

The widespread adoption of the Internet of Things (IoT) applications in China appeared in 2010. Smart Cities constitutes a major example of China's application of IoT. The National Development and Reform Commission (NDRC) and MIIT have also published a guideline for the development of smart cities, while the central government has selected 202 cities to pilot smart city projects by developing a large database and sensor networks for the collection, storage and analysis of information related to transportation, public safety, environment, etc.[328]. By 2015, there were over 285 pilot Smart Cities in China, as well as 41 special pilot projects.[329] The integration of the information and industry technology in Smart Cities can create new services that lead to the improvement also of transport infrastructure, as well as the efficiency of urban management. The Chinese government shows great interest in the Smart Cities development and has promoted the development of such technology in national policy.[330]

In the context of the Smart Cities development in China, an agreement has also been signed between several players in the UK and China Smart Cities initiatives for the development of a Joint Smart Cities Laboratory, co-located in Shanghai and Manchester. Digital China is funding the Jiao Tang University, so as to locate a Smart Cities laboratory there. The agreement requires a similar initiative to be established in Manchester, to enable collaboration around current and future best practices in Smart City

[325] Frost & Sullivan (2014). Smart, Seamless and Sustainable: The Future of Mobility in China. Retrieved from: http://ww2.frost.com/news/press-releases/smart-seamless-and-sustainable-future-mobility-china/
[326] Gob, M et al.(2015). China 2015: Transportation and Logistics Strategies. Retrieved from: https://www.atkearney.com/documents/10192/74d60d15-dc42-48a3-8dc8-7a2297f0be22
[327] The World Bank (2015). Logistics Centers Can Become Hubs of Freight Activity in China. Retrieved from: http://www.worldbank.org/en/news/press-release/2015/04/21/logistics-centers-can-become-hubs-of-freight-activity-in-china
[328] Atkinson, R. (2014). ICT Innovation Policy in China: A Review. Retrieved from: http://www2.itif.org/2014-china-ict.pdf
[329] Panori, A. (2016). Report: Smart cities in China. Retrieved from: http://www.urenio.org/2016/04/01/report-smart-cities-china/
[330] Johnson, D. (2014). Smart City Development in China. Retrieved from: http://www.chinabusinessreview.com/smart-city-development-in-china/

design and technologies. The three universities of Manchester, Manchester Metropolitan and Salford along with the eForum form the basis, for the UK side, of the Joint Laboratory.[331]

The overall expansion and development of the IoT also extends to the freight and logistics sector in China. Emerging technologies including Big Data, IoT and cloud computing offer major opportunities to develop this sector and have already been adopted by some companies, such as SF express, which has made its sorting operation very effective by integrating technologies, such as voucher, computer bar code and radio frequency identification.[332]

The Smart Freight Centre (SFC) is a global non-profit organization aiming to remove market barriers, as well as exploit existing initiatives for catalysing practical solutions throughout industry, in the freight and logistics sector.[333] The SFC, together with the Beijing Transport Energy Environment Centre (BTEC), have started a pilot project concerning the reduction of air pollution and CO2 emissions, through the "Green Trucks" initiative, including the use of innovative technologies by freight carriers and the development of a platform for both carriers and technology suppliers to cooperate, in order to promote and enhance technology adoption.[334]

3.3.2.3 Industry

The Ministry of Industry and Information Technology (MIIT) plans to invest and build on China's Integrated Circuit (IC) design industry's capability for mobile smart terminals, cloud computing, IoT, and Big Data. To become international lead market a further goal is to anchor the designs in international standards that other countries have to adapt to. Thus, the country does not only want to become less reliant on imports and foreign technology but also make all other parts of the world dependent on the domestically developed technology. The MIIT is also planning to establish a national industry investment fund to attract venture capital and private equity investment in the IC industry.[335] Integrated Circuit design is the fastest growing segment of China's semiconductor industry.[336]

In the context of the changing mobility trends in China, OEMs are required to co-operate with local governments to create new mobility solutions adapt their work to local customer needs including safety issues, infrastructure constraints and yearn for flexibiity. The challenge for them is to take these issues into consideration while also staying competitive with cheap public transport and taxi service.[337]

Many foreign enterprises, mainly IT companies and telecommunication operators, have also started participating and cooperating in the construction and development of Smart Cities in China. However, as in other areas of action, all these companies have to deal with various problems, risks and challenges related to their ability to join and, thus, work under the different conditions of China (i.e. legislation framework).[338]

Additionally, in the context of the logistics sector development in China and the integration of smart technologies, the logistic industry is becoming more mature. A wave of industries is expected to emerge that will lead to a more compact market and facilitate local companies in competing with foreign corporations.[339]

---

[331] euForum (2012). EU-China Smart Cities. Retrieved from: http://www.eu-forum.org/smart-cities

[332] Deloitte (2015). Investment Promotion Report of China's Logistics Industry 2014-2015 - Simplified Version. Retrieved from: http://www2.deloitte.com/content/dam/Deloitte/cn/Documents/public-sector/deloitte-cn-ps-china-logistics-industry20142015-en-150708.pdf

[333] Smart Freight Centre (2016). Smart Freight Centre aims to make the global freight sector more efficient and environmentally sustainable. Retrieved from: http://www.smartfreightcentre.org/main/what-we-do/overview-vi

[334] Smart Freight Centre (2016). Green Trucks China Pilot Kickoff Workshop. Retrieved from: http://www.smartfreightcentre.org/news/green-trucks-china-pilot-kickoff-workshop

[335] EUSME Centre and China-Britain Business Council (2015). The ICT Market in China. Retrieved from: http://www.ccilc.pt/sites/default/files/eu_sme_centre_report_-_the_ict_market_in_china_update_-_july_2015.pdf

[336] PWC (2015). China's Impact on the Semiconductor Industry – 2015 Update. Retrieved from: http://www.pwc.com/gx/en/industries/technology/publications/semiconductor-china-ic-design-industry.html

[337] Raymond Tsang and Pierre-Henri Boutot (2015). China New Mobility Study. Retrieved from: http://www.bain.com/publications/articles/china-new-mobility-study-2015.aspx

[338] Hu Yang (2015). Smart city: opportunity and challenge for enterprises. Retrieved from: http://www.chinadaily.com.cn/business/2012-11/15/content_15935688.htm

[339] Gob, M-F., Wang, T., Gan, C.W., Li, J. and Yu, Z. (2015). China 2015: Transportation and Logistics Strategies. Retrieved from: https://www.atkearney.com/documents/10192/74d60d15-dc42-48a3-8dc8-7a2297f0be22

3.3.2.4 Market

While the government of China is trying to balance supply and demand in basic sectors of the economy, like transportation, big industry players are beginning to adopt the internet of things products and services. Logistics companies are more and more using real-time information, provided by connectivity, in order to enhance efficiency and decrease their costs[340]. The logistics market of China is developing rapidly through the last years. However, logistics software is considered an area that still needs to be upgraded, in order to enhance the ability of logistics companies to offer fast and high quality services.[341]

In 2013, the Ministry of Industry and Information Technology (MIIT) published a document called the "Informatisation Development Plan" concerning the progress of the Chinese ICT sector. In this document several encouraged sub-sectors were listed, including informationised logistics with e-commerce as well as intelligent transportation systems. In order to maximize the potential and benefits of ICT, China has developed several industry-specific mid and long-term ICT policies[342]. Regarding the long-term ICT development, the General Office of the Communist Party of China (CPC) Central Committee and the General Office of the State Council have published the State Informatization Development Strategy (2006- 2020) which defines China's goals for informatization development for the next 15 years.[343]

In order to boost of several policy priorities related to the IoT industry and IoT applications, a national IoT Center was established in Shanghai in 2010. The government-owned institute receives an annual investment of CNY 10 billion to operate across a multitude of areas including health applications, intelligent buildings and household, smart power grids and smart transportation.[344]

According to the International Data Corporation (IDC), the construction of "smart cities", deployment of the IoT and cloud services, as well as mobility and IT products will be the main drivers of the Chinese ICT market development.[345]

In 2015, the EU SME Centre published a report called "Smart Cities in China". The centre is an initiative of the European Union, aiming to provide support to European small and medium-sized enterprises (SMEs) in order to help them get ready to do business in China[346]. This report not only gives an overview of the market and the state of play regarding Smart Cities in China but also acts as an "advisory tool" for EU SMEs that want to expand their activity in this sector. A list of barriers encountered by EU SMEs is also presented in the report, including some legal and regulatory issues, market and operational difficulties, etc. It suggests advice to help tackle these problems.[347]

[340] GSMA (2015). How China is Scaling the Internet of Things. Retrieved from: http://www.gsma.com/newsroom/wp-content/uploads/16531-China-IoT-Report-LR.pdf
[341] Deloitte (2015). Investment Promotion Report of China's Logistics Industry 2014-2015 - Simplified Version. Retrieved from: http://www2.deloitte.com/content/dam/Deloitte/cn/Documents/public-sector/deloitte-cn-ps-china-logistics-industry20142015-en-150708.pdf
[342] EUSME Centre and China-Britain Business Council (2015). The ICT Market in China. Retrieved from: http://www.ccilc.pt/sites/default/files/eu_sme_centre_report_-_the_ict_market_in_china_update_-_july_2015.pdf
[343] Atkinson, R. (2014). ICT Innovation Policy in China: A Review. Retrieved from: http://www2.itif.org/2014-china-ict.pdf
[344] Atkinson, R. (2014). ICT Innovation Policy in China: A Review. Retrieved from: http://www2.itif.org/2014-china-ict.pdf
[345] EUSME Centre and China-Britain Business Council (2015). The ICT Market in China. Retrieved from: http://www.ccilc.pt/sites/default/files/eu_sme_centre_report_-_the_ict_market_in_china_update_-_july_2015.pdf
[346] EUSME (2016). The Centre. Retrieved from http://www.eusmecentre.org.cn/about-centre
[347] Panori, A. (2016). Report: Smart cities in China. Retrieved from: http://www.urenio.org/2016/04/01/report-smart-cities-china/

3.3.2.5 SWOT Analysis

Strengths	Weaknesses
• Major IT companies are engaged in developing technologies for societal advancement creating the baseline for the development of smart mobility services • Strong IT knowhow and a multitude of innovation activities • Well-established IoT knowhow and industry • Well-established multi-modal logistics industry with economies of scale • Ride and bike sharing are increasingly popular in China	• Big regional differences regarding technological progress and technology readiness level • Despite affordable transport possibilities there is hardly any development of smart mobility services in small cities
Opportunities	**Threats**
• Fast deployment of smart mobility services possible due to fast infrastructure building • Many opportunities for logistics/freight development due to well-established infrastructure and export-oriented economy	• Uncertainty in local government regulations. • Threats concerning safety issues

3.3.3 India

3.3.3.1 General Information

India faces various mobility challenges such as traffic congestion, pollution and road accidents. On top of that, public transport has not been able to cope with the increasing travel demand, resulting in overcrowded buses and trains and thus, the preference of cars over public transport.[348] In order to ease traffic congestion and efficient vehicle movement in Indian cities, various services for smart mobility in India are applied, such as smart card ticketing machines and smart mobile phone application. The use of the smart mobility apps are expected to grow as the average mobile app usage has grown exponentially by at least 131%.[349]

The Indian logistics and supply chain management sector is informal and fragmented, mostly with low-tech vehicles and often without warehouses. Yet, there are a few large companies that are operating big fleets of well-coordinated vehicles with different capacities. Currently, some institutions such as Indian Railway Institute of Logistics and Material Management, Indian Institute of Logistics in Chennai and Kochi are carrying out the research in the field of logistics and supply chain management in India.[350] Also, smart logistics start-ups are also growing in India for efficient goods delivery. However, poor transport and mobile network infrastructure hinder smart mobility services in India.

[348] Reddy, P. (2016). How mobility apps are transforming the urban transportation in India. Retrieved from https://www.moveforward.com/how-mobility-apps-are-transforming-the-urban-transportation-in-india/
[349] The Times of India. (2015). App usage in India grows 131%. Retrieved from http://timesofindia.indiatimes.com/tech/tech-news/App-usage-in-India-grows-131/articleshow/48553584.cms
[350] Thaller, C et al. (n.d.). Analysis of the Logistics Research in India – White Paper

3.3.3.2 Industry

The Information Technology department - Delhi Integrated Multi-Modal Transit System Ltd. (DIMTS) has built strength in the Transport Analytics domain backed by its versatile Research & Development capabilities. It has contributed significantly to the Urban Mobility space through time-tested Intelligent Transport Systems evolved on gathering field knowledge over the years. Some of the products/ solutions are[351]:

- Automatic Vehicle Location System (AVLS)- DIMTS has solutions for Vehicle Tracking and Fleet Management for all categories of public transport, based on a combination of GPS, GPRS, GIS and Web technologies. Customized mobile and email alerts based on different conditions are sent to stakeholders while tracking movement of the fleet / vehicle, for security and monitoring purposes.
- Mobile Applications:
    - Pooch-O, the flagship product is a 'One-Stop Transit App' from DIMTS, with a commuter-centric interface giving options for travel by Auto Rickshaws, buses and provides traffic information to help commuters plan better travel.
    - NextBus Delhi is a bus application that provide route information, live occupancy status and estimated time of arrival (exact time of the next bus' arrival with its bus number) for cluster buses in Delhi. The app also gives information regarding bus frequency, bus stop locations, and maps for better visibility to the commuter.
    - TellTail is a security app for Indian citizens, especially for lady commuters. This application can be used all over the country for basic security features. Residents of Delhi travelling by auto can share the location of the Auto Rickshaw they are travelling in with their family/friends and can be tracked. In case of emergency, pressing the panic button thrice or shaking the mobile violently will indicate the danger situation. Emergency contacts will be alerted with an alarm even if their phone is on Silent mode and receive a message that contains the location of the user and a map for further guidance.
- Automatic Fare Collection (AFC) - Enabling payments for multiple purposes including public transport with DIMTSPay, the unique payments platform for ticketing / passes / parking / toll. It has options of a Mobile Wallet, Smart Card, and the standard Credit / Debit Card facility.
- Identity Management - Smart-Card based solutions for issuance of Driving License, Registration Certificates of vehicles, Permits for State / National level commercial vehicles and Public Service Vehicle badges.

Cycle rickshaws are a popular form of non-motorised transport (NMT) in India, and also are preferred mode of travel in cities, especially for shorter distances and can carry up to two passengers at a time. Cycle rickshaws not only serve as an affordable means of travel but also have various other environmental benefits. Their compact and flexible design allows them to comfortably pass through narrow lanes where other public transport modes generally have difficulty. Therefore, with the use of modern technology, its use has been increased to promote sustainable mode of transportation.[352] Some of the initiatives are:[353]

Ecocab: An "Ecocab" is basically a dial-a-rickshaw service developed on similar lines as a dial-a-cab service. The main idea was to bridge the gap between demand and supply through equal distribution of fleet and automation using latest IT tools and real time technologies. The concept was launched for the first time in Fazilka, a small town in the state of Punjab. It saved about 900 liters of fuel daily which could pollute 14,500 kg of fresh air. It also provides better law and order in the city by providing employment and quality Ecocab services. On average, one Ecocab saves about 3 liter of fuel per day as

[351] DIMTS. (2013). Transportation Technology and IT Solutions. Retrieved from http://www.dimts.in/Services_Transportation_Technology_IT_Solutions.aspx
[352] Ecocabs. (2013). About Ecocabs. Retrieved from http://chandigarh.ecocabs.org/about
[353] NIUA. (2015). Urban Transportation in Indian Cities

it is being propelled with pedal power instead of thermal or fossil fuel. In Fazilka alone, 500 Ecocabs save about 1,500 liters of fuel per day. Advocacy through Ecocabs is saving about 900,000 liter of fuel across Punjab and Haryana per day.

G-Auto: The company offers an innovative solution to organize the auto rickshaw drivers under one common umbrella brand to offer safer and reliable services to customers while improving the lifestyle of auto rickshaw drivers. It has been using mobile technology to offer 'call an auto service' at passengers' doorsteps at a Government approved cost per meter rate. This is used in the cities - Delhi, Ahmedabad, Gandhinagar, Baroda, Surat and Rajkot.

At least two companies based in India market efreight software packages. Hans Infomatic[354] offers its iCaffee software and various other programs, including warehouse and transport management systems for logistics operators. Another company, NewAge[355], provides "a complete, feature-rich end-to-end eCommerce suite for Freight Forwarders, SOCs, Custom Brokers, Carrier Agents, Third Party Logistics, Multi Model Operators, Movers and WMS".

Some logistics start-ups are growing in India to provide effective goods delivery, such as Ecom Express (for ecommerce sites), Delhivery (provides end-to-end logistics solutions to the customer and also helps to connect the country's fragmented logistics ecosystem), BalckBuck (uses its technology to aggregate freight to transport goods between cities) and Gojavas (provides end-to-end logistics solutions to companies).[356] Some private start-ups on road logistics industry are also growing in India with the aim to make the logistics space more organized. They are Moovo (connects users to trusted mini-truck drivers), Shipsy (picks, packs and delivers parcels from the customer's doorstep), Turant Delivery (works with the vendors to help them optimise their inventory utilisation) and Blowhorn (offers a tech platform connecting customers with owners of mini-trucks to move goods from one place to another), etc. These logistics start-ups have mobile (Android) apps to connectivity.[357]

3.3.3.3 Market

The carsharing provider Zoom is India's first membership-based, self-drive car hire service, started in 2011 in Bangalore. It offers state-of-the-art carsharing technology, for example vehicle access via smart phone, and a fleet including various models of car. Based on the cooperation with Golden Gate Properties, an Indian property developer, carsharing stations of Zoom are mainly in residential apartment complexes. Another cooperation with GM, Mahindra and BMW, allows the provider to access vehicles, maintenance, insurance, financing and logistical support. Zoom plans to offer specific tariffs to students and expand the system to Mumbai and Delhi.[358]

Another startup carsharing facility in India is by Ridingo.com, founded in 2012 in Bangalore and focusing on improving the efficiency of urban road transport with the help of ride share. Once people are registered, they can use this facility through a phone.

Likewise, Uberpool[359] apps, an American online transportation network company, also offer car sharing in many Indian cities (such as New Delhi, Pune, Mumbai, Chennai and Jaipur) with wide varieties of vehicle options from scooter to luxurious cars. Besides car sharing, an Indian online transportation network company named Ola is also providing taxi sharing service in 100 Indian cities.[360] Users can select cars of their choice[361]. Ola has started a pilot on-demand auto rickshaw services too in Banga-

[354] Hans Informatic (2016) , About Us . Retrieved from http://www.hansinfomatic.com/about_us.html
[355] Foreight suite (2016). Retrieved from http://efreightsuite.com/
[356] Meghna, R. (2015). 10 top-funded logistics startups in India this year. Retrieved from https://www.techinasia.com/ten-top-funded-logistics-startups-india-2015
[357] Sangwan, S. (2015, November 16). Can these 9 Startups Change the On Road Logistics Industry in India? Retrieved from http://www.iamwire.com/2015/11/9-startups-easing-pain-shifting-heavy-packages-moovo-shipsy-instavans-turant-delivery-blowhorn-thekarrier-shippr-theporter-parcelled/125572
[358] Jung, A. (2014). Carsharing Services in Emerging Economies. GIZ.
[359] UBER (2016). Retrieved from https://www.uber.com/ride/uberpool/
[360] Russell, J. (2015). India's Ola Announces Carpooling Service That Matches Customers Within Social Groups. Retrieved from https://techcrunch.com/2015/10/13/indias-ola-announces-carpooling-service-that-matches-customers-within-social-groups/
[361] Ola (2016). Retrieved from https://www.olacabs.com/fares

lore.[362] With the Indian Supreme Court's decision of ban on diesel cabs in May 2016, the effect is seen not only on the decrease in the number of diesel driven taxis on the road[363] but also on the Ola and Uber facilities.[364] Besides that, Ola is also going to get hard hit in terms of competing with Uber, as Uber has decided to sell off its Chinese operations to local rival Didi Chuxing and invest more in India, thus changing the current Indian market.[365]

3.3.3.4 SWOT Analysis

Strengths	**Weaknesses**
• Wide-spread use of smart card ticketing machines and smart mobile phone applications • Smart Mobility Services offer an answer to country-specific challenges • Well-deployed automatic fare collection and smart cards	• Poor transport and mobile network infrastructure, mainly in rural areas • Not enough mobile apps in local (Hindi) language
Opportunities	**Threats**
• Huge potential for smart services such as car and ride sharing • The use of the smart mobility apps are expected to grow as the average mobile app usage has grown exponentially • Fast uptake of new technologies (smartphones) boost the development of new services since there is no path dependency on old technologies	• Developed solutions have no fertile ground because of high poverty rate • Framework conditions for the implementation of smart mobility solutions are non-existent • Framework conditions for the implementation of smart mobility solutions are limited

3.3.4 Japan

3.3.4.1 General Information

Japan's 5th Basic Plan foresees the integration of different systems (energy, transportation, manufacturing, service, etc.) to cope with the increasing complexity of today's transport systems. One of the application areas that integrate this complexity was formed in the smart community or smart city projects. At the moment there are more than 200 running smart city projects, organized by the central government, local government as well as the private sector. The developments towards smart cities is anchored within the Ministry of Economy, Trade and Industry's (METI) flagship project "Next-Generation Energy and Social Systems Test-Bed", in the 2012 Japan Revival Strategy as well as the 2013 Japan Reconstruction Strategy. The smart city project in Japan focuses mainly on energy and the reduction of their respective carbon footprints (opposed to surveillance in e.g. Songdo or Glasgow). The smart-city market is expected to reach at least a cumulative JPY 5,000 trillion in value between 2011 and 2030, including smart infrastructure as water and housing, smart grids, renewable energy, battery storage, etc.

As shown in Focus Area 2, Japan's transport system mainly developed around the railway infrastructure. Smart mobility services also came into being because railway companies had to diversify their business to make up for decreasing profits in their core business. Plus, major train stations have become focal points in cities offering a variety of different mobility services. There is a widespread use of "on the go"-services through GPS, mobile phones and data ports in convenience stores.

[362] NDTV correspondent. (2014). Now Book Auto Rickshaws in Bangalore via Ola Cabs. Retrieved from http://gadgets.ndtv.com/apps/news/now-book-auto-rickshaws-in-bangalore-via-ola-cabs-623314
[363] Rajagopal, K. (2016). SC converts ban on diesel cabs to 'gradual phase-out'. Retrieved from http://www.thehindu.com/news/national/ban-on-delhi-diesel-cabs-supreme-court-changes-mind-modifies-ban-to-gradual-phaseout/article8581050.ece
[364] IANS. (2016). Ola and Uber Face Effect of Ban on Diesel & Petrol Cabs in Delhi. Retrieved from http://www.thequint.com/hot-wire/2016/05/01/ola-and-uber-face-effect-of-ban-on-diesel-and-petrol-cabs-in-delhi
[365] Reuters. (2016). VB. Retrieved from Uber targets Ola in India after losing to Didi in China

However, a major setback is that Japanese citizens are neither involved in the governance system and political economies nor in the planning, design and deployment of these urban infrastructures. The reason behind this supply-based approach might be the highly monopolized economic sphere that is slow to change since the industry is reluctant to undertake initiatives that might threaten their running business models.

As for logistics and freight, the most important means of transport are road transports and coastal shipping. In fact, trucks are the most used means of transportation making up 50%, followed by shipping with 44%, rail by 5% and airlines with 0.2%.[366] As can be seen, rail transportation only plays a minor role in freight in Japan, the major company being JR Freight which only concentrates on certain express routes and niche markets. Due to cost efficiencies in airborne freight transportation in the United States, the international air transports on trans-Pacific routes, including freight from other Asian countries, have climbed and Japan's decentralized port system is suffering from the effects. Additionally, Japan's industry has focused more intensely on manufacturing in international locations resulting in falling freight volume for Japanese logistics service providers. Faced simultaneously with stronger international competition, Japanese logistics service companies are trying to strengthen their position in sea, land and air transports by offering multimodal shipping provided by a single source. ITS Japan and academia are also putting enormous effort into Multimodal Logistic Systems and Platooning technology.

The most important domestic logistics service providers are Nippon Express, Yusen Air / Sea Service, Yamato Holdings and Sagawa Express.[367] Even though Japan has a well-established railway infrastructure, the problem with connectivity in rail is that freight cars have neither their own power supply nor their own sensors. Despite the fact that there is such a good railway infrastructure, rail is mainly used for passenger transport in Japan (see Focus Area 3). However, automation offers a lot of potential for freight since sensors could measure temperature, location, humidity, and vibration (when maneuvered) in the cargo space in all transport modes.[368]

In general, the Japanese transport system is characterized by very fluid transportation modes, well-established management and a high level of service-orientation. The advanced system has mainly been possible because of the Japanese culture that values efficiency, technological advancements and service orientation.

3.3.4.2 Research, Development & Innovation

Japan is pushing technological development in many ways. Smart Systems that are currently being tested in Japan include: Traffic Information Control System (Next Generation Systems), Contactless Electronic Charging, Advanced Rapid Transit, Advanced Public Transport Priority System, Next Generation Telematics (connecting cars and people, connecting cars and smartphones), C-ITS, Energy Management (connected with homes, offices, stores, factories via cloud technologies; optimized energy use), Next Generation Urban Traffic System (combining cars with public transit and last-mile-mobility systems), vehicle as a resource (storage, communication/networking capability, information/signal processing, electric power, sensing). All these technologies are to be developed in light of the push towards increasing resilience. Especially, the vehicular network is not perceived as a separate entity but as a framework around already known networks creating a vehicle-based network and puts the car in a central position in ICT architecture.[369]

Toyota's is putting their vision of smart mobility "Ha:mo", a next-generation urban transport system that has been tested in Toyoda City, Grenoble and Tokyo. Ha:mo, short for "Harmonious Mobility Network", aims for optimally combining personal mobility vehicles such as automobiles with public transporta-

[366] JR Freight (2015). Freight Rail Overview & Freight Management in Japan. Retrieved from http://www.carecprogram.org/uploads/events/2015/035-Railway-WG-Meeting/Presentation-Materials/Day-2/2015-RWG-Meeting-P15_%20JR%20Freight_KNishimura_EN.pdf

[367] DHL (n.d.). Japan. Retrieved from https://www.dhl-discoverlogistics.com/cms/en/course/trends/asia/japan.jsp

[368] Bosch (2016). Connected freight trains are better freight trains. Retrieved from http://www.bosch-presse.de/presseforum/details.htm?txtID=7511&locale=en

[369] Altintas, O. (2015). Towards Smart Mobility: Vehicle-Centric View of Information and Communication Technologies. Retrieved from http://sites.ieee.org/italy/files/2016/03/Toyota-Altintas_RTSI_2015.pdf

tion. The system features new mobility options such as the "Toyota i-Road" personal mobility concept car, "COMS" ultra-compact single-occupant electric vehicle and "Winglet" an ultra-compact personal transport assistance robot. Another stream of efforts is put on Next-Generation Telematics that enable the gathering and processing of data and turning it into information that is useful to both large and small-scale users. These include: Voice Recognition Agent, Smart G-BOOK (smartphone-based navigation service) and Big Data Traffic Information Service that collects large-scale driving data (including vehicle position, speed, and other statistical data), and which is being used for traffic flow improvement, map information and disaster response measures.[370]

Fujitsu uses real-time display of information to generate a predictive determination of what there is to come and what there is to be done. By doing so, they want to realize a modal shift, improving the user/passenger experience and facilitating the management for urban transportation.[371] To do so, Fujitsu Laboratories and MIT have partnered up to develop an on-demand transportation technology that dynamically assigns the same vehicle to different modes of transport depending on demand. Thus, they can balance vehicle oversupply or shortages. The partnership shall respond to various needs of transport users while increase profits for operators. The main driver is Japan's aging population and efforts to increase sustainability.[372]

Furthermore, Fujitsu has entered co-operation with the Center for Infrastructure Asset Management Technology and Gifu University to enhance the ability of road inspection based on G-sensors. Based on smartphones and on-board devices, the Roadway Patrol Support Service uses Fujitsu's cloud to continuously check road quality which is then automatically reported to and analyzed by the municipal government for road facility maintenance.[373]

As for rail freight, JR Freight is increasingly relying on automation for its freight handling based on three systems: IT-FRENS for selecting the optimal route, DRIVER for navigation, and TRACE for location information based on RFID tags and GPS (see figure 16).[374]

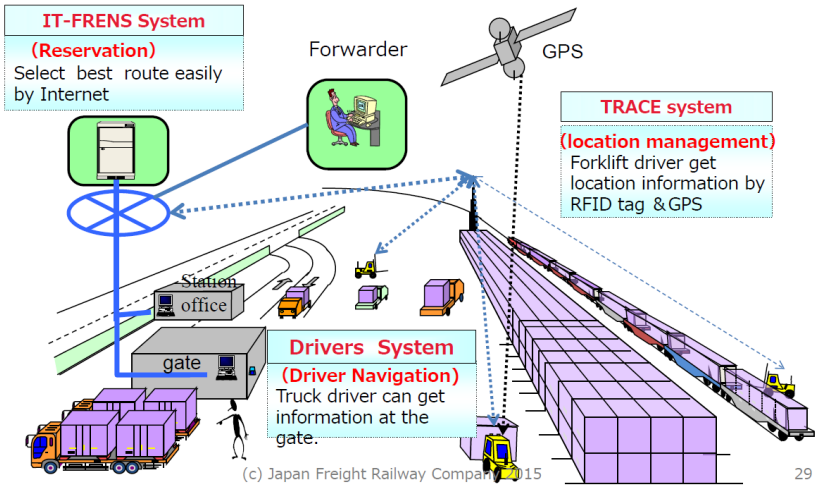


Figure 20: Automation of freight handling developed by JR Freight[375]

[370] Toyota (2013). Toyota's Vision of Smart Mobility to Feature at Tokyo Motor Show. Retrieved from http://www2.toyota.co.jp/en/news/13/11/1108.html

[371] Fujitsu (n.d.). Vision of Smart Mobility. Smart Mobility, an emerging need for Modern Cities. Retrieved from http://www.fujitsu.com/global/solutions/business-technology/intelligent-society/smart-mobility/vision

[372] Fujitsu (2014). Fujitsu and MIT Develop On-Demand Transport Service Technology to Support User Needs and Increase Service Operator Profits. Retrieved from http://www.fujitsu.com/global/about/resources/news/press-releases/2014/0508-01.html

[373] Murakami, S. et al. (2014). Manipulating Data to Maintain Transportation Infrastructure. In: Fujitsu Scientific & Technical Journal, Vol. 50 (2), pp. 26-34. Retrieved from http://www.fujitsu.com/global/documents/about/resources/publications/fstj/archives/vol50-2/paper04.pdf

[374] JR Freight (2015). Freight Rail Overview & Freight Management in Japan. Retrieved from http://www.carecprogram.org/uploads/events/2015/035-Railway-WG-Meeting/Presentation-Materials/Day-2/2015-RWG-Meeting-P15_%20JR%20Freight_KNishimura_EN.pdf

The Smart Mobility Research Center of Tokyo's University of Agriculture and Technology comprises three laboratories into an open-innovation laboratory in the field of vehicle and mobility engineering. The focus lies on zero accidents and zero emissions but it also covers active safety and advanced driver assistance systems as well as environment-friendly vehicles and alternative power systems for enhancing energy efficiency. Methodologically, it focuses on near-miss incident data, in-depth analyses based on image-captured drive recorder data, as well as vehicle control by using Car-Robotics technology.[376]

Whereas there is a lot of research on multimodal logistics at Hitotsubashi University,[377] other universities such as Osaka University, Osaka Prefecture University, Kyushu University at Fukuoka, Kobe University, Tokyo University are putting a strong focus on maritime logistics.[378]

Toyota's InfoTechnology Center, established in January 2001 in Tokyo, was founded as a joint venture of eight companies, including Toyota Motor Corporation, DENSO, KDDI and other Toyota group companies.

The Japan Ship Technology Research Association's (JSTRA) efforts are directed at a series of technical challenges requiring urgent solutions for the maritime industry such as improvement of logistic efficiency, securing safety and environment protection.[379]

3.3.4.3 Industry

Like the central government and local governments, the private sector is engaging in the establishment and development of smart cities.

In September 2009, the Smart City Project group was founded by 25 companies and one association, the Future Design Centre. The Smart City Project gathers some of the largest firms in Smart City technology and planning such as Azbil Corporation, NEC, Itochu, SAP, Kaneka, NTT, LG CNS, JX Nippon Oil & Energy, Kawasaki, Kokusai Kogyo, Sumitomo Forestry, Sharp, Tsuneishi, Sekisui, Toschiba, Toppan, Tokyo Gas, Hitachi, Nikken Sekkei, HP and Mitsui.

This includes Sekisui House's "smart towns", Panasonic's FujisawaSST "smart city" initiative, Hitachi's "Hitachi City", Mitsui Fudosan and Mitsui Home and various initiatives by Toshiba such as greenfield Ibaraki City Smart Community Project. Other companies involved are Azbil, e - solutions, Itoch u, SAP, NEC, NTT Communications, LG CNS , Kaneka, Kawasaki, Kokusai Kyogo Group, JX Nippon Oil & Energy, Shimizu, Sharp, Sumitomo Forestry, Seven & iHoldings, Tsuneishi Holdings Corporation, Tokyo Gas, Toppan, Nikken Sekkei, HP.

Hitachi's plan is to market their ITS applications for a wider variety of social innovations in areas such as logistics or urban planning by using probe technology, so that it can help provide safer and more comfortable lives and contribute to the progress of a society that is conscious of the environment.[380] Regarding logistics, Hitachi also works on smart logistics technology including automation, simulation and analysis technologies.[381]

[375] JR Freight (2015). Freight Rail Overview & Freight Management in Japan. Retrieved from http://www.carecprogram.org/uploads/events/2015/035-Railway-WG-Meeting/Presentation-Materials/Day-2/2015-RWG-Meeting-P15_%20JR%20Freight_KNishimura_EN.pdf
[376] TUAT (ND). Smart Mobility Research Center. Researches. Retrieved from http://web.tuat.ac.jp/~smrc/research.html
[377] Hitotsubashi Unversity (2016). Hitotsubashi Researchers Information. Retrieved from https://hri.ad.hit-u.ac.jp/html/141_research_activity_en.html
[378] EduMaritime (2016). Some of the Best Education in Maritime & Logistics in Japan. Retrieved from http://www.edumaritime.net/international/japan
[379] JSTRA. (2016). Introduction. Retrieved from http://www.jstra.jp/english/
[380] Okubo, T. et al. (2014). Realizing Smart Mobility Using Probe Data. Hitachi Review Vol. 63(6), pp. 359-363. Retrieved from http://www.hitachi.com/rev/pdf/2014/r2014_06_110.pdf
[381] Hitachi (2016). Smart Logistics Technologies. Retrieved from http://www.hitachi-transportsystem.com/en/solution/smartlogistics

Recently, VIA Technologies, Inc. and Japan Taxi Co., Ltd. unveiled the Smart IoT Mobility System based on highly-customizable, in-vehicle system platforms which integrate a full suite of communication and connectivity features in a highly-optimized solution for commercial vehicle applications, creating a smart fleet management and the development of new on-demand passenger services.[382]

The Japanese logistics industry comprises independent operators of land transportation, marine transportation, air freight forwarding and warehousing.[383] The biggest companies are: Yamamoto Global Logistics, Yusen Logistics, Fukuyama, Hitachi, Nippon Express, MOL Logistics, Transcontainer Ltd, Kintetsu World Express, NEC Corporation, Japan Cargo Express Co., Ltd. The two main industry associations are Japan Aircargo Forwarders Association (JAFA) and Japan International Freight Forwarders Association (JIFFA).

Murata/Muratec are developing a variety of smart transportation technologies for logistics such as Laser Guided Vehicles (LGV), Automated Transportation and Sorting Vehicles (RTN-X), Conveyor Systems, Intra-bay Automated Overhead Traveling Vehicles, Inter-bay Automated Overhead Traveling Vehicles, Rail Guided Vehicles (RGV), Automated Overhead Traveling Vehicles (SKY-RAV), and Magnetic-guided Automated Transportation Vehicles (AGV).[384]

3.3.4.4 Market

There have been two waves of Smart City projects subsidized by METI. The first wave focused on the Test Projects for Next Generation Energy and Social Systems. The four key pilots were Keihanna, Kitakyushu, Toyota City, and Yokohama. The second round was launched in 2012, the year after 3-11, in order to foster the urban and economic reconstruction of some disaster hit areas and improve their resilience. The total budget allocated to the projects for promoting the introduction of smart communities is JPY 8.06 billion. The ten chosen municipalities are: Fukushima, Aizuwakamatsu City, Iwaki City, Minamisoma City, Ishinomaki City, Kesennuma City, Ohira Village, Yamamoto Town, Kamaishi City, Miyako City, Mogami. One of them is the Future City Initiative (FCI), the successor of the initiative – Eco-city models – launched in 2008.

Japan is leading in ITS. One of its central goals has been the provision of real-time information on traffic conditions from 1996 onwards. Real-time traffic information can be either collected through fixed devices or sensors embedded in or beside roadways or through mobile probes delivered by taxis or mobile devices such as smartphones. Japan was the first country to use fixed devices (1996-2003), and then switched to mobile probes (as of 2003).

Japan's VICS "Smartway" takes information collected by Japan's Road Traffic Information Center on roadway conditions, accidents, congestion, and road closures or repairs. It processes, edits, and digitizes this information; and then sends it to vehicle navigation systems via different transmission mechanisms. It provides users with three different services: (1) information and direct driving assistance, (2) internet connection services, and (3) cashless payment services at toll booths, parking lots, gas stations, convenience stores, etc. By combining knowledge of the vehicle's location on the roadway with context-specific traffic flow information, it advances towards AHS (Advanced Cruise- Assist Highway System) and ASV (Advanced Safety Vehicle) to offer safer "smart driving" via vehicle-to-vehicle communications. Information is provided visually and audio, via actual live camera images, including real-time traffic information during natural disasters—particularly earthquakes, landslides, and tsunamis. It has additionally designed mechanisms to automatically feed data about such events into the dynamic message signs on roadways.[385]

About 68% of all vehicles regularly using Japan's toll expressways are equipped with ETC on-board units. Japan operates a single national standard for electronic tolling to make the system compatible nationwide for transactions across all the country's toll roads for expanding ETC. In this way, private

[382] VIA (2016). VIA and Japan Taxi Unveil Smart IoT Mobility System. Retrieved from http://www.viatech.com/en/2016/03/via-and-japan-taxi-unveil-smart-iot-mobility-system
[383] Mitsubishi Logistics (2016). Japan. Retrieved from http://www.mitsubishi-logistics.co.jp/english/service/pd/district/japan.html
[384] Muratec (2016). Transportation Systems. Retrieved from http://www.muratec.net/logistics/products/transportation/index.html
[385] Ezell, S. (2010). Explaining International IT Application Leaderhip: Intelligent Transportation Systems. Retrieved from http://www.itif.org/files/2010-1-27-ITS_Leadership.pdf

companies can offer automatic toll collection options, such as in private parking garages. Japan also regularly uses variable-toll pricing, easy to implement electronically, to variably price tolls as a means to manage traffic flow and congestion in metropolitan areas.[386]

The widespread deployment of Variable-Message Signs (VMS), Integrated Traffic Control Systems (ITCS) and the automated traffic light control systems have facilitated a smooth transfer between modes and has decreased the overall congestion in urban areas. In 2016, there were 10,810 car sharing vehicle stations in Japan, showing a year-on-year increase of 14%, 19,717 vehicles, a 20.1% year-on-year increase and 846,240 car sharing users, mirroring a 24.2% year-on-year increase).[387] Compared to 2002, the first year of data gathering, when there were only 21 vehicles and 50 users, this shows an enormous growth (Figure 21). One of the main actors is the Japan Car Sharing Association.

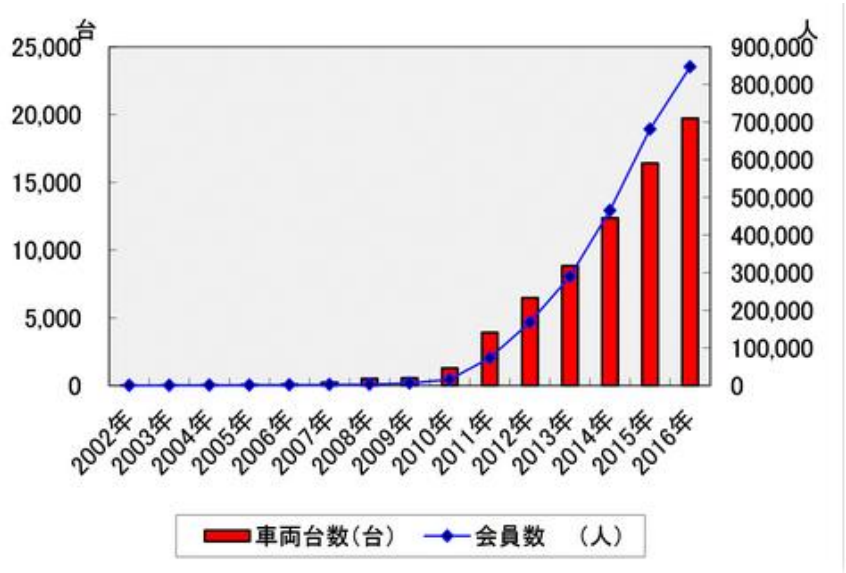


Figure 21: Japan's growing car sharing market (left/red: number of vehicles; right/blue: number of users)[388]

Japan's intermodal freight policies are embedded in the framework of the "Comprehensive Programme of Logistics Policies" launched in 1997. It focuses on infrastructure and deregulation (safety, abolition of demand-supply adjustment rules) and the realization of a sophisticated logistical system (IT, standardization, new technologies). It is revised annually.[389] It was distinguished between three levels of logistics systems: city logistics, regional logistics, and international logistics. Whereas intermodality was not specifically mentioned, especially within regional logistics the focus was put on modal integration: modal role-sharing, promotion of coastal shipping and related equipment, promotion of rail cargo, access to roads and other modes.[390]

[386] Ezell, S. (2010). Explaining International IT Application Leaderhip: Intelligent Transportation Systems. Retrieved from http://www.itif.org/files/2010-1-27-ITS_Leadership.pdf

[387] Foundation for Promoting Personal Mobility and Ecological Transportation (2016). Changes in Japan's car-sharing number of vehicles and the number of members. Retrieved from http://www.ecomo.or.jp/environment/carshare/carshare_graph2016.3.html&usg=ALkJrhjNfPCdE4hxODyyQeI7aXKriCRnug

[388] Foundation for Promoting Personal Mobility and Ecological Transportation (2016). Changes in Japan's car-sharing number of vehicles and the number of members. Retrieved from http://www.ecomo.or.jp/environment/carshare/carshare_graph2016.3.html&usg=ALkJrhjNfPCdE4hxODyyQeI7aXKriCRnug

[389] OECD (2001). Intermodal Freight Transport. Institutional Aspects. OECD Publishing.

[390] Horn, B. , Nemoto, T. (2004). Intermodal Logistics Policies in the EU, the U.S. and Japan. Retrieved from https://hermes-ir.lib.hit-u.ac.jp/rs/bitstream/10086/16054/1/070cmWP_93.pdf

In 2013, the Cabinet approved the Fundamental Principles of General Logistics Policy (2013-2017) in order to present guiding principles on the logistics policies and administration.[391] The three main policy measures are the collection of freights, the creation of freights by industrial clusters behind strategic ports, and the increase of the competitive power of strategic ports. [392]

Within the ASEAN-Japan Transport Partnership that runs since 2003, the Pakse Action Plan was defined. It is based on four pillars comprising Transport Facilitation, Transport Infrastructure, Quality and Sustainable Infrastructure, and Human Resource Development. In the ASEAN-Japan Transport Work Plan (AJTP) 2015-2016 and Green Logistics there are 22 projects clustered along the four pillars (see Figure 22).[393]

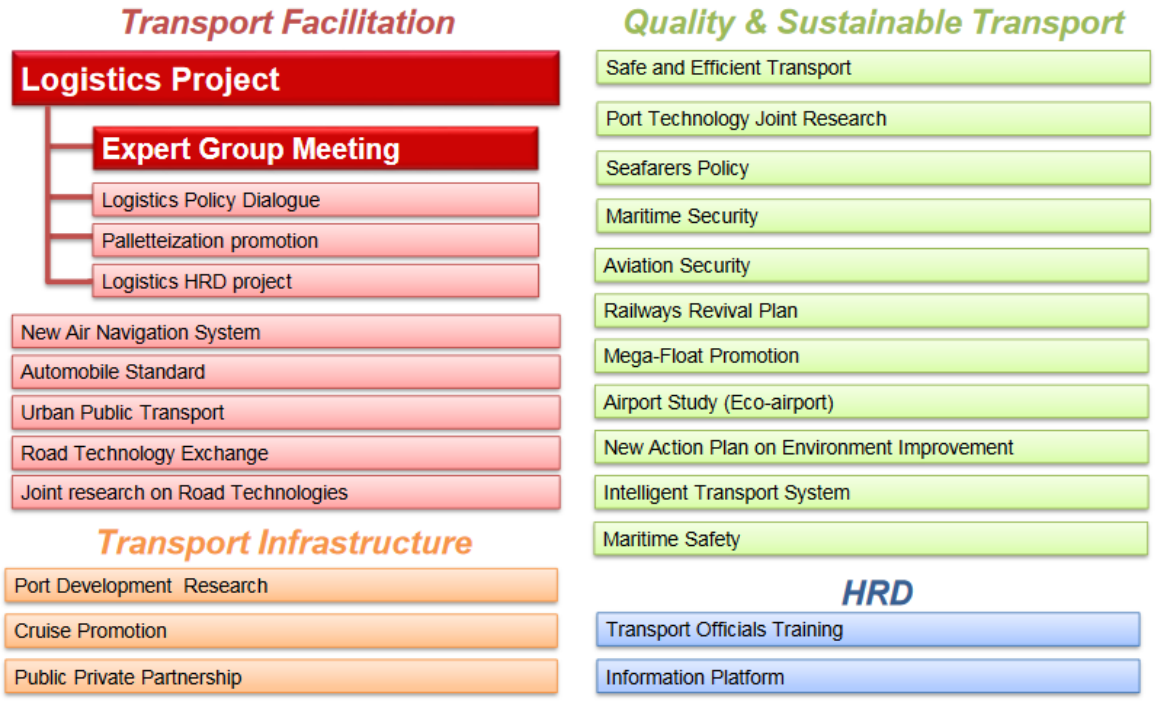


Figure 22: ASEAN-Japan Transport Partnership Work Plan for 2015-2016 and Green Logistics[394]

The government's logistics strategy was formulated within the Framework for General Measures for Logistics (2013-2017), issued by the Ministry of Economy, Trade and Industry defined the following three key points: (1) logistics that support enterprises' global supply chains, (2) logistics with lower environmental burdens, and (3) logistics with disaster resilience.[395]

[391] Ministry of Economy, Trade and Industry (2013). Announcement of the Fundamental Principles of General Logistics Policy (2013–2017). Retrieved from http://www.meti.go.jp/english/press/2013/0625_01.html
[392] Kose, T. (2013). Logistics Policy in Japan. Retrieved from http://www.japantransport.com/seminar/Kose_Presentation_20140327.pdf
[393] Ministry of Land, Infrastructure, transport and Tourism (2014). Introduction of Japan's activity in promotion of Green Freight and Logistics in ASEAN. Retrieved from http://www.gms-eoc.org/uploads/resources/955/attachment/Day%202-Green%20Freight-Japan%20and%20ASEAN.pdf
[394] Ministry of Land, Infrastructure, Transport and Tourism (2016). Introduction of Japan's Activity in Promotion of Green Freight and Logistics in ASEAN. 2nd Workshop on Green Freight and Logistics co-hosted by ADB/GIZ. Retrieved from: http://www.gms-eoc.org/uploads/resources/955/attachment/Day%202-Green%20Freight-Japan%20and%20ASEAN.pdf#page=1&zoom=auto,-17,540
[395] Ministry of Economy, Trade and Industry (2013). Announcement of the Fundamental Principles of General Logistics Policy (2013–2017). Retrieved from http://www.meti.go.jp/english/press/2013/0625_01.html

3.3.4.5 SWOT Analysis

Strengths	Weaknesses
• Development of smart mobility services due to industry's necessity of diversifying business • Widespread deployment of advanced traffic management systems • Many industrial research activities and demonstration projects (e.g. Toyota's ha:mo) • Development of international, high-volume multi-modal distribution terminals • Government support available, particularly for smart communities aiming at energy efficiency and savings • Well-established industrial cooperation • Strong academic R&D	• Even though smart service system are service-oriented, their development is pushed from the supply rather than demand side • Citizens not involved in governance system, political economies as well as planning, design and deployment of urban infrastructures • Highly monopolized economic sphere that is slow to change • Even though Japan has a strong rail industry, the majority of logistics and freight is done by road transport and coastal shipping
Opportunities	**Threats**
• Growing car sharing market, particularly in highly urbanized areas • Need for resilient systems increases development of smart mobility services • Because shifting production overseas reduces freight volume for Japanese logistics services, Japanese shipping providers have to find innovative solutions	• Japan's port system suffers from the effects of international shift towards airborne freight transportation

3.3.5 South Korea

3.3.5.1 General Information

According to the South Korea Ministry of Science, ICT, and Future Planning and the Ministry of Trade, Industry, and Energy, the government's goal is to foster an Internet of Things (IoT) and smart car business by 2024 that will be worth KRW 100 billion. During 2015, the government provided KRW 1 trillion in funding for various IT-related industries, including KRW 77.2 billion for IoT, KRW 28.2 billion for smart cars, and KRW 77.1 billion on its 5G networks.[396]

Korea's Songdo City was built entirely as a smart city, with a focus on surveillance, however, it was critized as being a corporate-led, resource-intensive smart city.[397]

With regard to freight and logistics, the Korean government has established various policies since the turn of the millenia to promote Korea as the logistics center of Northeast Asia (2002), to foster logistics companies (2006), to establish the basic plan for the logistics industry (2001, 2011) and to bring the Korean logistics industry in line with advanced markets (2009-2013). Whereas in the early stage, logistics policies in Korea were focused on the expansion of logistics infrastructure and the development of logistics experts, recently, the focus of its industrial policy has shifted to promoting third-party logistics, fostering global logistics companies and the sophistication of the logistics industry.[398]

[396] Mu-Hyun, C. (2015). South Korea to invest USD 5b by 2020 in IoT and smart cars. Retrieved from http://www.zdnet.com/article/south-korea-to-invest-5b-by-2020-in-iot-and-smart-cars

[397] DeWit, A. (2014). Japan's Resilient, Decarbonizing and Democratic Smart Communities. In: The Asia-Pacific Journal, Vol. 12(50), No. 3. Retrieved from http://apjjf.org/2014/12/50/Andrew-DeWit/4236.html

[398] Invest Korea (n.d.). Investment Opportunities in Korea. Logistics & Distribution.Retrieved from http://www.investkorea.org/en/published/publications03.do?mode=download&articleNo=71363&attachNo=10692

3.3.5.2 Research, Development & Innovation

Korea's technological strengths include: 1) real-time traffic information provision, 2) advanced public transportation information systems, and 3) electronic fare payment and electronic toll collection The ITS Master Plan identified three phases of ITS development in Korea through to 2020, originally estimating a cost for the entire plan of KRW 8.34 trillion. As of 2007, South Korea updated its investment schedule, committing to invest a total of KRW 4 trillion from 2007 to 2020. "ITS Model Cities" were built as of 1998 with a pilot in Kwa-chon city, followed by three more model cities (Daejon, Jeonju, and Jeju) until 2002 and 25 more until 2007. These 29 cities are part of South Korea's Ubiquitous Cities initiative.[399]

Since 2007, the Ministry of Land, Infrastructure and Transport and the Korea Expressway Corporation (KEC) have spent KRW 88.8 billion to develop 18 technologies related to communications and road management for the Smart-Highway initiative. Altogether, the Smart-Highway project draws from various communications, information, road construction and management technologies and requires collaboration with multiple industries. Via a traffic-monitoring system known as Smart-I, drivers are alerted to crucial information (car accidents, traffic jams or construction) that is sent through a device set in real-time to their vehicles. The system is based on Wireless Access in Vehicular Environments (WAVE), a public communications network for traffic and roadway analysis. [400]

3.3.5.3 Industry

The Smart Transit Cards and Integrated Fare Collection System, also known as T-Money, is a unified fare smart card system for public transportation. It was developed by Korea Smart Card Co., Ltd., a joint venture spearheaded by The Seoul Metropolitan Government and including LG Group, credit card companies, and smaller telecommunications companies and financially supported by the Asian Development Bank. [401] It is an integrated fare collection system that provides nationwide compatibility and allows users to pay for almost all kinds of public transport with a single card. It is based on a rechargeable series of cards and other smart devices used for paying transportation fares. [402] It can be used to pay for transportation, including bus, train, and taxi service, as e-money to make purchases at vending machines, convenience stores, and museums, to pay fines or taxes, and even as a mileage or membership card. As of March 2009, customers used T-money for 30 million public transit transactions per day (15.4 million bus and 14.6 million subway transactions). Within the Seoul metropolitan area, 18 million T-money smart cards have been issued, with T-money accepted at the reader terminals of 19,750 buses; over 8,000 subway terminals; 73,000 taxi cabs; 21,000 vending machines; and 8,300 convenience stores, fast food stores, and parking garages. As Seoul's subway system has moved from paper tickets to smart cards, it has eliminated the need for 450 million paper magnetic stripe tickets at a savings of KRW 3 billion per year.[403] The successful system was already exported to New Zealand, Malaysia, Mongolia, and Colombia.[404]

The LG group is further investing in smart transportation. Their products cover automatic fare collection (as deployed with the smart transit cards in Seoul), fleet management service and traffic management service for road transportation; telecommunication technologies and platform screen doors for rail as well as air traffic control technology for airborne transportation.[405]

In mid-2015, a Uber-like service "KakaoTaxi" was launched by Kakao Corporation, mainly known for its messaging service KakaoTalk. However, the difference is that KakaoTaxi is not a peer-to-peer

[399] Ezell, S. (2010). Explaining International IT Application Leaderhip: Intelligent Transportation Systems. Retrieved from http://www.itif.org/files/2010-1-27-ITS_Leadership.pdf

[400] Suk-Man, Y. and Yoon-Seo, N. (2015). Expressway at center of Smart Highway initiative. Retrieved from http://koreajoongangdaily.joins.com/news/article/article.aspx?aid=3006530&cloc=joongangdaily|home|newslist2

[401] Hwang, S. and Kim, G. (2014). 50 Praxes for Better Transport in Korea, The Korea Transport Institute, Gyeonggi-do, 411-701, Republic of Korea, p. 14.

[402] Korea Smart Card Co., Ltd (2016) Retrieved from http://eng.koreasmartcard.com

[403] Ezell, S. (2010). Explaining International IT Application Leaderhip: Intelligent Transportation Systems. Retrieved from http://www.itif.org/files/2010-1-27-ITS_Leadership.pdf

[404] Sojung, Y. (2016). Korean transport systems gain international recognition. Retrieved from http://www.korea.net/NewsFocus/Business/view?articleId=138090

[405] LG CNS (n.d.). Social Infrastructure. Smart Transportation. Retrieved from https://www.lgcns.com/LGCNS.GHP.Main/Service/ServiceContent?MENU_CD=GHPSV202

sharing service but it connects people to licensed taxi-drivers. Another difference is that there are no fees for a taxi driver or for a user; the main aim seems to be the collection of data about trips and taxi movements. The service is also likely to be linked to the company's KakaoPay service.[406] Until June 2016, the app has been downloaded more than 100 million times.[407] In May 2016, the company additionally launched Kakao Driver, a driver-for-hire service similar to Uber that is connected to Kakao Navi that leads the driver through the city.[408]

Another app the company launched in April 2016, Kakao Bus, provides real-time tracking of public buses, their routes, and stop locations, covering multiple cities across Korea. For the red bus line, users can even check the availability of free seats.[409] Another service, Kakao Metro, released in June 2016, lets users check detailed information on metro stations and metro lines in the nation's five big cities (Busan, Daegu, Gwangju, Daejeon, and Seoul). The company's goal is "to connect a greater range of aspects of people's lives through its mobile platform enhancing user benefits and tackling problems of existing industries such as a supply-and-demand imbalance and complicated distribution structure."[410]

Many logistics companies are spin-offs of big Korean companies, such as Samsung Electronics Logitech[411] and Hyundai Glovis[412]. Profiting from their in-house technology knowledge, they offer some of the most advancing logistics systems.

3.3.5.4 Market

There are 29 cities participating in South Korea's Ubiquitous Cities Initiative, which endeavors to embody information technology throughout all city services spanning across traffic services to public services through a unified platform. This includes South Korea's Expressway Traffic Management System (ETMS) that collects real-time traffic information through three primary mechanisms: vehicle detection systems (VDS), closed-circuit cameras, and vehicle probe data. Data from 79 different transport authorities is communicated to South Korea's National Transport Information Center (NTIC) to support the country's ITS applications, such as the Hi-Pass electronic toll collection and electronic fare payment systems.[413] Traffic congestion was further alleviated with automatic illegal parking detectors. [414]

Fares are collected via the Electronic Toll Collection System (ETCS) "Hi-Pass", a non-stop electronic toll payment system made up of an on-board unit (OBU), a smart card, road facilities to collect tolls and collection booths. The system started in 2005 and later expanded across the nation. As of July 2013, there were 332 Hi-Pass systems in operation on highways and in 5 million vehicles. Korea's Hi-Pass is covering over 3,200 km of highway, making up a highway utilization rate over 30%. Hi-Pass cards can also be used for other purchases beyond highway tolls, including at parking lots, gas stations, and convenience stores.[415]

The system was further developed into ETC 2.0. Developed technologies include Smart Tolls (reducing congestion and traffic accidents through an optimized network use, Smart Toll Gates enabling smooth transit, Smart Logistics through optimized truck transport, big-data-based Smart Investment optimizing infrastructure investment. By now the cover ratio is 100% on expressways, 88% on national

[406] Nikola (2015). KakaoTaxi Revolutionizing Korea's Taxi Service. Retrieved from http://kojects.com/2015/10/12/kakaotaxi-revolutionizing-koreas-taxi-service
[407] Yoo-chul, K. (2016). 'KakaoMetro' gains rising momentum. Retrieved from http://www.koreatimes.co.kr/www/news/tech/2016/06/133_207459.html
[408] Sung-won, Y (2016). Kakao expands into substitute driver service. Retrieved from http://www.koreatimes.co.kr/www/news/tech/2016/05/133_205956.html .
[409] Korea Bizwire (2016). Kakao Launches New 'KakaoBus' App. Retrieved from http://koreabizwire.com/kakao-launches-new-kakaobus-app/53545
[410] Sung-won, Y (2016). Kakao expands into substitute driver service. Retrieved from http://www.koreatimes.co.kr/www/news/tech/2016/05/133_205956.html
[411] Samsung Electronics Logitech. Retrieved from https://selc.co.kr/eng/main.jsp
[412] Hyundai Glovis (2016). Retrieved from http://www.glovis.net/eng
[413] Ezell, S. (2010). Explaining International IT Application Leaderhip: Intelligent Transportation Systems. Retrieved from http://www.itif.org/files/2010-1-27-ITS_Leadership.pdf
[414] Hwang, Sang-Kyu & Kim, Gunyoung (2014): 50 Praxes for Better Transport in Korea, The Korea Transport Institute, Gyeonggi-do, 411-701, Republic of Korea, p. 16.
[415] Ezell, S. (2010). Explaining International IT Application Leaderhip: Intelligent Transportation Systems. Retrieved from http://www.itif.org/files/2010-1-27-ITS_Leadership.pdf

highway (managed by central government), 61% national highway (managed by local government), 49% principal prefectural roads, and 31% on other prefectural roads.[416]

One of the smart cities is of course Seoul. “Smart Seoul 2015 – Basic Strategic Plan for Informatization of Seoul Metropolitan City (2011-2015)” was adopted to overcome the limitations of the preceding ICT-advancing program “u-Seoul” that started in 2004. Whereas u-Seoul only applied ICT technology to traditional city infrastructure, Smart Seoul takes a more holistic, systemic approach that follows a people-oriented and human-centric approach. It is based on the three pillars (1) ICT infrastructure, (2) integrated city-management framework, and (3) smart users. With respect to mobility and transportation the Traffic Operation Information Service (TOPIS) was developed within the program. Its goal is to bring together traffic-related information and provide smart traffic information in real time in order to ensure efficient traffic flow. It connects taxi and public transport data for service improvement provided for users and service providers. The information is displayed through various media, including web pages, mobile apps, and Variable Message Signs. The bus information system provides users with real-time location and expected arrival time of buses. Data for meta-analyses such as traffic patterns are gathered from various agencies including Seoul Regional Construction Management Administration and Korea Highway Corporation. [417]

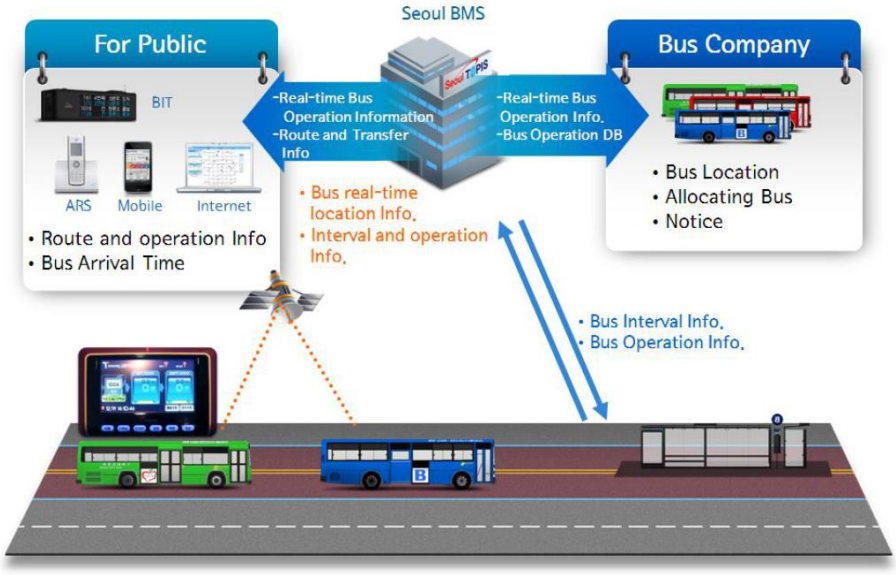


Figure 23: Bus Management System (BMS) in Seoul

Seoul has also developed into a car sharing city. When the Seoul Metropolitan Government launched “Socar” in 2013, the market started to become very dynamic with a lot of new market entrants. There is a multitude of different services including Socar and Green Car by Seoul Metropolitan Government, City Car by LG, Green Square by Korail (Korean Rail Service), WeShareCar by Korea Car Sharing, and Rent-a-Car by KT Kumho.[418] Interestingly, almost all services use the Kia Ray, an all-electric minivan.[419]

Based on the comprehensive Framework Act on Logistics Policies (also known as Basic Logistics Policy Act), issued in 2007, every five years, the Ministry of Land, Transport and Maritime Affairs

[416] Kanoshima, H. (n.d.). Recent ITS Development in Japan. Retrieved from http://fot-net.eu/wp-content/uploads/sites/7/2015/10/7_FOT_Kanoshima.pdf
[417] Hi Seoul. (2015). Smart Seoul 2015. Retrieved from http://english.seoul.go.kr/wp-content/uploads/2014/02/SMART_SEOUL_2015_41.pdf
[418] Korea IT Times (2013). Seoul launches “EV Sharing” program, offering electric car rental at 3,000 won for 30 minutes. Retrieved from http://www.koreaittimes.com/story/28572/seoul-launches-%E2%80%9Cev-sharing%E2%80%9D-program-offering-electric-car-rental-3000-won-30-minutes
[419] Medimorec, N. (2013). Overview of Seoul’s Car-Sharing Services. Retrieved from http://kojects.com/2013/04/18/overview-of-seoul-car-sharing-services/

(MLTM) has to formulate a ten-year master plan for national (National Logistics Master Plan), metropolitan (Metropolitan Logistics Master Plan) and provincial (Provincial Logistics Master Plan) logistics which sets the direction for logistics policy. The vision of the national logistics master plan for 2011-2020 to become a leading hub for Northeast Asia is translated into three strategic objectives, contributing to five development strategies. Each strategy is translated into specific implementation tasks, including the development of logistics facilities, the enhancement of the competitiveness of urban logistics, new concepts for freight transport systems (particularly relating to development of green transport and promotion of multimodality through integrated technology), a comprehensive support system to promote rail logistics, support for revitalizing coastal, and promoting regional specialization of ports. The development of "hardware" is complemented by six implementation tasks for "software". Outsourcing by public institutions to third party logistics companies is encouraged and third-party logistics are specifically promoted through measures such as tax breaks and consulting services.[420]

3.3.5.5 SWOT Analysis

Strengths • Strong government support for smart mobility related industries (IoT, energy, telecommunication, transport) • Nation-wide integration of smart cards and fare collection • Well-developed centralized data system (Traffic Operation Information Service) providing smart traffic information in real time • Well-established inland multi-modal logistic hubs (dry ports) in all five districts • Recently revolutionized bus management system allows for easy transit	**Weaknesses** • Monopolistic industry decreases innovation effects based on competition
Opportunities • IoT and smart car industry estimated to be worth KRW 100 billion by 2024 • Car sharing services in Seoul on the rise with new market entrants in regular periods • Due to lack of geographical space the need for smart mobility services is very strong • Technological affinity of citizens is very high. The huge demand acts as a strong pull factor for the development of smart mobility services • Ministry of Land, Infrastructure and Transport receives data (e.g. fuel consumption, speed, etc.) from 600,000 freight vehicles that could be used for intelligent transport organization	**Threats** • Focus on safety decreases speed of innovations and hampers uptake of new mobility services

3.3.6 United States of America

3.3.6.1 General Information

The period of smart mobility is characterized by new business models inspired by the sharing economy and innovative technologies that introduce a new age in transportation. On-demand ride services like Uber and Lyft, real-time ridesharing services such as Carma and Zimride, carsharing programs

[420] UNSESCAP. (n.d.). Comprehensive Policy Framework For Logistics:
National Logistics Strategy. Retrieved from http://www.unescap.org/sites/default/files/Logistics_policy_ch4.pdf

such as Zipcar and car2go, bike sharing programs and new urban bike lanes are completely changing the way people move[421].

New and alternative ways of transfer, enabled by new technology, have provided individuals with more choices. The convenience of arranging a ride from your mobile phone or the cheaper solution of arranging a ride with a co-worker or a friend has promoted ride-sharing in the context of a sharing economy[422].

Uber, which is a very strong start-up company in the ride-sharing field and which has faced many issues and challenges regarding regulations around the world is "pushing" cities to make and pass new laws and regulations that will help the ride-sharing and car-sharing services to be released from legal problems. Up until now, at least 17 US cities and four states have passed laws concerning such ride-sharing issues and covering practices such as vehicle inspections, driver training programs, criminal background checks, insurance policies, etc.[423].

3.3.6.2 Research, Development & Innovation

In 2005, the Transit Cooperation Research Program of the Transportation Research Board (U.S. National Academies of Science) conducted a study (Synthesis 59) on the role and importance of strategic planning and management in U.S. Transit Agencies[424]. The study addressed a number of strategic planning related questions including: How is strategic planning being used and to what extent? What forms does it take? How effective has it been? What benefits has it produced?

The project involved a review of relevant literature on the subject, both in general and as related to public transportation. In addition, two surveys were conducted of transit agencies. The first was a random survey of one agency from each state and the District of Columbia to determine the prevalence of the use of strategic planning and management. There were 38 responses to this survey. The second was a more detailed survey of selected agencies to examine specific practices. Twenty-four agencies responded to that survey. In addition, five agencies were selected as case studies based on the comprehensiveness of their process or innovative or noteworthy practices that they use.

The study concluded that strategic management and planning have an important role in the transit industry, with some kind of strategic planning and management being implemented by more than the 80% of the transit agencies which were randomly sampled, indicating that the practice is providing some real value. As would be expected, its use is more dominant in big agencies.

Although specific planning practices varied from agency to agency, there were a number of common steps in the overall planning processes, including the broad use of SWOT analysis. The main planning steps included the creation of an organizational vision and a vision statement, the development of a mission statement, as well as goals and objectives, the identification of the organization's core values, the implementation of a stakeholder" analysis, the conduction of a SWOT analysis, the identification of the key strategic issues facing the organization and formulating strategies, the development of an effective process for implementing and managing the strategic initiatives and the evaluation of progress[425].

Two key implementation strategies were used in regard to strategic plan implementation. One was to make sure that the strategic plan was linked to the operating budget and capital programming processes. This helped to ensure that the resources necessary to support the plan would be available. The other key strategy was to link the plan to performance measures that created accountability for implementation and that allowed progress toward plan achievement to be tracked. One strategy used

[421] Viechnicki, P., Khuperkar, A., Fishman, T.D., and Eggers, W.D. (2015). Smart mobility: Reducing congestion and fostering faster, greener, and cheaper transportation options. Retrieved from: http://dupress.com/articles/smart-mobility-trends/
[422] Nicol, E. and Armstrong, S. (2016). Ride-sharing: The rise of innovative transportation services. Retrieved from: https://www.marsdd.com/news-and-insights/ride-sharing-the-rise-of-innovative-transportation-services/
[423] McMillan, D. (2015). Uber Laws: A Primer on Ridesharing Regulations. Retrieved from: http://blogs.wsj.com/digits/2015/01/29/uber-laws-a-primer-on-ridesharing-regulations/
[424] TRB "Synthesis Study 59. (2005).Strategic Planning and Management in Transit Agencies", sponsored by the Federal Transit Administration. Retrieved from: http://www.tcrponline.org/PDFDocuments/tsyn59.pdf
[425] TRB "Synthesis Study 59. (2005).Strategic Planning and Management in Transit Agencies", sponsored by the Federal Transit Administration. Retrieved from: http://www.tcrponline.org/PDFDocuments/tsyn59.pdf

by several agencies was to link strategic plan achievement with the chief executive officer's performance appraisal.

The Montachusett Area Regional Transit Authority (MART) provides transportation through fixed-route and paratransit operations throughout Fitchburg, Leominster, and Gardner area in north central Massachusetts. MART's extensive brokerage operations allows for brokerage/coordination of human service transportation in four regions (70%) of Massachusetts. MART was involved in a project through the United We Ride/ Mobility Services for All Americans (UWR/MSAA) Initiative, sponsored by the U.S. Department of Transportation's Federal Transit Administration (USDOT/FTA)[426]. Phase I of this research project was the development and systems design of a model for a Transportation Management Coordination Center (TMCC). The model is named MART's Integrated Traveller Services (M-ITS).

The objective of the UWR/MSAA initiative was to simplify access to transportation services for persons with disabilities, persons with lower incomes and older adults by developing a coordinated human service transportation system which will provide a simple point of access for consumers. Another objective of this phase was to find alternative funding options for the implementation of the system. MART and many of its stakeholders have been coordinating transportation services across multiple funding programs, communities, and demographics since 2001. The demography that MART and its partners support covers not only older adults and persons with disabilities, but also children, low-income individuals, and employment seekers[427].

The UWR phased-implementation grant allowed MART to pursue selected modules of the M-ITS coordinated model design submitted under the Phase I. Three projects were chosen: 1) Web-based call-taking and trip-management software; 2) a Web-based bulletin board system that implemented the Trip Board Portal; and 3) evaluation of the feasibility of implementing a billing system the size and scale of that is proposed in Phase I[428].

As part of the planning process for Phase II of the project, the M-ITS project team performed a SWOT analysis on the data collected and the overall design and data collection process during Phase I. According to the results of this analysis concerning Phase I, the implementation of all technological components, the strong relationships with stakeholders and the success in identifying alternative funding opportunities can be considered strengths of Phase I, while among the weaknesses are the non-consistency with marketing and outreach, the non-maintenance of strong stakeholder support[429].

Many public transit systems across the United States are moving towards innovative systems for fare collection that save time for passengers. The value of this approach is that it provides hundreds of on-the-ground laboratories to test various interconnectivity and mobility devices. The drawback is that implementation of new innovations is restricted to regions and communities and is decidedly incremental in nature. Hence, system change will likely proceed at a slower rate than if new interconnectivity and mobility devices were guided by the Federal Government and comprehensively implemented nationally.

The Dallas Area Rapid Transit (DART) in collaboration Vix, Inc., is implementing a new, contactless fare payment system. The new system will enable commuters to pay and travel on DART's buses and light-rail trains using NFC-enabled smartphones, third-party or agency-issued transit cards, or EMV contactless cards.

[426] Federal Transit Administration (2012). USR/MSAA Demonstration of Coordinated Human-Services Transportation Modes, FTA Report No. 0058. Retrieved from: https://www.transit.dot.gov/sites/fta.dot.gov/files/FTA_Report_No._0058.pdf
[427] Federal Transit Administration (2012)." UWR/MSAA Demonstration of Coordinated Human-Services Transportation Models." (FTA Report No. 0058). Retrieved from: https://www.transit.dot.gov/sites/fta.dot
[428] Federal Transit Administration (2012)." UWR/MSAA Demonstration of Coordinated Human-Services Transportation Models." (FTA Report No. 0058). Retrieved from: https://www.transit.dot.gov/sites/fta.dot
[429] Federal Transit Administration (2012)." UWR/MSAA Demonstration of Coordinated Human-Services Transportation Models." (FTA Report No. 0058). Retrieved from: https://www.transit.dot.gov/sites/fta.dot

The system will be delivered through an account-based, open architecture and PCI-compliant fare collection platform.[430]

In the United States, the implementation of IoT based smart devices in the railway sector has been slow until recently. In the United States, pilot installations of this IoT technology from MPEC Technology[431] were started in 2014 — specifically, SA380 series sensors and Centrix data analytics software – have been installed on two Class 1 railroads, with further pilot installations planned for two additional Class 1 railroads this year[432]. Several heavy rail transit operators focused in the Northeast U.S. are also actively planning pilot projects. The objective of the U.S. installations is to provide remote monitoring of track switches, track circuits, and, in the case of the transits, third-rail power systems and train trip stops.

The MPEC Technology remote condition monitoring system enables railroad maintainers adopting modern condition-based maintenance strategies. By appropriate training and access to data through systems like Centrix, maintenance work can be conducted more efficiently, with less time spent travelling to work sites, while at the same time reducing the number of disruptive failures[433].

The Accessible Transportation Technologies Research Initiative (ATTRI[434]) is a joint U.S. Department of Transportation (USDoT) initiative, co-led by the Federal Highway Administration (FHWA) and Federal Transit Administration (FTA), with support from the Intelligent Transportation Systems (ITS) Joint Program Office (JPO) and other Federal partners.

For people with disabilities and older adults, inadequate mobility and transportation can prevent them from completing important tasks, such as working, commuting, shopping or even attending social events. ATTRI leads efforts to research, development and implementation of solutions, applications and systems to help all people, in order to effectively plan and execute their travel, addressing individual mobility needs.

ATTRI exploits advances in vehicle, infrastructure, and pedestrian-based technologies, as well as accessible data, mobile computing, artificial intelligence, navigation, etc. These technologies are enabled by ever present wireless communications connecting travellers to their mobile devices, vehicles and roadside infrastructure.

ATTRI research focuses on the needs of three stakeholder groups (people with disabilities, veterans with disabilities, and elderly), while promoting the development of technological solutions to decrease or remove barriers to transportation according to 4 functional disabilities: motor, visual, hearing and cognitive.

The USDoT has determined 4 priority areas for the development of ATTRI applications:

- Smart Wayfinding and Navigation Systems
- Pre-Trip Concierge and Virtualization
- Shared Use, Automation and Robotics
- Safe Intersection Crossing

[430] News Release by DART (2015). Dallas Area Rapid Transit (DART) Chooses Vix Technology to Deliver a New, Advanced Fare Collection System. Retrieved from: http://www.dart.org/news/news.asp?ID=1209

[431] MPEC, based in England, provides industrial data acquisition units designed for the unique safety and environmental requirements of the railway.

[432] Class I railroads, which, unlike their smaller companions do not really have another name that they are known by (such as Class IIIs known as short lines and Class IIs as regionals). Perhaps that is because they are the industrial leaders and are always at the forefront of the latest technologies and newest locomotives on the market. Over the years the number major railroads have shrunk due to mergers, and what remains today are very large mega systems; they include CSX Transportation, Norfolk Southern Corporation, Union Pacific, BNSF Railway, and Kansas City Southern.

[433] Andrew Whawell (2016). Perspective: Cloud-Connected Sensors Support On-Time Train Performance by Monitoring Wayside Equipment**.** Retrieved from: http://www.progressiverailroading.com/rail_industry_trends/article/Perspective-Cloud-Connected-Sensors-Support-On-Time-Train-Performance-by-Monitoring-Wayside-Equipment--47806

[434] USDoT - Federal Transit Administration (2014). Accessible Transportation Technologies Research Initiative (ATTRI). Retrieved from: http://www.its.dot.gov/factsheets/pdf/JPO_ATTRI.pdf and https://www.transit.dot.gov/research-innovation/mobility-demand-mod-sandbox-program.html

Furthermore, ATTRI has also determined 4 foundational considerations that should be considered:

- Standard Accessible Data Platform
- Universal Design Standards and Information and Communications Technology (ICT)
- Integrated Payment Systems
- Leverage Existing Technologies and Ongoing Research[435]

On May 2016, the Federal Transit Administration (FTA) announced the investment of USD 8 million in funding for Mobility on Demand public transportation projects.

FTA notes that the market for personal mobility is changing rapidly due to changing social and cultural trends and technological advances. New mobility concepts, from bike- and car-sharing systems to demand-responsive bus services, are offering to travellers flexible transportation options[436].

FTA is interested in conducting research on new service options, in combination with available technologies, that allow for greater individual mobility, the improvement of transportation efficiency through enabling technologies and innovative partnerships, the increase of the transportation effectiveness by the full integration of transit and for the enhancement of the customer's experience by providing to each one equitable, accessible, traveller-centric service.

FTA launched the Mobility on Demand (MoD) initiative for the development of a multimodal, automated, accessible and connected transportation system. MoD allows the use of on-demand information and real-time data, providing travellers with transportation choices that best serve their needs[437].

FTA's MoD Sandbox Demonstration Program provides a venue through which integrated MoD concepts and solutions, supported by local partnerships, are demonstrated in real-world settings. FTA seeks to fund innovative project teams, explore partnerships, develop new business models, integrate transit and MoD solutions and investigate new technical capabilities[438].

Importantly, the MoD Sandbox can also provide FTA the opportunity to assess project impacts and how existing FTA policies and regulations may support these new service transportation models[437].

The USDoT has also committed to give USD USD 40 million funding to one city, in order to help it become the country's first Smart City and be able to fully integrate innovative technologies, like self-driving cars, connected vehicles and smart sensors into their transportation network, via the Smart City Challenge.[439]

More particular, the US DoT issued the Smart City Challenge on 1th of December 2015, encouraging cities to put forward their best and most creative ideas for innovatively addressing the challenges they are facing. 78 cities developed visions and plans to address how emerging transportation data, technologies, and applications can be integrated with existing systems in their city to address transportation challenges – including challenges identified by the USDOT in its "2045 Beyond Traffic" report.

On 23 June 2016, the Secretary of US DoT announced Columbus as the winner of the Smart City Challenge.

Smart Cities initiative is a global move that concerns the development of an urban environment integrating multiple information and communication technology (ICT) solutions in a secure way for the management of each city's assets, such as local departments information systems, transportation systems, law enforcement, waste management and other community services. ICT is used to enhance quality, performance and interactivity of urban services, safety, improve access to jobs and services and accessibility, while also reduce congestion, transportation costs and resource consumption, emis-

[435] USDoT - Intelligent Transportation Systems Joint Program Office (n.d). Accessible Transportation Technologies Research Initiative. Retrieved from: http://www.its.dot.gov/research_archives/attri/index.htm
[436] Federal Transit Administration (2016). Public Transportation Innovation Funding Opportunity; Mobility on Demand (MOD) Sandbox Demonstration Program. Retrieved from: https://www.federalregister.gov/articles/2016/05/03/2016-10320/public-transportation-innovation-funding-opportunity-mobility-on-demand-mod-sandbox-demonstration
[437] Federal Transit Administration (2016). Mobility on Demand (MOD) Sandbox Program. Retrieved from: https://www.transit.dot.gov/research-innovation/mobility-demand-mod-sandbox-program.html
[438] Federal Transit Administration (2016). Mobility on Demand (MOD) Sandbox Program. Retrieved from: https://www.transit.dot.gov/funding/applying/notices-funding/mobility-demand-mod-sandbox-program
[439] US Department of Transportation (2016). Smart City Challenge. Retrieved from: https://www.transportation.gov/smartcity

sions and use of fossil fuels and improve contact between citizens and government[440]. Smart city applications are developed with the goal of improving the management of urban flows and allowing for real time responses to challenges[441].

Smart Cities are exploiting new technologies to transform their systems, operations and services and although several limitations exist due to tight budgets, scarce resources and legacy systems such new and innovative technologies can turn challenges into great opportunities.

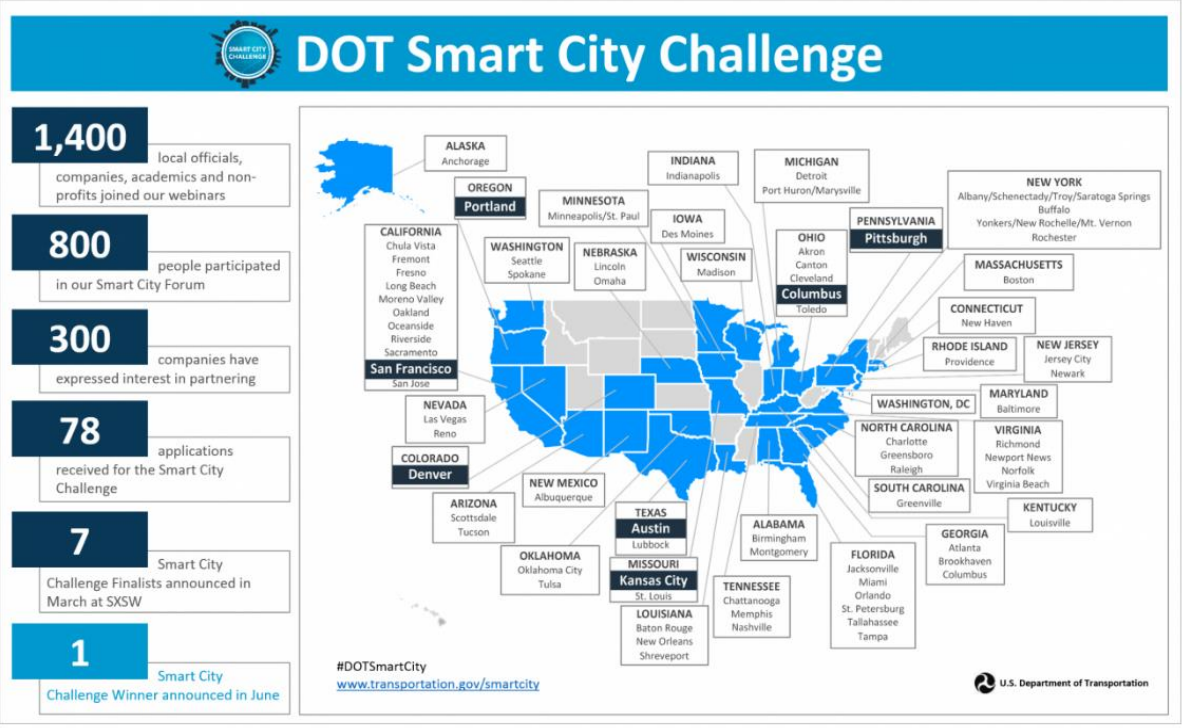


Figure 24: Participants of the Smart City Challenge organized the USDoT

Smart Cities provide possibilities in using big data and analytics, cloud for collaboration among different agencies, IoT, mobile for data collection and troubleshooting, social technologies for better engagement with citizens[442]. As mentioned in Focus Area 1, the USDOT USDoT has given funding of USD 40 million to one US city, in order to help it become the country's first city that will fully incorporate innovative technologies into their transportation network[443].

Regarding the logistic and freight areas, it is estimated that the technology gap will begin to disappear due to the evolving nature of e-commerce and its impact on the global economy and how its development is continuously changing the ways of package delivery. Transportation execution continues to be an important issue with more companies looking to handle their freight internally. According to the Logistics Viewpoints, concerning freight moves, an increase is expected in crowdsourced delivery options available to customers for almost any product, and 2016 will bring about an increase in the number of companies and the markets they serve[444].

[440] NYC Mayor's Office of Tech & Innovation (2016). Building a Smart + Equitable City. Retrieved from: http://www1.nyc.gov/site/forward/innovations/smartnyc.page
[441] Komninos Nicos (2013). What makes cities intelligent? Retrieved from: https://books.google.gr/books?hl=el&lr=&id=_QOCAAAAQBAJ&oi=fnd&pg=PA77&dq=Komninos,+Nicos+(2013-08-22).+%22What+makes+cities+intelligent%3F%22.&ots=_Vp1_-7nlG&sig=isn9afy3iKAYkbrBh9U8gJ1Q4uY&redir_esc=y#v=onepage&q&f=false
[442] IBM (n.d.). Analyzing the future of cities. Retrieved from: http://www.ibm.com/smarterplanet/us/en/smarter_cities/overview/
[443] USDoT (2016). Smart City Challenge. Retrieved from: https://www.transportation.gov/smartcity
[444] Steve Banker, Chris Cunnane and Clint Reiser (2016). Logistics and Supply Chain Trends to Monitor in 2016. Retrieved from: https://logisticsviewpoints.com/2016/01/11/logistics-and-supply-chain-trends-to-monitor-in-2016/

The application of Internet of Things (IoT) in the logistics sector has helped considerably in its development and is constantly evolving. IoT has revolutionized the supply chain management by connecting in intelligent ways, people, things and data with the use of sensors and has led to major improvement to all stages of the chain (from the manufacturing process until the warehouse). An area that is predicted to have a leading role in the future supply chain is the impact of IoT to in-transit visibility which can offer several tracking information (i.e. location, identity, weather and traffic conditions, and driver related to data etc.) by using RFID and cloud-based GPS technologies. This offers the stakeholders the opportunity to make efficient decisions that enhance the whole procedure[445].

3.3.6.3 Industry

The automotive industry is preparing for great changes as far as the ownership and automation of personal vehicles is concerned. Connected car technologies are already being used, while the broad use of intelligent traffic management systems will bring together manufacturers and operators responsible for road networks to come up with new solutions for smart mobility in the urban environment[446].

As far as Smart Cities are concerned, OEMs are gradually operating as product manufacturers and mobility services companies. OEMs are currently investing in new mobility services, like trip-planning application up to car-sharing services, while they are also developing next-generation, connected and autonomous vehicles[447].

In January 2016, General Motors Corp., aligned itself with the rideshare company Lyft, for USD 500 million, while Ford Motor Co. has also been in discussions with Uber and Lyft [448].

Intel and the City of San Jose are collaborating on a PPP project implementing Intel's IoT Smart City Demonstration Platform to expand the City's Green Vision initiative. The project, called Smart Cities USA, will help San Jose's economic growth, foster 25,000 new jobs, support environmental sustainability and enhance the life quality of its citizens. The Smart Cities USA public-private partnership, will explore and demonstrate how cities can use IoT to improve life for its citizens[449].

Regarding the freight and logistics sector, the respective industry in USA is highly developed and competitive. Many international and local companies are operating in this sector, enjoying the benefits of relatively low cost and regulatory burdens. Some of the main industry sub-areas of the logistics sector, include logistics services for the planning and execution of the goods transfer, freight rail, air and express delivery services, maritime freight and trucking[450].

Internet of Things (IoT) solutions in the Transportation and Warehousing sector are being developed by various enterprises and governments. During the application of IoT in the logistics area, many companies have also been engaged in the development of relevant systems. Intel, for example, has developed an IoT platform for the connection of sensor-tracking technology with gateways communicating with the legacy data analytics of the customer as well as the management system through an API firewall[451].

[445] Shankar, U. (2016). How the Internet of Things Impacts Supply Chains. Retrieved from: http://www.inboundlogistics.com/cms/article/how-the-internet-of-things-impacts-supply-chains/
[446] Deloitte (2015). Transport in Digital Age – Disruptive Trends for Smart Mobility. Retrieved from: http://www2.deloitte.com/content/dam/Deloitte/tr/Documents/public-sector/transport-digital-age.pdf
[447] Viechnicki, P., Khuperkar, A., Fishman, T.D., and Eggers, W.D. (2015). Smart mobility: Reducing congestion and fostering faster, greener, and cheaper transportation options. Retrieved from: http://dupress.com/articles/smart-mobility-trends/
[448] Flavelle, D. (2016). Car makers see future in ride sharing services. Retrieved from: https://www.thestar.com/business/2016/05/27/car-makers-see-future-in-ride-sharing-services.html
[449] Intel PR (2014). San Jose Implements Intel Technology for a Smarter City. Retrieved from: https://newsroom.intel.com/news-releases/san-jose-implements-intel-technology-for-a-smarter-city/
[450] SelectUSA (n.d). Logistics and Transportation Spotlight - The Logistics and Transportation Industry in the United States. Retrieved from: https://www.selectusa.gov/logistics-and-transportation-industry-united-states
[451] Moakley, G. (2016). Smart Freight Technology Powered by the Internet of Things. Retrieved from: http://www.intel.com/content/dam/www/public/us/en/documents/solution-briefs/smart-freight-technology-brief.pdf

3.3.6.4 Market

The development of Smart Mobility in USA enjoys the strategic support of the government. For example the "Beyond Traffic 2045" scheme is an invitation to the American public (users, developers, owners, and operators of the transportation network), as well as policy officials, to set some baselines concerning the shape, size, and condition of that system and discuss how it will meet the needs and goals of the future decades. Beyond Traffic is a draft framework, which mainly aims to stress out the critical decision points of the country with the help of data driven analysis, research, expert opinions and public engagement[452].

Some of the key factors for the development of Smart Mobility in general and Smart Cities include: technological advancements in the field of IoT, cloud, sensors and mobility, government initiatives, requirement for optimization of energy usage, increasing share of renewable energy, decrease in operational cost for smart building infrastructures hyper-urbanization, etc[453].

By the year 2025, 34 cities worldwide are estimated to have a population of more than 10 million people. In order for the U.S. urban centers to address the increasing demands of all those inhabitants living, working, driving and interacting, cities are looking to the Internet of Things (IoT) technology in order to be more flexible in responding to citizens' needs. It is also estimated that city governments will invest nearly USD 41 trillion over the next 20 years so as to upgrade their infrastructure and be able to benefit from the IoT.[454] However, the federally financed process is limited to a relatively few regions and communities, and is also limited mainly to road – a fact that also limits the possibilities of environmental benefits.

According to estimations and analysis made by the International Data Corporation (IDC), U.S. organizations are going to invest more than USD 232 billion in IoT hardware, software connectivity and services in 2016, while the revenues expected by the IoT sector will present an annual growth rate of 16.1% over the 2015-2019 period, overtaking the USD 357 billion in 2019. The key industries in IoT investments in USA are Manufacturing, with USD 35.5 billion, and Transportation with USD 24.9 billion in 2016. Additionally, cross-industry investment is estimated to reach USD 31 billion in 2016[455].

3.3.6.5 SWOT Analysis

Strengths	**Weaknesses**
• A multitude of demonstrations for smart mobility projects exist • Strategic governmental support, e.g. by the Beyond Traffic 2035 scheme • Availability of a best practice guide for smart mobility services (DOT) • High number of companies and initiatives for ride sharing and platooning • Fertile ground for companies due to already existing number of start-ups • Well-established freight infrastructure	• Federally-financed process is limited to a relatively few regions and communities • Smart mobility services are limited to road • Potential for smart mobility services in terms of environmental benefits is very limited due to limitation to road (no multimodality)

[452] U.S. Department of Transportation (2015). Beyond Traffic: US DOT's 30 Year Framework for the Future. Retrieved from: https://www.transportation.gov/BeyondTraffic

[453] Rohan, S. (n.d). Smart Cities Market worth 757.74 Billion USD by 2020. Retrieved from: http://www.marketsandmarkets.com/PressReleases/smart-cities.asp

[454] SmartAmerica (n.d). Smart Cities USA. Retrieved from: http://smartamerica.org/teams/smart-cities-usa/

[455] IDC (2016). IDC Spending Guide Finds U.S. Organizations Accelerating Their Investment in the Internet of Things as Meaningful Use Cases Find Their Way to Fruition. Retrieved from: https://www.idc.com/getdoc.jsp?containerId=prUS41547916

Opportunities	Threats
• Smart City Challenge: The USDOT has pledged up to USD 40 million (funding subject to future appropriations) to one city to help it define what it means to be a "Smart City "and become the country's first city to fully integrate innovative technologies – self-driving cars, connected vehicles, and smart sensors – into their transportation network • Nudging effect of the smart city challenge and its leverage potential • Due to lack of public transport infrastructure many solutions for smart mobility services	• Potential lack of necessity towards developing multi-modal smart service systems because of high-quality road infrastructure • New businesses are entering competition with old industries, leading to layoffs or other unwanted social effect, e.g. in the taxi sector

3.4 Focus Area 4 – Standardization and Interoperability

3.4.1 Brazil

3.4.1.1 General Information

The Associação Brasileira de Normas Técnicas (ABNT), a non-profit organization founded in 1940, is engaged in the preparation of national standards. In 1973 it created the National System of Metrology, Standardisation and Industrial Quality (Inmetro), sponsored by the Ministry of Industry and Commerce. In 1992, ABNT was responsible for the management of the Brazilian Standardization Process and has declared the National Forum for Standardisation. The regulatory System in Brazil included 27 regulatory bodies including ministries and public organisation.[456] Brazilian standards whenever possible, follow international trends and guidelines (e.g. World Trade Organisation), include safety issues and promote the participation of the interested parties.[457]

ENABLE (Stimulate Sustainable Freight Transport Systems with Latin-American Countries, FP7, 2009–2011) contributed to improving external relations between the EU and Latin American countries, namely Argentina and Brazil, in co-modal and intermodal freight transport. Attention was given to networking and building partnerships to strengthen research links between the two regions.[458]

Interoperability is not applied yet widely in Brazil. But it can be a great opportunity for logistics transformation of organizations, sharing supply, distribution and storage of goods, without loss of autonomy. Enable companies provide better services, as well as helping decision making, providing better performance and aggregation of value, being an alternative to reduce logistics costs.[459]

No specific information could be found on Research, Development & Innovation, Industry or Market activities regarding Standardization and Interoperability in Brazil.

3.4.1.2 SWOT Analysis

Strengths	Weaknesses
• National body for Brazilian Standardisation Process • Projects running for international co-operation for co-modal and intermodal freight transport	• Interoperability is not applied yet widely in Brazil. But it can be a great opportunity for logistics transformation of organizations, sharing supply, distribution and storage of goods, without loss of autonomy

[456] ISO. (2016). *Brazil (ABNT)*. Retrieved from http://www.iso.org/iso/about/iso_members/iso_member_body.htm?member_id=1579
[457] Jornada, J. (n.d.). *Technical Regulation in Brazil*. Retrieved from http://www.inmetro.gov.br/barreirastecnicas/apresentacoes/TechnicalRegulationBrazil.pdf
[458] European Union. (2014). Transport R&D-cooperation with international partner countries. Tranport Research and Innovation Portal.
[459] Pereira, E. D., Salum, M. I., and Rodriguez, C. M. (2016). Organizational Interoperability in support of competitiveness. In: Brazilian Journal of Operations and Production Management ,Vol.13 (1), pp 58-65.

	• Limited say in international negotiations • Lack of enforcement
Opportunities • Interoperability is not applied yet widely in Brazil. But it can be a great opportunity for logistics transformation of organizations, sharing supply, distribution and storage of goods, without loss of autonomy • Lack of legacy of standards	**Threats** • Standardization is mainly dictated due to little involvement in international negotiations

3.4.2 China

3.4.2.1 General Information

China's standardization system is administrated by the General Administration of Quality Supervision, Inspection and Quarantine (AQSIQ) and managed by the Standardization Administration of the People's Republic of China (SAC). Other public and private organizations provide input and participate in the process of establishing standards[460].

SAC (China Standardization Administration) is the State Council authorized government organization that co-ordinate the national standards drafting process. However, it is the technical committees and their secretariat-organizations that are in charge with the standards drafting. Figure 25 depicts the structure of China's standardization system.

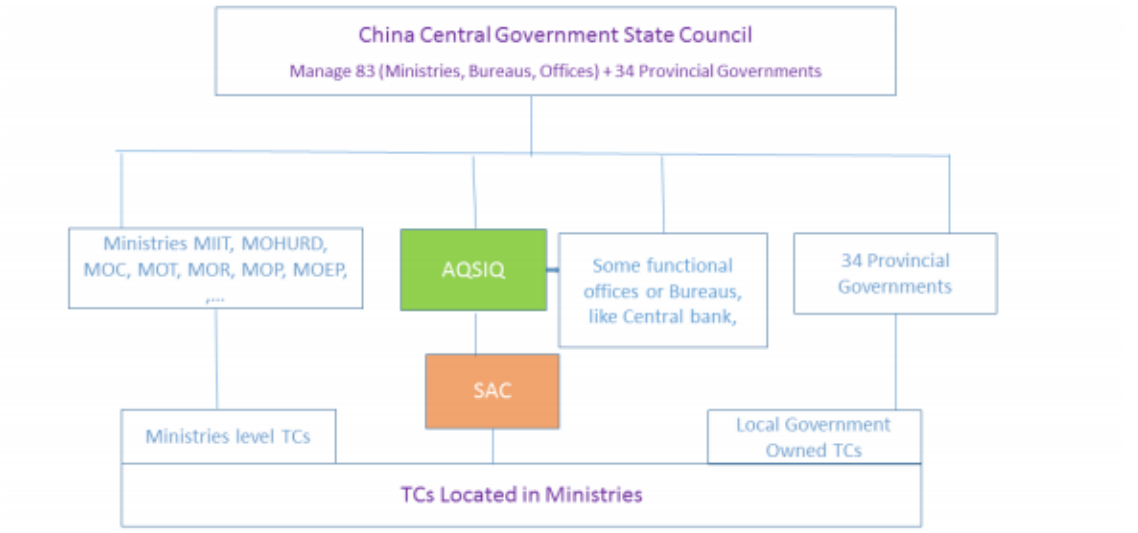


Figure 25: China standardization system

There are mainly 4 ministries/ministry level organizations that are relevant to ITS standardization in China. Besides the official or governmental organizations, there are also some industry associations or local organizations that are also working in this area:

- SAC (China Standardization Administration)
- Ministry of Transport
- Ministry of Information Technology and Industry (MIIT)
- Ministry of Science[461]

[460] American National Standards Institute (2015). PRC Standards System: standards Used in China. Retrieved from: https://www.standardsportal.org/usa_en/prc_standards_system/standards_used_in_china.aspx
[461] XU, B. (2015). China's ITS Standardization (Part 1: Main organizations). Retrieved from: http://sesec.eu/app/uploads/2015/06/2015_01_SESEC-Report-China-ITS-standardization-report-Part-11.pdf.

Chinese standards may be either mandatory or voluntary. Standards of the first category are equal to law as do other technical regulations in China. All other standards that do not have these characteristics are considered to be voluntary standards. There are four levels of Chinese standards which are hierarchical, as presented in Figure 26 below.

Figure 26: Levels of Chinese standards[462]

As shown in Figure 26 Local Standards enter into Enterprise Standards, Professional Standards enter into Local Standards and so on. For any product or service, only one type of Chinese standard applies[463].

The Chinese government is also cooperating closely with the German DIN Standards (the Chinese standards body, SAC cooperates with DIN since 1979 with the signing of an official agreement). In regular exchanges, Chinese and German experts discuss topics such as quality assurance, occupational health and safety, environmental protection, consumer protection, and the relationship between standards and the law.[464]

3.4.2.2 Research, Development & Innovation

The Technical committees relevant to ITS standardization in China are the following:

- **SAC TC 83 Electronics Business (E-Business) Standardization Technical Committee**

  SAC TC 83 Electronics Business Standardization Technical committee is in charge of standardization on EDI, Open EDI, data element and code, data structuring technology, electronic document format (exchange structure), processes, data maintenance and management, message service and key supporting technologies in the fields of EDI, open EDI, paper-based document format, administrative, commercial, transportation and industry, responsible for work related to ISO/TC154, UN/CEFACT, ISO/IEC JTC1/SC32/WG1.The secretariat of SAC TC 83 is the China National Standardization Institute (CNIS). CNIS is under the leadership of SAC.

- **SAC TC 223 Traffic Engineering Facilities (Highway) Standardization Technical Committee**

  SAC TC 223 is in charge of national highway engineering facilities standardization work. The secretariat of SAC TC 223 is China Research Institute of Highway, which is under Ministry of Transport.

- **SAC/TC 230 National Geographic Information Standardization Technical Committee**

  SAC/TC 230 National Geographic Information Standardization Technical Committee is in charge of geographic information national standards plan, coordination and management. Its mission is

[462] American National Standards Institute (2015). PRC Standards System: Standards Used in China. Retrieved from: https://www.standardsportal.org/usa_en/prc_standards_system/standards_used_in_china.aspx.
[463] American National Standards Institute (2015). PRC Standards System: Standards Used in China. Retrieved from: https://www.standardsportal.org/usa_en/prc_standards_system/standards_used_in_china.aspx.
[464] DIN (2016). International Cooperation. Retrieved from: http://www.din.de/en/din-and-our-partners/international-cooperations.

to accelerate China geographic information standardizations, promote geographic information resources construction and application, and encourage/coordinate the geographic information sharing. The secretariat of SAC TC 230 is National Administration of Surveying, Mapping, and Geoinformation of China. The famous BeiDou Navigation Satellite System and standardization work was done by this organization.

In addition, there is a widespread use of RFID tagging systems in China, often installed as original equipment in newly constructed track beds and / or on the rolling stock of the railway system. There are a number of uses, but its use for maintenance purposes seems to be most innovative.

Small-scale wireless sensor networks and RFID technologies for logistics management and predicted maintenance of equipment will be widely used in factories by 2020.

The governments' priorities for the use of RFID technology are: Agriculture and Livestock, Defence and Security, Environmental Applications, Healthcare and Welfare, Identification, and Transportation.

Public transportation is another popular sector for RFID technology applications. China has the largest smart card transport system in the world[465].

3.4.2.3 Industry

On 15th Dec 2014, the annual meeting of China National Intelligent Transportation System Standardization Technical Committee was held in Beijing. 100 experts from the Ministry of Transport, SAC and other stakeholders attended this meeting and the main areas of the future standardization work were agreed as being:

- Standards drafting in intelligent transportation and logistics;
- Standards drafting in driving through E-toll system in the highways and city roads;
- Standards drafting in transportation Information security;
- Standards drafting in cooperative intelligent transportation;
- Standards drafting in vehicle safety auxiliary driving system.

China's Integration Intelligent Transportation Industry and Service Alliance (China ITS Industry Alliance) is an non-profit industry platform, composed of units and organizations involved in the field of intelligent transportation system who are focusing on the research and development, production, management, of relevant technology, product and services, aiming to establish a new development mode in ITS in China. Part of the Alliance's mission is to promote standardization of integrated intelligent transportation industry and services, enhance integrated intelligent transportation applications, and share domestic and international market resources, etc.[466]

China ITS Industry Alliance is organized by the Ministry of Transport, and its secretariat is located in the Research Institute of Highway. The management of the alliance is one of the efforts of the Ministry of Transport to bring together different stakeholders in the ITS realm like IT manufactures, telecommunications and vehicle manufactures.[467]

3.4.2.4 Market

In 2015, the State Council of China issued a guideline on the deeper amendment of its standardization system. Based on the perception that the existing one is considered to be inefficient and, at times, unable to keep up with China's social and economic development, the reformation of the standardization system is necessary for the support of the establishment of a consolidated market which is essential for the upgrade of China's economy to a medium-high level.

One of the key elements needed to achieve this change in the standardization system is the unification and integration of local and national standards. The Chinese government also plans to promote a

[465] Jung, K., Lee, S. (2015). A systematic review of RFID applications and diffusion: key areas and public policy issues. Retrieved from: http://jopeninnovation.springeropen.com/articles/10.1186/s40852-015-0010-z.
[466] C-ITS. (2016).Retrieved from: http://www.c-its.org/english/about.htm.
[467] American National Standards Institute. (2015). PRC Standards System: Standards Used in China. Retrieved from: https://www.standardsportal.org/usa_en/prc_standards_system/standards_used_in_china.aspx.

system that is developed by the major market players by encouraging alliances in which standards are developed jointly in order to better meet market needs. Another goal of these efforts is to reach the country's objectives in terms of innovation.[468]

3.4.2.5 SWOT Analysis

Strengths	Weaknesses
• Own standard setting yields high power of self-assertion • Standardization is used as a means to increase foreign economic affairs	• Standardization is not pursued with other key industrial nations • Disagreement between central and local governments, as well as between local governments
Opportunities	**Threats**
• If standards are set early on in technology development, China as an export-oriented nation, could establish international standard • Governmental support on future standardization work	• High uncertainty of the Chinese economic situation • If standards set in China are not accepted by the international community, the country might suffer from re-bound effects

3.4.3 India

3.4.3.1 General Information

Under the national Standard body of India - Bureau of Indian Standards (BIS), Transport Engineering Division Council (TEDC) develops the standardisation in the field of transport engineering including air, water, road and rail transport; diesel engines for stationery application and ISO freight containers, transport packaging.[469] The latest programme of work for TEDC was prepared in 2014 and are arranged, in the sequential order of the committee number, such as TED 2 Automotive prime movers, transmission system and internal combustion engines and TED 12 Freight containers and pallets etc. The standards are updated regularly.[470] Various exchange programmes/ projects exist to exchange experiences between India and European countries, such as the Seconded European Standardisation Expert for India (SESEI) project in 2013 to raise awareness on the European Standardisation System, values and assets in India.[471]

The Society of Indian Automobile Manufacturers (SIAM) is an important channel of communication for the Automobile Industry with various stakeholders (the Government, National and International organisations). The Society works closely with all concerned stakeholders and actively participates in the formulation of rules, regulations and policies related to the Automobile Industry. It provides technical regulations such as regulatory framework on vehicles, emission norms, safety regulations, in-use vehicle norms and fuel efficiency data.[472]

India is aiming at integrating various modes of transport like bus and Metro service with train schedule to provide end-to-end service to commuters so that a passenger, after descending from a train, gets a convenient transport to reach the destination.[473]

No specific information could be found on research, development & innovation, and market activities regarding standardization and interoperability in India.

[468] Hong, W., Cheung, D., Sit, D. (2015). China's 13th Five-Year Plan (2016-2020): Redefining China's development paradigm under the New Normal. Retrieved from: http://www.ccilc.pt/sites/default/files/chinas_13th_five-year_plan_2016-2020_redefining_chinas_development_paradigm_under_the_new_normal.pdf.
[469] BIS. (n.d.). Technical Division Council. Retrieved from: http://164.100.105.199:8071/php/BIS/TechnicalDepartments.php.
[470] BIS. (2014). TED Programme of Work. Retrieved from: http://www.bis.org.in/sf/pow/ted.pdf.
[471] EU Standards India. (2016). Seconded European Standardization Expert in India. Retrieved from: http://eustandards.in/#.
[472] SIAM. (n.d.). Regulatory Framework. Retrieved from: http://www.siamindia.com/technical-regulation.aspx?mpgid=31&pgidtrail=32.
[473] Prabhu, S. (2015). Integrated transportation system for railways soon, but no privatisation. Retrieved from: http://www.dnaindia.com/india/report-integrated-transportation-system-for-railways-soon-but-no-privatisation-suresh-prabhu-2052590.

3.4.3.2 Industry

The committee-wise programme of work of Transport Engineering Department (TED) as of 2014 includes[474]:

- TED 2 Automotive primemovers, transmission system and internal combustion engines
- TED 4 Automotive Braking systems, steering systems, vehicle testing and performance evaluation
- TED 6 Automotive Body, Chassis, Accessories and Garage Equipment
- TED 7 Automotive Tyres, Tubes and Rims
- TED 11 Automotive electrical equipement and instruments
- TED 12 Freight containers and pallets etc. The standards are updated regularly
- TED 14 Aircraft, Space Vehicles, Air Cargo Handling and Aircraft Electrical and Instruments
- TED 16 Bicycles
- TED 17 Shipbuilding
- TED 18 Inland, Harbour Crafts and Fishing Vessels
- TED 19 Marine Engineering and Safety Ads
- TED 21 Automotive Springs and Suspension Systems
- TED 22 Tranport Tractors, Trailers and Industrial Trucks
- TED 24 Transport Packages and Packaging Codes
- TED 26 Automotive Vehicles Running on Non-Conventional Energy Sources
- TED 27 Electric and Hybrid vehicles
- TED 28 Intelligent Transport System

Automotive Research Association of India (ARAI) is the government-approved test agency to carry out mandatory certification testing. It is also a research association and service provider to carry out sponsored R&D work, development testing and dissemination of information and knowledge sharing in association with Industry/academia.[475] It published automotive industry standards; some of them as of August 2, 2016, are listed below:[476]

- AIS-001 Automotive Vehicles – Rear-view mirrors – Specification
- AIS-007 Information on Technical Specifications to be Submitted by the Vehicle Manufacturer
- AIS-025 Safety and Procedural Requirement for type approval of CNG operated vehicles

Indian automotive standards are leading as well as lagging technology. For example, Emission norms have led the innovation in power train technology (from conventional engines – BSII to Fuel Cells/Evs/hybrids – BSV), while advanced lighting systems were introduced first on vehicle and standards are followed later.[477]

3.4.3.3 SWOT Analysis

Strengths	**Weaknesses**
• National support on automotive standards development and implementation • Organisations such as Society of Indian Automobile Manufacturers (SIAM) provides technical regulations	• Standards are not in harmony with technology development • Limited influence in international negotiations

[474] BIS. (2014). TED Programme of Work. Retrieved from: http://www.bis.org.in/sf/pow/ted.pdf.
[475] Urdhwareshe, R. (2013). Automotive Industry: Regulations Scenario in India. Retrieved from: http://www.iesaonline.org/downloads/IESA_VS2013_ARAI_Rashmi_Urdhwareshe.pdf.
[476] ARAI. (2016). List of published automative Industry Standards. Retrieved from https://araiindia.com/hmr/Control/AIS/83201693748AM0_List_of_AIS_published_02_08_2016.pdf.
[477] Urdhwareshe, R. (2013). Automotive Industry: Regulations Scenario in India. Retrieved from: http://www.iesaonline.org/downloads/IESA_VS2013_ARAI_Rashmi_Urdhwareshe.pdf.

Opportunities	Threats
• With the development/improvement on smarter mobility technology or with smart city in place, standardisation are required to be speed up or upgraded accordingly. TED (Transport Engineering Department) is responsible for that.	• Standardization is mainly dictated due to little involvement in international negotiations

3.4.4 Japan

Transport in Japan has a long history. Therefore, all modes have developed their own standards on the domestic Japanese market. For example, cars drive on the left and the rail gauge is different from international standards.

Regarding road transport vehicle related technologies, one of the main actors is the ITS Standardization Committee (see ITS Initiatives in Japan FA1). Especially TC22 (Road Vehicle) and TC204 (ITS) are very active. However, most effort is put on standardization of automated driving. This involves not only ISO activities but also UN ECE, WP1, and WP29 activities and in the near future ITU-T. In addition, IEEE will contribute to the standardization of telecommunication needs for automated driving. The national standardization committees are under the leadership of corresponding bureaus of Ministry of Land Infrastructure and Transport. Concerning the promotion of international standardization a multitude of different Japanese actors are involved. Under the name “Building a safe and secure road transport society using cooperative systems” the Cabinet Secretariat (CS), the Cabinet Office (CO), the National Police Agency (NPA), the Ministry of Internal Affairs and Communications (MIC), the Ministry of Economy, Trade, and Industry (METI), and the Ministry of Land, Infrastructure, Transport and Tourism (MLIT) are pushing safe and secure road transportation.

Japan Ship Technology Research Association (JSTRA) was established by the merger of three associations: the Shipbuilding Research Association of Japan, Japan Marine Standards Association and Japanese Association of the Ship Scrapping Promotion. Since its foundation, JSTRA has been under the guidance of the Ministry of Land, Infrastructure, Transport and Tourism (MLIT) and supported by The Nippon Foundation and many other maritime organizations. The keywords of JSTRA are “ship regulations, standards and R&D.” All projects are based on comprehensive and strategic approaches through a synergy of these three elements and some projects are closely related to important agendas in international organizations such as the International Maritime Organization (IMO), International Organization for Standardization (ISO) and International Electro-technical Commission (IEC). Such projects include marine transportation of hydrogen vehicles, new generation standards of stability, prevention of air pollution from ships, assessment of environmental impacts of stain-resistant substances and coatings, intra-ship LAN, and improvement of energy efficiency.[478]

With respect to mobile networks necessary for establishing an automated and connected transport system, many governments, including the European Union, are supporting the development of a 5G network. In Japan, however, this is not the case, since the country tries to push its own solutions. This protectionism drastically reduces the possibility of international interoperability of network systems.

[478] JSTRA. (2016). Introduction. Retrieved from http://www.jstra.jp/english/.

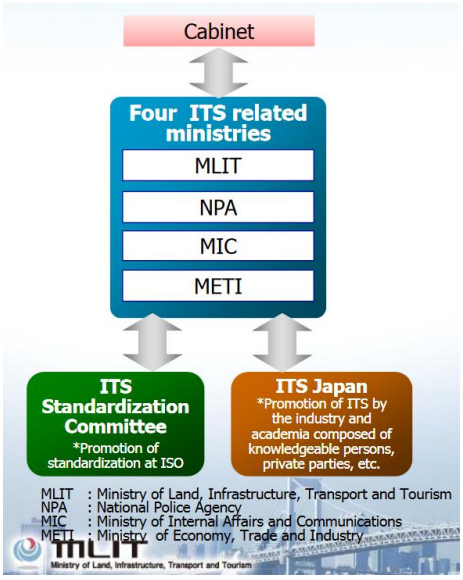


Figure 27: Organization of ITS Japan and involved parties

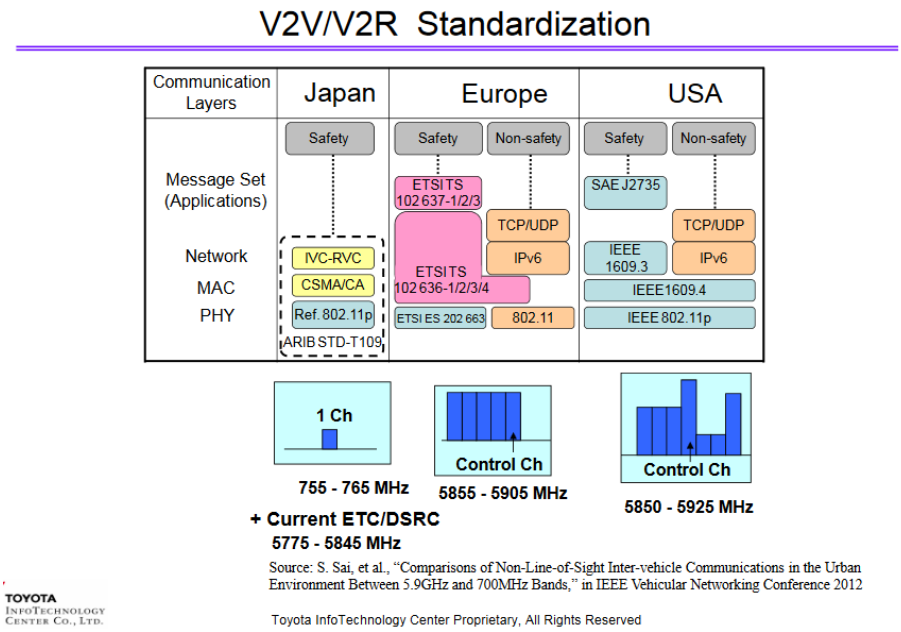


Figure 28: V2V/V2R Standardization in Japan compared to Europe and USA

3.4.4.1 SWOT Analysis

Strengths • Many different actors involved (CS, CO, NPA, MIC, METI, MLIT, ITS) • Anchored in government programs (e.g. Society 5.0 – Super Smart Society) • Very active ITS standardization (TC22 and TC204) • Japan Ship Technology Research Association (JSTRA) actively involved in regulation and standardization in the maritime industry	**Weaknesses** • Focus is rather placed on standardization for foreign economic policy rather than for interoperability • Japan does not manage to make standards binding
Opportunities • If government uses standardization for foreign policy making, then responsibility lies with industry increasing their stake • International collaboration: creates a multitude of links to US standardization	**Threats** • Because of its special role, Japan does not manage to respond to international standardisation market needs • “Island solutions” problem: technologies are not interoperable; they cannot be adapted to different environments or countries • 5G standardization is problematic because of protectionist approach

3.4.5 South Korea

3.4.5.1 General Information

Out of 896 total ISO/IEC committies, Korea was a full member of 737 and an associate member of 126 in 2010. However, the US, Germany, Japan, Great Britain, France, and China are still leaders in standard setting in conventional industrial areas. Also, they account for 80% of internationally set standards in ICT industries. In light of these facts, Korea aims at becoming a standard setter for new technologies and areas such as smart green transportation systems and green intelligent transport systems (G-ITS). Therefore, the KOTI has established four working groups dealing with (1) traffic flow control and services; (2) connectivity of new transport modes based on eco-friendly vehicles; (3) connection of cloud- and network-based new transport infrastructure; and (4) connection of mobile network-based new technologies.[479]

Considering the country's expertise in smart cards, it is no surprise that Korea engages in various working groups of the ISO/TC204. It does not only have a big say in the subordinated ISO/IEC 24014 "Interoperable fare management system – Architecture" but also pushes the inclusion of new items, namely standards in the open payment system and conformance test. On a national level, there are several standards equal to EU standards, the most important one being KSX6923. It further aims at developing standards towards an interoperable Asia Pacific Transportation Card to be used across the Asian Pacific region by pushing compatibility standards that can be acceptable to the standards of each country participating. Field tests are undertaken in China, Japan, Korea, and Singapore.[480]

Korean Industrial Standards (KS) are developed and coordinated by the Korean Agency for Technology and Standards (KATS). Even though they are not obligatory, KS are frequently referenced in government regulations and technical specifications. There are about 22,760 KS of which 19.000 are referenced in over 106 types of laws and regulations. These are separated in three categories (product standards, procedure standards, and horizontal standards) and are subject for review every five years. However, KATS reviews them more frequently in order to harmonize them with international standards.[481] Apart from KATS, another major stakeholder is the Korean Standards Association (KSA) that is the primary distributor of KS.

The Korea Motor Vehicle Safety Standards Enactment/Revision Procedure for Automobile Management Act and Self Certification System follows UNECE standards for sustainable transportation. Seoul is continuously putting efforts into becoming an advanced smart city. It follows the international ISO – "Smart Community Infrastructure Metrics" (ISO TC 268/SC 1) guidelines. The Metropolitan Transportation Authority is a public corporation established as a joint metropolitan transport administration in Seoul, Incheon Metropolitan City and Gyeonggi Province. It is responsible for establishing a comprehensive metropolitan public transport plan, conducting consultations and adjustments on metropolitan transport policy and administering metropolitan public transport transfer facilities, as well as the metropolitan bus rapid transit and metropolitan transport policies as delegated by union members. Seoul, Gyeonggi Province and Incheon Metropolitan City dispatched 48 personnel at a ratio of 5:5:3 respectively to do administrative work for their union while sharing general operating costs.[482]

Since 2006, logistics service providers can apply for the Logistics Company Certification (as of 2012 there is also a separate global certificate). The certificate assesses companies on transport, facilities and services and has to be renewed every two years. It is organized and coordinated by the Korea Transport Institute, with operational funds from the government. The incentives for companies to apply for this certification include priority entrance to public logistics facilities and reputational benefit.[483]

[479] Moon, Y., Kim, S. (2013). International Standardization Strategies for Green Transport System. In: KOTI World Brief Vol. 5, (45). Retrieved from: http://www.koti.re.kr/mail/pdf2/world13-45/Focus.pdf.
[480] Lee, K. (2014). Korea Transportation Card and Proposal. Retrieved from http://www.asiaiccardforum.net/news/03-19-2015-01/data/Korea_SmartCard_Status-AICF-2014-12-05.pdf.
[481] Standards Portal (n.d.). ROK Standards System: Standards Used in Korea. Retrieved from: https://www.standardsportal.org/usa_kr/e/standards_system/standards_used_in_korea.aspx.
[482] Sang-Kyu, H., Kim, G.(2014). 50 Praxes for Better Transport in Korea, The Korea Transport Institute, Gyeonggi-do, 411-701, Republic of Korea, p. 55.
[483] UNSESCAP. (n.d.). Comprehensive Policy Framework For Logistics:

The Ministry of Trade, Industry and Energy (MOTIE) is responsible for setting standards for petroleum and petroleum substitutes, and MOE is responsible for regulating air pollution. In 2003, Korea began preparing official biodiesel standards. The final standards, drafted in September 2004 by MOCIE, were adopted in January 2006 and are very similar to EN14214, the European biodiesel standards.[484]

3.4.5.2 SWOT Analysis

Strengths • UNECE standards for sustainable transportation was included in the Korea Motor Vehicle Safety Standards Enactment • Strong involvement in smart transportation card standardization • Even though standards are not legally binding, the majority is referenced in different laws and regulations • Industry standards are reviewed recently in order to harmonize them with international standardization	**Weaknesses** • South Korea only recently started to proactively become involved in international standard setting
Opportunities • KOTI has established working groups for standardization on different transport-related issues • Because companies are interlinked in huge Chaebols (big conglomerates) the necessity for standardization is very high, leading to many efforts on standardisation	**Threats** • Most internationally binding standardization done in the US, Europe, and China

3.4.6 United States of America

3.4.6.1 General Information

Since 1996, the USDoT's ITS Standards Program has cooperated with the industry and the public sector to determine where standards are needed and facilitate their development and use. Since its beginning, the program and its partners have established approximately 100 standards, resulting in greater interoperability among ITS centres, field equipment and traveller information systems.

For both freight and personal transport, the major focus on standard setting has been the human safety – for the operators of all transport modes/vehicles, for the persons being transported as passengers, and for the people who might be impacted by the operations of said transport – other highway travellers or those living near airports or rail lines.

There are industry standards for the equipment and the physical facilities used in the operation of the mode – rail strength, braking capabilities, etc. When industry has been slow in adopting standards which the broadly defined "public" perceives as necessary, regulatory bodies (at federal, state or local level) may create regulations to set requirements – such as the recent changes in the methods used to record and track hours worked by long-haul truck/lorry drivers.

The confusion in regulations is created by the fact that certain regulations are set at federal level, such as the example just noted or various environmental regulations, at state level, such as speed limits,

National Logistics Strategy. Retrieved from: http://www.unescap.org/sites/default/files/Logistics_policy_ch4.pdf.
[484] EGNRET.(2016). Korea Biofuels Activities. Retrieved from: http://www.egnret.ewg.apec.org/Archive/me_korea.html.

traffic laws, and operator licensing, or at local level, such as restrictions on the applicability of particular traffic laws or the restrictions on the hours of operation for urban deliveries or port facilities.[485]

A representative example of standardization, also mentioned in Focus Area 1, is the SAE International's new standard J3016: Taxonomy and Definitions for Terms Related to On-Road Motor Vehicle Automated Driving Systems, which is a classification system identifying six levels of automated driving, which range from "no automation" up to "full automation". These levels, presented in Figure 29, are descriptive, not regulatory and more normative and technical than legal, while the elements described indicate minimum rather than maximum system capabilities for each level. This means that a particular vehicle may have multiple driving automation features.[486]

SAE level	Name	Narrative Definition	Execution of Steering and Acceleration/ Deceleration	*Monitoring* of Driving Environment	Fallback Performance of *Dynamic Driving Task*	System Capability *(Driving Modes)*
***Human driver* monitors the driving environment**						
0	**No Automation**	the full-time performance by the *human driver* of all aspects of the *dynamic driving task*, even when enhanced by warning or intervention systems	Human driver	Human driver	Human driver	n/a
1	**Driver Assistance**	the *driving mode*-specific execution by a driver assistance system of either steering or acceleration/deceleration using information about the driving environment and with the expectation that the *human driver* perform all remaining aspects of the *dynamic driving task*	Human driver and system	Human driver	Human driver	Some driving modes
2	**Partial Automation**	the *driving mode*-specific execution by one or more driver assistance systems of both steering and acceleration/ deceleration using information about the driving environment and with the expectation that the *human driver* perform all remaining aspects of the *dynamic driving task*	**System**	Human driver	Human driver	Some driving modes
***Automated driving system* ("system") monitors the driving environment**						
3	**Conditional Automation**	the *driving mode*-specific performance by an *automated driving system* of all aspects of the dynamic driving task with the expectation that the *human driver* will respond appropriately to a *request to intervene*	System	**System**	Human driver	Some driving modes
4	**High Automation**	the *driving mode*-specific performance by an automated driving system of all aspects of the *dynamic driving task*, even if a *human driver* does not respond appropriately to a *request to intervene*	System	System	**System**	Some driving modes
5	**Full Automation**	the full-time performance by an *automated driving system* of all aspects of the *dynamic driving task* under all roadway and environmental conditions that can be managed by a *human driver*	System	System	System	**All driving modes**

Figure 29: Summary of SAE International's Levels of Driving Automation for On-Road Vehicle (Copyright © 2014 SAE International. The summary table may be freely copied and distributed provided SAE International and J3016 are acknowledged as the source and must be reproduced AS-IS.) [487]

3.4.6.2 Research, Development & Innovation

The SPY Car Act[488], mentioned also in the "Connected & Automated Driving" focus area, was based on a February 2015 report by Senator Markey, who had surveyed OEMs about cybersecurity threats to safety and the collection and storage of driving data, including location, driving history, and user data. The report found that nearly all cars on the market have wireless technologies and identified several purported weaknesses in the security of connected features in cars.

The SPY Car Act would require collaboration between the NHTSA and the FTC to implement cybersecurity standards for vehicle system and driving data security, including hacking protection and mitiga-

[485] Department of Transportation -Intelligent Transportation Systems Joint Program Office. (2005). ITS Standards Acquire A New Mission: Transitioning the ITS Standards Program to Align with the USDOT's New ITS Research Initiatives. Retrieved from: http://library.ite.org/pub/e267a25c-2354-d714-5152-63167e78de7a.

[486] SAE International (2014). Automated Driving Levels of Driving Automation Are Defined in new SAE International Standard J3016. Retrieved from: http://www.sae.org/misc/pdfs/automated_driving.pdf.

[487] SAE International (2014). Automated Driving Levels of Driving Automation Are Defined in new SAE International Standard J3016. Retrieved from: http://www.sae.org/misc/pdfs/automated_driving.pdf

[488] Markey, S. Edward, J. [D-MA] (2015). Security and Privacy in Your Car Act of 2015 or the SPY Car Act of 2015. Retrieved from: https://www.congress.gov/bill/114th-congress/senate-bill/1806/all-info

tion, a “cyber dashboard” display label describing the vehicle’s compliance with cybersecurity and privacy requirements, certain privacy standards including providing notice and choice regarding the use and collection of data, and limiting the use of driving data by manufacturers.

Violations of these privacy standards would be treated according to Section 5 of the FTC Act. and violators would be punished up to USD 5,000 per violation.[489]

Additionally, the ITS Standards Program is currently transitioning activities to align them with ten new ITS initiatives being promoted by the ITS Joint Programs Office (JPO).

Recent progress in ITS standards development (2016) includes.[490]

- IEEE’s publication of IEEE 1609.3-2016 Standard for Wireless Access in Vehicular Environments - Networking Services. IEEE 1609.3 defines network and transport layer services, including addressing and routing, in support of secure WAVE data exchange. It also defines Wave Short Messages, providing an efficient WAVE-specific alternative to IPv6 (Internet Protocol version 6) that can be directly supported by applications. Further, this standard defines the Management Information Base (MIB) for the WAVE protocol stack.
- Publication of SAE International's publication of J2735, Dedicated Short Range Communications (DSRC) Message Set Dictionary, for applications utilizing the 5.9 GHz DSRC for Wireless Access in Vehicular Environments (DSRC/WAVE) communications systems. This document defines the messages, data frames and data elements that make up the messages and is facilitated through tables in this document. Additionally, SAE published the J2945/1 On-Board System Requirements for V2V Safety Communications standard. This standard focuses on vehicle-to-vehicle (V2V) safety communications systems' requirements to support a set of six V2V Safety applications. The standards can be purchased from the SAE site at http://store.sae.org.
- IEEE's publication of IEEE 1609.2-2016 Standard for Wireless Access in Vehicular Environments - Security Services for Applications and Management Messages and IEEE 1609.12-2016 Standard for Wireless Access in Vehicular Environments (WAVE) - Identifier Allocations. IEEE 1609.2 defines secure message formats, and the processing of those secure messages, within the DSRC/WAVE system. IEEE 1609.12 specifies allocations of WAVE identifiers defined in the IEEE 1609™ series of standards. The IEEE 1609.4 WAVE – Multi-Channel Operations standard is also published; this standard describes various standard message formats for DSRC applications at 5.9 GHz.

Different types of standards that are of prime importance include standards associated with the applications (i.e. application layer), 5.9 GHz spectrum allocation (i.e. access layer) and security (i.e. security layer). This is because some standards will be dependent on the applications and functionality that need to be deployed. It is considered that a minimum set of standards is required in order to deploy the core functions of C-ITS and to deliver the applications which local stakeholders wish to deploy early.

The United States is currently developing a WAVE Protocol architecture (focused on a 5.9 GHz radio interface as opposed to supporting multiple network stacks proposed by the European Union (e.g., ETSI set of standards which focus on 5.9 GHz 54 CVRIA (2015).[491]

The WAVE protocol architecture is separate from the U.S. Connected Vehicle Reference Implementation Architecture (CVRIA) project. The United States has set aside a 70 MHz spectrum within the 5.9 GHz band (5.855-5.925 GHz), while Europe a 50 MHz spectrum (5.855-5.905 GHz). However, DSRC hardware will likely be able to comply with both the U.S. and European standards, though there will be some software differences. It is understood that the U.S. scenario aims to standardize the interfaces

[489] Pittman, F.P. (2016). Legal Developments in Connected Car Arena Provide Glimpse of Privacy and Data Security Regulation in Internet of Things. Retrieved from: https://www.dataprivacymonitor.com/cybersecurity/legal-developments-in-connected-car-arena-provide-glimpse-of-privacy-and-data-security-regulation-in-internet-of-things/.

[490] USDoT – Intelligent Transportation Systems Joint Program Office. (2016). ITS Standard Program. Retrieved from: https://www.standards.its.dot.gov/news.

[491] Office of the Assistant Secretary for Research and Technology, ITS Standards Program. (2016). IEEE 1609 - Family of Standards for Wireless Access in Vehicular Environments (WAVE).Retrieved from: https://www.standards.its.dot.gov/factsheets/factsheet/80.

while the EU scenario is creating an ITS station which would manage all communications within the one platform.

Both the U.S. and EU scenarios focus on 5.9 GHz communications. Nevertheless, many experts argue that the EU scenario has a clearer path towards the use of hybrid communications (through the proposed CALM approach) than does the U.S. scenario. Thus, the EU scenario is considered more integrated and scalable[492].

3.4.6.3 Industry

Due to the increased consumer demand for data and services in Connected Cars, the industry consortium W3C[493] recently announced a new automotive industry-based international collaboration, in order to help drivers and passengers to access key operational data through the Web[494].

In February 2013 OEMs, chip and browse makers and mobile operators started working on draft specifications for vehicle data (i.e. vehicle identification, speed, tire pressure, battery status and personalization information). Today's new Automotive Working Group converts those draft specifications to Web standards. The W3C also started working on the Web of Things to boost the development of open markets for products and services based on tags, sensors and actuators, etc.

Along with this standardization effort, the Automotive and Web Platform Business Group will now focus its attention to the development of requirements on a number of new topics, such as media tuners and speech interfaces[495].

3.4.6.4 Market

The increasing demand for improved road safety is one of the most important and primary factors behind the development of the world market of intelligent transport systems. According to the World Health Organization, 1.25 million people die every year due to traffic accidents[496]. Moreover, the increase of the number of vehicles in all big cities has also increased the demand for upgrading of existing transport networks.

The possibilities offered by the Intelligent Transport Systems regarding the reduction of road accidents, as well as the reduction of fuel consumption and travel delays are also leading to their adoption and use by the traffic management systems and principles. However, the economic downturn eliminates the funding opportunities for intelligent transport systems, while the lack of interoperability between existing infrastructure and the advanced intelligent transport systems is probable going to be a barrier in the market's growth. The assessment of the Intelligent Transportation System market is anticipated to reach USD 30.2 bn by the end of 2019[497].

This development and the flourishing of this market requires the simultaneous and direct development and modernization of the relevant Standardization System of wireless technologies, subject to and from also major players in this market, such as Xerox Corporation, DENSO Corporation, WS Atkins PLC, TomTom NV, etc.

In parallel to the Spy Car Act, analysed in Section 3.1.6.2, legislation has also been suggested, concerning vehicle data privacy and safety, that would require OEMs to develop a privacy policy regarding

[492] Michigan Department of Transportation and Center for Automotive Research. (2016). Global Harmonization of Connected Vehicle Communication Standards. Retrieved from: http://www.cargroup.org/?module=Publications&event=View&pubID=129.

[493] The World Wide Web Consortium (W3C) is an international consortium where Member organizations, a full-time staff, and the public work together to develop Web standards. W3C primarily pursues its mission through the creation of Web standards and guidelines designed to ensure long-term growth for the Web. The Open Web Platform is a current major focus. Over 390 organizations are Members of the Consortium. W3C is jointly run by the MIT Computer Science and Artificial Intelligence Laboratory (MIT CSAIL) in the USA, the European Research Consortium for Informatics and Mathematics (ERCIM) headquartered in France, Keio University in Japan, and Beihang University in China, and has additional Offices worldwide.

[494] W3C Press Release Archive (2015). W3C and Automotive Industry Start New Web Standards Work for Connected Cars. Retrieved from: https://www.w3.org/2015/02/auto.html.en.

[495] W3C Press Release Archive (2015). W3C and Automotive Industry Start New Web Standards Work for Connected Cars. Retrieved from: https://www.w3.org/2015/02/auto.html.en.

[496] World Health Organization (2016). Road traffic injuries. Retrieved from: http://www.who.int/mediacentre/factsheets/fs358/en/

[497] Transparency Market Research (2016). Growing Global Intelligent Transportation System Market Looks to Standardization of Wireless Technologies, Set to Rise to USD 30.2 bn by 2019, TMR Says. Retrieved from: http://www.transparencymarketresearch.com/pressrelease/global-intelligent-transportation-system-market.html.

the collection, sharing, and use of driver and vehicle data, file their privacy policies with the Secretary of Transportation, acquire reasonable security measures to be protected against hacking and enforce on auto manufacturers' penalties of up to USD 1 million for failing to file a privacy policy or comply with an express privacy policy and penalties of up to USD 100,000 for failing to prevent hacking.

This suggested legislation also requires NHTSA to create an Automotive Cybersecurity Advisory Council to develop cybersecurity best practices for vehicle manufacturers[498].

Regarding the electric vehicles charging, the Standard applied in North America is the SAE J1772. It concerns electrical connectors for electric vehicles maintained by the SAE International and it covers the general physical, electrical, communication protocol, and performance requirements for the electric vehicle conductive charge system and coupler.[499]. Additionally, the Standards used in USA for fuel cell vehicles and vehicular hydrogen systems are the SAE J2578 and SAE J2579 respectively.[500] [501]

3.4.6.5 SWOT Analysis

Strengths	**Weaknesses**
• World leader in standardization because of traditionally established system (a big, diverse country needs to be standardized) • Federal system pushes for country-wide standardization (with strong States leading the way, i.e. California, Michigan) • Fast implementation of standards because of case-based jurisdiction system • Long experience in mass production pushes standardization • Centralized standardization and interoperability activities of the U.S. DOT in the ITS Joint Program Office • Automation standard, universally agreed, based on SAE typology • An Initial ITS Framework and Architecture is in place in the USA	• Big inefficiencies and redundancies (especially in logistics and delivery) based on a lack of standards • Need for declaration at States level only • Business fragmentation between logistics companies
Opportunities	**Threats**
• International collaboration framework through the Trilateral Group (between USA, EU and Japan) focused on connected automation as a mean of achieving maximum benefits in safety, mobility and environmental impacts	• Full harmonization of standards is not yet available (i.e. gaps in connected driving or C-ITS), as regional differences exist in C-ITS hardware and software that must be harmonized irrespective of location (IEEE leads the way)

[498] Pittman, F.P. (2016). Legal Developments in Connected Car Arena Provide Glimpse of Privacy and Data Security Regulation in Internet of Things. Retrieved from: https://www.dataprivacymonitor.com/cybersecurity/legal-developments-in-connected-car-arena-provide-glimpse-of-privacy-and-data-security-regulation-in-internet-of-things/.

[499] SAE International (2016). SAE Electric Vehicle and Plug in Hybrid Electric Vehicle Conductive Charge Coupler. Retrieved from: http://standards.sae.org/j1772_201602/.

[500] SAE International (2014). Recommended Practice for General Fuel Cell Vehicle Safety. Retrieved from: http://standards.sae.org/j2578_201408/.

[501] SAE International (2013). Standard for Fuel Systems in Fuel Cell and Other Hydrogen Vehicles. Retrieved from: http://standards.sae.org/j2579_201303/.

3.5 Focus Area 5 – Alternative Fuels Other than Electrification

3.5.1 Brazil

3.5.1.1 General Information

Brazil is considered as a regional pioneer or market leader in establishing ethanol as a transport fuel. Brazil's ethanol fuel program was based on the most efficient agricultural technology for sugarcane cultivation in the world.[502] The National Program for Production and Use of Biodiesel (PNPB) is a federal government program that aims to implement the production and use of biodiesel in a sustainable manner, focusing on social inclusion and regional development, by generating employment and income. Its main guidelines are to implement a sustainable program, promoting social inclusion; to ensure competitive prices, quality and supply; and to produce biodiesel from different oil sources and in different regions.[503] In 2005, the law nº 11.097 made it obligatory to add a minimum percentage of biodiesel to diesel sold to consumers anywhere in the country. The current blend is 7% biodiesel and 93% diesel. This measure has saved Brazil from importing 1.2 billion liters of diesel per year.

Traditionally, Brazilian drivers choose biodiesel when its price is below 70 percent of the price of gasoline, as the biofuel extracted from sugar cane yields about 30 percent less energy per liter. Now, its price surges and it's comparable to conventional fuel, which has affected its use.[504] The use of flex vehicles (powered by both petrol or ethanol) are in demand and in use in Brazil. Although biofuels (mainly ethanol) and natural gas for passenger cars remain important fuel technology in Brazil, natural gas for trucks is getting attention and its market is expected to develop.[505] Research on the use of biofuels as an alternative fuel is taking place in Brazil.

Besides that, electric vehicles (EV) could also be an option for the sustainable urban transport in Brazil. However, EV market is still immature and has lower demand. Brazil is still the EV producer rather than an EV consumer due to its liberal structures, low switching costs for suppliers, well-educated workers and low entrance barriers for European SMEs.[506]

3.5.1.2 Research, Development & Innovation

Various research on efficient flex fuel vehicles is carried out in Brazil and some vehicle manufacturers have tested it on its roads and are in the process of deployment. Petrobras in Brazil is carrying out and financing technical and commercial feasibility studies for the production of advanced biofuels (from cellulose crops and residues). The Ministry of Mines and Energy has initiated to work in partnership with other national institutions in Brazil to provide substantial technological and financial support to R&D projects for production, transportation, storage and distribution of hydrogen.[507]

Brazil in moving towards a next step on alternative aviation fuels that helps to reduce aviation's carbon footprint. Within the action plan Flightpath to Aviation Biofuels in Brazil, a series of workshops were carried out from 2012-2013 in which Boeing, Embraer, the São Paulo Research Foundation and the State University of Campinas came together to support it. In 2015, Embraer and Boeing opened a joint sustainable aviation biofuel research center in a collaborative effort to establish the aviation biofuel industry in Brazil. The center has already started supporting regional initiatives to foster the aviation biofuel value chain; identifying partnerships in universities, research and development centers and

[502] Rothkopf, G. (n.d.). A Blueprint for Green Energy in the Americas: Brazil.
[503] De Moura, A. S. (2010). The Biodiesel Program and Sustainable Development in Brazil. Retrieved from www.iucnael.org/en/documents/467-regulatory-regime-for-biofuels-in-brazil/file
[504] Freitas Jr., G. (2016). Sugar-Cane Fuel Wins in Brazil as Cheap Ethanol Beats Gasoline. Retrieved from http://www.bloomberg.com/news/articles/2016-03-01/sugar-cane-fuel-wins-in-brazil-as-cheap-ethanol-beats-gasoline
[505] Winkel, R., Hamelinck, C., Matthieu, B., Bucquet, C., Ping, S., Cuijpers, M., et al. (2016). Alternative fuels and infrstructure in seven non-EU markets - Final report. European Commission.
[506] Meyer, G., Uribe Altuna, M., & Mujika, A. (2015). Electric Vehicle Supply Chain: Global Opportunities for Electric Mobility: Brazil. Global Opportunites for European SMEs.
[507] Winkel, R., Hamelinck, C., Matthieu, B., Bucquet, C., Ping, S., Cuijpers, M., et al. (2016). Alternative fuels and infrstructure in seven non-EU markets - Final report. European Commission.

suppliers for aviation biofuel research in the country; and engaging with government agencies to establish a national policy for the development and promotion of biofuel.[508]

3.5.1.3 Industry

All buses in Brazil produced by manufacturers such as Mercedes-Benz do Brasil, Scania, Volvo, MAN, are equipped with environmentally friendly BlueTec 5-technology (clean diesel technology) and meet the PROCONVE P-7 exhaust standard (Deppe, 2013) that lowers limits on emissions of local air pollutants, including carbon monoxide (CO), hydrocarbons (HC), nitrogen oxides (NOX), and particulate matter (PM).

The study by D'Agosto et al. (2013), states that the use of CNG dedicated buses and diesel-gas systems best suits in Brazil (mainly in Rio de Janeiro) where natural gas is available at a competitive price with diesel. The same thing occurs for the use of ethanol in buses. The use of hybrid-drive buses is suitable at congested large city urban transit. The other fuel options (biodiesel and diesel from sugarcane) can be used across the country without problems, if the alternative fuel's price cope diesel price.[509]

Renewable Natural Gas (RNG), as an alternative sources of fuel, is emerging in Brazil. It is harvested from waste product and wastewater, contributing to emissions reduction and with potential generation and application in a decentralised manner, which is also suited to rural and other off-grid fuelling of local fleets. ABiogás, a Brazilian association of companies with the RNG focus, is presenting a proposal to the Ministry of Mines and Energy for supported introduction of the fuel, pointing out it needs no additional refuelling infrastructure given the country's long established Compressed Natural Gas (CNG) fuel industry where there are about 1,693 filling stations. Some companies are using RNG, such as CIBiogás (International Centre for biogas) supplied more than 40 vehicles of Itaipu Binacional and intends to double capacity by end of 2016.[510]

The National Agency of Petroleum, Natural Gas and Biofuels (ANP) of Brazil has set the specifications of biomethane – a natural gas produced from organic waste and its application for vehicles (NGVs), residences and businesses. The biomethane is an alternative and 100% renewable fuel, and it has been received under the GNVerde brand in Rio Grande do Sul. With the support of the State Gas Company (Sulgás), it has being tested in vehicles since 2013, but the distribution company was awaiting the decision of the ANP to start selling this alternative fuel, which can be mixed with the natural gas transported by pipelines. The demonstration of the first biomethane powered bus with GNVerde was demonstrated in Rio Grande do Sul in 2015.[511]

Recently, Nissan is producing e-Bio Fuel-Cell cars which use Solid Oxide Fuel Cell (SOFC). It offers the flexibility of using fuels ranging from natural gas to ethanol to ethanol-water blends. An on-board reformation step is required to extract the hydrogen needed for the SOFC from any hydrocarbon fuel. Nissan's SOFC initiative is being tested on public road and it is hoped that this biofuel approach fits well with local infrastructure (Brazil with lots of ethanol) and can enable lower mobility costs and higher driving satisfaction.[512]

3.5.1.4 Market

Cars capable of running on ethanol (such as E100 vehicles) arrived on the Brazilian market in the late 1970s, when ethanol was cheaper than gasoline. In support of ethanol, Brazil has the National Alcohol Program -Pró-Álcool- (Portuguese: 'Programa Nacional do Álcool'), launched in 1975, which was a

[508] ATAG. (n.d.). A new biofuels research centre in Brazil. Retrieved from http://aviationbenefits.org/case-studies/a-new-biofuels-research-centre-in-brazil/

[509] de Almeida D'Agosto, M., Ribeiro, S., de Souza, C. (2013). Opportunity to reduce greenhouse gas by the use of alternative fuels and technologies in urban public transport in Brazil. *Current Opinion in Environmental Sustainability*. Vol. 5 (2). pp 177-183.

[510] NGV Global. (2016). Renewable Natural Gas Sector Emerging in Brazil. Retrieved from :http://www.ngvglobal.com/blog/renewable-natural-gas-sector-emerging-in-brazil-0222.

[511] NDTV Auto Team. (2015). Current and Upcoming Affordable Cars With AMT in India. Retrieved from: http://auto.ndtv.com/news/present-and-upcoming-affordable-cars-with-amt-in-india-766447.

[512] Gross, M. (2016). Nissan's Fuel-Cell Car Hits the Road in Brazil, Extracts Hydrogen from Biofuel. Retrieved from: http://blog.caranddriver.com/nissans-fuel-cell-car-hits-the-road-in-brazil-extracts-hydrogen-from-bio-fuel/

nationwide program financed by the government to phase out automobile fuels derived from fossil fuels, such as gasoline, in favour of ethanol produced from sugar cane. Though sugarcane was criticized as could impact on the price of food, many studies have concluded Brazilian ethanol is far less damaging for global food prices.[513] Pró-Álcool's main objectives are (i) to reduce national dependence on oil imports, (ii) to promote technical and industrial development through ethanol fuel production; and (iii) to strengthen the sugarcane and sugar sectors. However, in 1990s Brazil became the world's main importer of alcohol fuels for several years, including methanol as there was insufficient ethanol available on global markets.[514] The sale of ethanol cars decreased, not only due to fuel price difference, but also in response to a reduction of taxes on gasoline cars. In 2003-2004, flex-fuel technology was launched and acted as a game-changing solution and considered as the successful phase in the problem-innovation sequence.[515] Currently there are several flex-fuel cars in the market that offer mix use of fuels. All the light commercial vehicles produced in Brazil have this bi-fuel technology and at least 17 new models imported from Argentina, China, Mexico, Korea and Thailand were adapted with this system in order to adapt to the Brazilian need.[516]

3.5.1.5 SWOT Analysis

Strengths	**Weaknesses**
• Well-established use of bioethanol as the price was comparatively lower than gasoline	• The sale of ethanol cars decreased, not only due to fuel price difference, but also in response to a reduction of taxes on gasoline cars • No necessity felt for further development because there is a CO_2-free alternative that gives independence • Need to strengthen government support for alternative fuels
Opportunities	**Threats**
• Local manufacturers of vehicles with alternative fuels	• Potential for further development of other alternatives such as electrification not used

3.5.2 China

3.5.2.1 General Information

More than 200 cities in China will have a population of more than one million by 2030. The increase of urbanization combined with motorization greatly affects traffic congestion, traffic deaths and injuries, air pollution, noise, and energy consumption. In addition, big cities also face difficulties in meeting the demand for mobility and handling air pollution and energy consumption issues without negatively affecting economic growth.

The increased motorization of China has respectively led to significant increases in oil demand and oil imports and the Chinese government is adopting a broad range of policies concerning fuel economy of new vehicles and the promotion of alternative-fuel vehicles.[517]

China's objective is to maintain total energy consumption at around 4.34 billion tons of standard-coal equivalent in 2016, and non-fossil fuel consumption is to rise up to 13%. Gas consumption will account

[513] Capitani, D. (2014). Biofuels versus food: How much Brazilian ethanol production can affect domestic food prices? Retrieved from: http://ageconsearch.umn.edu/bitstream/170267/2/AAEA%202014_Capitani_paper%204941.pdf
[514] Moreira, J.,Goldemberg, J. (1999). The alcohol program. *Energy Policy* , Vol. 27 (4), pp. 299-245.
[515] Gee, S., McMeekin, A. (2011). Eco-innovation systems and problem sequences: The contrasting cases of US and Brazilian biofuels. *Industrial Innovation*.Vol. 18 (03), pp 301-315.
[516] The Brazil Business. (2016). Ethanol Market in Brazil. Retrieved from http://thebrazilbusiness.com/article/ethanol-market-in-brazil.
[517] Peng, Z-R, Sun, J., Lu, Q-C (2012). China's Public Transportation: Problems, Policies, and Prospective of Sustainability. Retrieved from: http://citeseerx.ist.psu.edu/viewdoc/download;jsessionid=23FC85FEB6FB25AAB6D24029E8994430?doi=10.1.1.437.2797&rep=rep1&type=pdf

for 6.3% of total energy consumption for 2016 and the proportion of coal consumption will fall below 63%. On the supply side, the country is expected to produce 3.6 billion tons of standard coal equivalent in 2016, with crude production reaching 200 million tones and gas production reaching 144 billion cubic meters. Chinese government also targets to reduce energy consumption per unit of gross domestic product by at least 3.4% in 2016, according to the guideline.[518]

The Chinese government called for efforts for the promotion of clean energy and the reduction of emissions, the optimization of the country's energy structure and the enhancement of the international energy cooperation.

3.5.2.2 Research, Development & Innovation

In a period when the demand for cleaner fuels and energy diversification is strong internationally, China is creating a strategy for the development and promotion of the alternative fuels sector. Apart from the great emphasis provided for the electrification of vehicles, the Chinese government is also playing a major role by forming initiatives for the promotion of natural gas imports (via pipeline or in the form of LNG).

CNG vehicles widely exist in China (especially in regions rich in gas). In addition, over the last years LNG-fuelled fleets have also made their appearance[519].

By the end of 2014, there were 6,955 natural gas stations in China. Among them, the newly-built LNG stations decreased by 36.5% compared to the previous year, while CNG stations had a year-on-year increase of 0.7%. The fall in the growth of new LNG stations in 2014 was mainly due to a fall in international oil price, slowing the investment in natural gas stations.[520]

3.5.2.3 Industry

The Chinese OEMs as well as the automotive industries worldwide, draw their attention and their efforts mainly in the electric vehicles field. Sales of such vehicles show increase during the latest months in China, as the government offers tax breaks and other incentives to encourage purchases of electric vehicles and plug-in hybrids. Additionally, international OEMs are willing to establish their alternative fuel vehicle teams in China, taking advantage of the country’s standing as the world's biggest auto market.

As for other propulsion systems, in 2015 the CNG station equipment industry had higher market concentration. For example, the top 3 companies operating CNG compressors for natural gas stations account for a combined 64% market share, totally concentrated in Zigong city, Sichuan Province. 74% shares of CNG gas storage facility market have been held by Zigong Huaqi Technology Co., Sichuan Chuanyou Natural Gas Technology Co., and Zigong Daye High Pressure Container Co., all from Zigong city, Sichuan province.

Concerning LNG station equipment industry, and with the rapid growth of LNG vehicles and accelerated market-oriented reform of natural gas prices, it is estimated that during 2015-2018 China's investment in LNG stations will rebound, but its growth rate will slow down. As LNG stations expand from Yangtze River Delta Region, Pearl River Delta Region, and Bohai Economic Rim to inland regions, the construction of mobile natural gas stations is moving up, so that LNG station equipment market size might increase gradually.[521]

[518] Xinhuanet (2016). China sets energy use target for 2016. Retrieved from: http://news.xinhuanet.com/english/2016-04/01/c_135244392.htm.

[519] Chen, Y. (2013). Development strategies of the Chinese natural Gas Market. Retrieved from: http://www.clingendaelenergy.com/inc/upload/files/Ciep_Paper_2013-07.pdf.

[520] PR NewsWire (2015). China Natural Gas Fueling Station Equipment Industry Report, 2015-2018. Retrieved from: http://www.prnewswire.com/news-releases/china-natural-gas-fueling-station-equipment-industry-report-2015-2018-300144354.html.

[521] PR NewsWire (2015). China Natural Gas Fueling Station Equipment Industry Report, 2015-2018. Retrieved from: http://www.prnewswire.com/news-releases/china-natural-gas-fueling-station-equipment-industry-report-2015-2018-300144354.html.

3.5.2.4 Market

China's government vehicle emissions are responsible for the 30% of pollution in Beijing. In this context, the government's policy for alternative fuels can be summarised as following:

- Strategic turn of China towards alternative fuels in order to decrease its reliance on foreign oil while creating great opportunities in natural gas vehicles (NGVs) and in the conversion of coal to ethanol.
- Development of policies for the promotion of alternative vehicle fuels (AVFs) and alternative fuel vehicles (AFVs**),** including city bus fleets.
- Plans for the promotion of the number of electric, hybrid and other alternative-fuel-powered vehicles used for public transport, at the same time that sales of such cars for private use have increased in recent months.
- The Ministry of Transport announced that officials aimed to add 200,000 buses and 100,000 taxis powered by alternative fuels by 2020. Last year, 15,000 alternative-fuel-powered buses have been added to its roads (at least 30% of government vehicles purchased will have to be fuelled by alternative energy sources within the next two years). After 2016, local provinces will also be required to meet the same target.
- China's promotion of liquefied natural gas (LNG) has created new opportunities for players in the natural gas vehicle (NGV) market. The initiatives of the government aim at a fleet of 1 million heavy-duty NGVs, creating the material and device demands for LNG storage and transportation.
- Coal-to-ethanol is a very popular and effective system due to the huge quantities of coal available in the country. Coal-to-ethanol presents great opportunities of large-scale commercialization, as big energy companies, research institutes are being involved and investing in this sector.
- China has abundance of renewable sources. It is estimated at 123 billion gallons of gasoline equivalent per year (BGGEY) and fossil resources (coal and natural gas) worth 360 BGGEY by 2020. Nevertheless, logistical obstacles come up, especially regarding biomass and waste collection.[522]

According to data statistics of the "Bulletin of Vehicle Manufacturers and Products" and the "Certificate of Conformity of Complete Motor Vehicle Delivered from Factory", as of the end of 2014, China has registered 1,253 new energy vehicle models in the "Bulletin" (including 872 models of battery electric products, 369 models of plug-in hybrid electric vehicles and 12 models of fuel cell electric vehicles), and has manufactured a total of 119,502 units of new energy vehicles.

The implementation of big efforts concerning the vehicles of alternative fuels the output of new energy vehicles from China was 84,884 units in 2014 exceeding the numbers in previous years and integrating a rapid growth trend.

Despite the increase in new energy vehicle production, in China in 2014, a huge gap between target numbers and actual sales volumes exist. The country targeted to reach an accumulative output/sales volume of 500,000 units of battery electric vehicles and plug-in hybrid electric vehicles in 2015 (the goal for production capacity in 2015 was 2 million), and an accumulative output/sales volume of 5 million units of battery electric vehicles and plug-in hybrid electric vehicles in 2020".[523] In Figure 30 the rates of new energy vehicles types produced in China is presented.

[522] Carole Jacques (n.d). Alternative Fuels in China Can Replace Up to 483 Billion Gallons of Gasoline in 2020. Retrieved from: http://www.luxresearchinc.com/news-and-events/press-releases/read/alternative-fuels-china-can-replace-483-billion-gallons-gasoline

[523] International Energy Agency (IEA) (2015). Hybrid and Electric Vehicles – The electric Drive Delivers. Retrieved from: http://www.ieahev.org/assets/1/7/Report2015_WEB.pdf

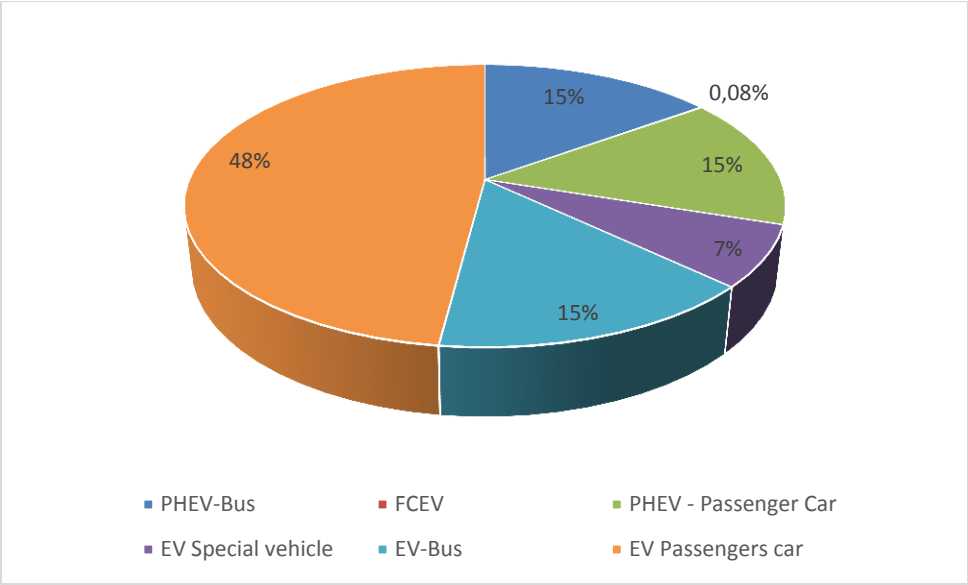


Figure 30: Share of alternatively fueled vehicles

Considering the above mentioned data, alternative fuels, other than electrification, are of low importance and market penetration in China.

The LPG vehicles are developing fast in some countries through the last years. Concerning China, Shanghai had nearly all taxis converted to LPGV in the beginning of the 2000s and today all taxis, as well as the 80% of buses in Guangzhou are LPGV. Nevertheless, the expansion of LPGV use in China (except from Hong Kong) presents some signs of regression[524].

However, China is also pioneering the development of a natural gas-powered truck and bus system.[525] The most important Chinese truck manufacturers have LNG trucks available. However, developing an LNG-based transport fuels market has its challenges, especially when it comes to creating a network of fuelling stations to ensure the supply of LNG, when most of the trucks and buses are powered by diesel or gasoline engines. To be able to handle such problems, the International Finance Corporation (IFC) is providing financing and expertise to facilitate some of the first-mover risk of developing China's LNG transport system. In 2013, the IFC provided a USD 150 million in financing to ENN Energy Holdings Limited., a leading gas distributor in China, in order to help develop an LNG fuelling network and provide LNG as a transport fuel for the replacement of diesel along China's major highways[526].

Replacing conventional gasoline with natural gas vehicles (NGVs) is of major importance for China in its efforts to reduce greenhouse gas emissions. The period between 2013 and 2014 was crucial for China's gas market, while arrangements have been done to secure sufficient future pipeline gas imports because of the increasing gap between supply and demand. However, there are still problems concerning China's NGV development, such as a shortage in natural gas supply and a relatively high price ratio of natural gas compared to gasoline[527].

However, China had in 2014 almost 4,900 natural gas fuelling stations to support the increasing use of natural gas vehicles, while the Chinese government has also secured the country's resources by the

[524] Leung, V. (2011). Slow diffusion of LPG vehicles in China—Lessons from Shanghai, Guangzhou and Hong Kong. Retrieved from: http://www.sciencedirect.com/science/article/pii/S0301421511002783
[525] GE Reports (2015). How to beat OPEC – Take the Highway to Natural Powered-Gas Trucking. Retrieved from: http://www.gereports.com/post/112059724948/how-to-beat-opec-take-the-highway-to-natural-gas-powered/.
[526] GE Reports (2015). How China Is Trucking Into The Age Of Gas. Retrieved from: http://www.gereports.com/post/117081848193/how-china-is-trucking-into-the-age-of-gas/.
[527] Wang, H. Fang.H., Yu, X., Wang, Ke (2015). Development of natural gas vehicles in China: An assessment of enabling factors and barriers. Retrieved from: http://www.sciencedirect.com/science/article/pii/S0301421515002050.

30 year natural gas deal with Russia. By 2020, about 3.8 million Chinese cars, trucks and buses are expected to use liquefied or compressed natural gas[528].

3.5.2.5 SWOT Analysis

Strengths • Many gas resources available • International deals established, especially with Russia • Taxis and buses converted to LPG in big cities • Well-established infrastructure of natural gas stations in China	**Weaknesses** • No extensive production of biofuel crops • Despite high number of gas resources there is a shortage in natural gas supply • Alternative fuels are priced very high in comparison to gasoline
Opportunities • China has the world's biggest automotive industry increasing the motivation for international companies to export alternatively fuelled vehicles to China • Air pollution in big cities is a big driver for switching to alternative fuels • "Cooling down" of Chinese economy development may promote further investments	**Threats** • Strong push of China towards electric vehicles puts lower priority on developing other alternative fuels

3.5.3 India

3.5.3.1 General Information

India lags behind international best practices in terms of fuel quality and vehicle emission standards. Sulphur levels in fuel remain high, well above the maximum of 10 ppm required for the best clean vehicle technologies to function optimally. Also India does not have any plans of implementing 10 ppm sulphur fuels nationwide any time soon.[529]

Although LPG and natural gas with CNG used busses remain important fuel/technology in India, application of natural gas in locomotives is under investigation.[530]

On the positive side the use of alternative fuels along with electric vehicles (EV) are on rise in India. The surge of EV manufacture in the country, mainly two wheelers, is seen after Indian government supported the EV industry through the 'National Electric Mobility Plan 2020' in 2012.[531] Regarding alternative fuels, some parts of Indian cities use vehicles with CNG, Ethanol and biogas, but the gas stations are not enough to run it effectively yet. Jatropha biofuel has been used in India for several decades and a huge investment has been done considering the potential of GHG emission saving compared to fossil-based diesel. However, it was a failure as it affected land and water problem.

No specific information could be found on Market activities regarding non-electric alternative fuels.

[528] Clean Energy Compression. (2014). Are Natural Gas Vehicles the Answer to Beijing's Nasty Smog Problems? Retrieved from: www.cleanenergyfuels.com/compression/blog/beijing-china-natural-gas-vehicles-strategy/.
[529] NTDPC. (2014). India Transport Report. National Transport Development Policy Committee. Routledge.
[530] Winkel, R.et al. (2016). Alternative fuels and infrstructure in seven non-EU markets - Final report. European Commission.
[531] Meyer et a. (2015a). Electric Vehicle Supply Chain: Global Opportunites for Electric Mobility: India. Global Opportunities for SMEs in Electro-Mobility.

3.5.3.2 Research, Development & Innovation

Scania's research and development in Bengaluru/Bangalore has introduced Metrolink coaches and trucks with the design adapted for Indian market and incorporating domestically sourced components that use alternative fuels (ethanol and biogas). Scania India introduced 100 bioethanol and biogas buses as a large pilot facility in Nagpur.[532]

In June 2016, a pilot Programme to run two wheelers on CNG was launched by the Government of India, Ministry of Petroleum and Natural Gas. Gas share in India is just 7 percent compared to world average of around 24 percent. This initiative aims to be expanded very fast. It is implemented by Indraprastha Gas Limited (IGL) and one of its parent companies, Gas Authority of India Limited (GAIL). The Pilot Programme involves 50 CNG retrofitted two wheelers. As per idle emission test, the hydrocarbon emissions from CNG retrofitted two wheelers are 75% less and CO emissions are 20% less compared to petrol driven, similar models. The CNG kit for two wheelers comprises two CNG cylinders of 4.8 liter water capacity each, which can be filled up to 1 kg of CNG in each cylinder. The kit was approved by the Automotive Research Association of India (ARAI), and has been retrofitted in the gearless scooters, built by Japanese two-wheeler manufacturer, Honda Motorcycles & Scooter India Ltd.[533]

3.5.3.3 Industry

Among Indian vehicle manufacturers, Tata motors developed the hydrogen fuel-fitted bus - CNG type bus – together with the Indian Space Research Organisation (ISRO). It was demonstrated at the Liquid Propulsion Systems Centre, an ISRO facility in Mahendragiri in Tamil Nadu. It is considered as a leap for the automobile industry for future transportation and it produces zero pollution since the product of cold combustion is water.[534]

In India, expectations from the oil-crop Jatropha have been high for the production of biodiesel. Jatropha is promoted as a drought and pest-resistant crop, with the potential to grow on degraded soil with a low amount of inputs. These characteristics encourage the Jatropha biodiesel production. However, experiences in the field show that Jatropha has failed to survive and/or grow on poor soils and that a majority of the farmers planted Jatropha on cropland. The plantations have not been able to tolerate drought as well as expected, and pest attacks have occurred in several cases. Farmers have experienced that the crop requires inputs for survival and growth and have used irrigation, fertilizers, manure, and pesticides. Later it was discontinued as it failed to provide enough income to the farmer and lack of government support.[535] Evidently, in the last few years, few stakeholders (from private and government sector) were engaged in identifying tree-borne oilseeds (neem, pongamia, mahua and kusum) as an alternate to jatropha for bio-diesel production, but on an experimental basis. However, availability, feasibility and sustainability of tree-borne oilseeds still need to be validated.[536]

For advanced bio-fuels, the Indian biofuel industry, both private and public sector, claim to be successful in developing and customizing technology for converting lingo-cellulosic materials in form of wood biomass, agricultural (corn cob, bagasse, straw and stover) waste and forest waste. The experimentations are underway to process municipal solid waste, micro-algae and photosynthetic organisms into advanced biofuels. However, due to the technological challenges, commercial production and economic viability remains unclear.[537]

[532] SCANIA. (2015). Biofuel dream comes true for India. Retrieved from https://www.scania.com/group/en/biofuel-dream-comes-true-for-india/.
[533] Government of India. (2016).Pilot Programme to run two wheelers on CNG launched by Shri Dharmendra Pradhan & Shri Prakash Javadekar. Retrieved from http://pib.nic.in/newsite/PrintRelease.aspx?relid=146451.
[534] The Times of India. (2015). Isro, Tata Motors develop India's first fuel cell bus. Retrieved from http://timesofindia.indiatimes.com/business/india-business/Isro-Tata-Motors-develop-Indias-first-fuel-cell-bus/articleshow/21430268.cms.
[535] Axelsson, L., Franzén, M., Ostwald, M., Berndes, G.,and Ravindranath, N. (2011). Performance of Jatropha biodiesel production and its environmental and socio-economic impacts - A case study in Southern India.
[536] Aradhey, A. (2014). India: Biofuels Annual. Global Agricultural Information Network.
[537] Aradhey, A. (2014). India: Biofuels Annual. Global Agricultural Information Network.

3.5.3.4 SWOT Analysis

Strengths	Weaknesses
• Some parts of Indian cities use vehicles with CNG, Ethanol and biogas	• Due to high poverty rate existing attempts for alternative fuels are hardly demanded • Not enough gas stations to run vehicles with alternative fuels
Opportunities	**Threats**
• As per Auto Fuel Policy 2025, BS-VI roll out was envisaged for the entire country by 2017, BS-V by 2021 and BS-VI by 2024	• India lags behind international best practices in terms of fuel quality and vehicle emission standards • India lags behind international best practices in terms of fuel quality and vehicle emission standards. Currently, Bharat Stage (BS) VI norms (equivalent to Euro 6 norms) are only applicable in 13 major Indian cities, while BS III are applicable in all cities

3.5.4 Japan

3.5.4.1 General Information

Japan currently spends around JPY 350 billion annually on energy-related R&D. At 0.07% of gross domestic product, that is one of the highest rates among industrialized nations.[538] Transport makes up around 25% of the final energy consumption in Japan. Different technologies that are currently developed attempt to increase energy security and resilience by diversifying its energy portfolio while at the same time lowering greenhouse gas emissions.

Japan is the leading global market for electric vehicles. Vehicle electrification is high on the government's agenda and shows consistent growth. Similarly, even though not as pushed, is hydrogen technology. For other technologies, such as biodiesel, bioethanol, biomethane, natural gas liquids (NGL), and liquefied petroleum gas (LPG).[539]

The Japanese government has set the goal to reduce greenhouse gas emissions by 26% by 2030 based on 2013 figures. To reach this goal, it set up a Strategic Roadmap for Hydrogen and Fuel Cells subsidizing the construction of hydrogen stations and reviewing regulations in order to transition resource-scarce Japan to alternative energy sources. The roadmap was part of the vision of a "hydrogen society" where fuel cells power homes and office buildings, as well as cars.[540] The government estimated that the nation's hydrogen market could expand to JPY 1 trillion by 2030.[541] The goal is 1,000 stations and 50,000 FCEVs deployed by 2020, and 5,000 stations and 1 million FCEVs by 2030.

Another stream of efforts is put on biofuels. In its 2010-plan the government stated that it wants to introduce 500 million liters by 2017. When considering biofuels, there are two significant issues that Japan takes into account: food v. fuel and carbon emissions. Japan has a low self-sufficiency rate for food, it imports the majority of the food its citizens consume. As a result, Japanese people are highly sensitive to issues of rising food prices, leading to a broad debate within Japan about the use of food crops to produce biofuels. This is a major reason why Japan is focusing research efforts on cellulosic

[538] Asian Review. (2016). Japan to boost spending on clean energy R&D. Retrieved from: http://asia.nikkei.com/Politics-Economy/Policy-Politics/Japan-to-boost-spending-on-clean-energy-R-D

[539] European Commission (2016). Alternative Fuels and Infrastructure in Seven Non-EU Markets. Retrieved from: http://ec.europa.eu/transport/themes/urban/studies/doc/2016-01-21-alternative-fuels-and-infrastructure-in-seven-non-eu-markets.pdf.

[540] Edelstein, S. (2015). Japan To Spend USD 385 Million On Hydrogen For 2020 Olympics Deadline. Retrieved from http://www.greencarreports.com/news/1096427_japan-to-spend-385-million-on-hydrogen-for-2020-olympics-deadline.

[541] Hagiwara, Y. and Trudell, C. (2015). Japan's plans to fuel world's cleanest cars hitting road block. Retrieved from http://www.japantimes.co.jp/news/2015/11/30/business/japans-plans-fuel-worlds-cleanest-cars-hitting-road-block/#.V1VfceSHhjU.

ethanol technology, which is not seen to compete with food.

The biofuels industry in Japan is less developed than that in Brazil, the US and Europe. However the Japanese government has announced a number of measures to accelerate use of bioethanol including increased collection of biomass resources and improvement of the bioethanol fuel station infrastructure. The aim is to increase bioethanol production from 50,000 kilo litres in 2011 to 6 million kilo litres by 2030. This is the equivalent of 10% of the country's annual gasoline use.[542]

3.5.4.2 Research, Development & Innovation

The Research Association of Hydrogen Supply/Utilization Technology (HySUT) has named two cities as testing and demonstration areas for hydrogen technology: Fukuoka and Kitakyushu. The Kitakyushu Hydrogen Town demonstration program includes small vehicles such as FC bicycles and lifts. In Fukuoka Hydrogenius, a research institution dedicated to hydrogen technology research, and the Hydrogen Energy Test & Research Center (HyTReC) opened to undertake research and also provide R&D support for start-ups. The two cities, Fukuoka and Kitakyushu, are linked by the Hydrogen Highway (Hy-Life project).

Another stream of research efforts is focused on Euglena, a type of algae – half plant, half animal – that uses photosynthesis to produce fat and oil which is then refined into fuel. Euglena Co., the company behind the alternative fuel works together with Isuzu Motors and All Nippon Airways. Their plan is to commercialize its operations by 2020.[543]

Japan Biofuels Supply Limited Liability Partnership was formed to bring together the expertise of several companies specializing in biofuels to establish efficient supply and distribution systems of biofuels to participating companies.[544]

The aviation industry has set itself the goal of halting growth in CO2 emissions by 2020. Therefore, many industrial players engage in the development of alternative fuels. Japan Airlines (JAP), for example, started a co-operation with the Japan Aerospace Exploration Agency, Toyo Engineering and other partners to collaboratively develop a technology that turns hydrogen and carbon monoxide generated at a waste disposal into jet fuel using catalytic agents. The plan is to blend it with kerosene to achieve major cost cuts and thus, become a reasonable substitute to traditional fuels. Eventually, the partnership will select a company to commercialize the technology.[545]

3.5.4.3 Industry

Toyota, Nissan and Honda have joined forces to support the development of hydrogen station infrastructure covering not only the establishment of infrastructure but also operational costs and customer service. Furthermore project partners will jointly raise awareness regarding these support measures, in order to encourage new companies to enter the hydrogen supply business. Financial assistance will be provided through the Research Association of Hydrogen Supply/Utilization Technology (HySUT).

Honda's strategy to develop stations and refuelling equipment and market them with Iwatani goes a step further. Honda developed the Smart Hydrogen Station along with Iwatani Corp., Japan's biggest hydrogen supplier, to boost supply outside of major cities. However, until today only two stations are open for testing: one in Saitama Prefecture and one in Kitakyushu. The installation cost of existing hydrogen stations is reportedly about JPY 400-500 million per unit, but Honda aims to reduce it by 90%. The unit can produce 1.5 kg of hydrogen per day and store up to about 18 kg of hydrogen, which can fully charge 4.5 FCVs. The installation area of the unit is as small as 7,8 m^2, and it can be installed

[542] European Biofuels (2016). Global Biofuels – An Overview. Retrieved from: http://www.biofuelstp.eu/global_overview.html.
[543] The Japan Times (2016). Company looks to alga to produce biofuel for jets, automobiles. Retrieved from http://www.japantimes.co.jp/news/2016/01/03/business/company-looks-alga-produce-biofuel-jets-automobiles/#.V7WcODXf-ec.
[544] Japan Biofuels Supply LLP. (n.d.). About JBSL. Retrieved from http://www.jbsl.jp/english/index.html
[545] Nikkei. (2016). JAL plans Japan's first waste-to-fuel plant. Retrieved from http://asia.nikkei.com/Tech-Science/Tech/JAL-plans-Japan-s-first-waste-to-fuel-plant.

in about a day.[546] [547]

Both Honda and Toyota are betting on fuel cell vehicles, with Honda's JPY 7.6 million Clarity fuel cell beginning sales in March, more than a year after Toyota started delivering its JPY 7.2 million Mirai. Honda expects to sell about 200 cars per year, while Toyota plans to build 2,000 Mirai sedans in 2016. Toyota is reportedly aiming for 30,000 Mirai sales (12,000 in Japan) by 2020.[548] [549]

In Japan, Nippon Yusen KK should become the first company to introduce an LNG-fuelled marine vessel this year. And Isuzu Motors is developing what will be the first LNG trucks made in Japan.[550]

3.5.4.4 Market

Renewable energy is the largest market in Japan's private-sector spending adding up to a total of JPY 2,37 trillion. In addition to the JPY 2.26 trillion spent on solar systems, JPY 59.5 billion were spent on biomass, JPY 23.5 billion on geothermal, and JPY 22.3 billion on wind power in 2013. Apart from that, batteries and other energy storage equipment totalled just over JPY 103 billion while efficiency-enhancing energy management systems amounted to almost JPY 334 billion. Japan's total private-sector investment in disaster-resilient renewable energy, storage and energy management is estimated to be a JPY 4.92 trillion market by 2020 and the core market in National Resilience is expected to total between JPY 11.8 and 13.5 trillion in 2020. Thus, renewable energy generation, storage and management are estimated to be between 36% to 42% of core markets in Japan's private-sector expenditures on National Resilience by 2020.[551]

In 2014, demand for gasoline was 53 billion litres, and the demand for diesel was 34 billion litres. By 2020, Japan's gasoline and diesel demands are forecast to decrease to 47 billion litres and 33 billion litres respectively. Demand for jet fuel is expected to decline slightly due mainly to improvement in airplane fuel efficiency. Japan's transportation sector (excluding railways) depends on fossil fuel for 98% of its energy, followed by electricity (two percent) and natural gas (0.1%). In its 2014 Basic Energy Plan, the government stated that it will promote diversification of energy sources in the transportation sector. Biofuels are considered to be an important energy source along with electricity, natural and LP gases, and hydrogen. Although the demand for jet fuel is expected to decline, the Japanese government of Japan projects that the proportion of the use of biofuels in jet fuel will increase in the future.[552]

The Government of Japan has been expanding its efforts to promote EST in Japan and in the Asian region. The main actor is the Ministry of Land, Infrastructure and Transport who included development of EST in their Environmental Action Plan. To test EST, 18 model regions were defined: Sapporo, Sendai, Kashiwa City and Nagareyama, Misato City and Yashio, Toyama, Mie Prefecture, Toyota City, Kyoto, Nara Prefecture, Machida, Kobe, Matsuyama, Yokohama, Nagoya, Osaka, Okinawa Prefecture, Ofunato, Tahara.[553]

In June 2014, the Japanese government unveiled its Strategic Road Map for Hydrogen and Fuel Cells, which involves subsidizing the construction of hydrogen stations and reviewing regulations. Furthermore, it decided to partially subsidize hydrogen station operational expenses in order to help stimulate new demand for FCVs. In such ways, the Japanese government continues to contribute to the devel-

[546] Hagiwara, Y. and Trudell, C. (2015). Japan's plans to fuel world's cleanest cars hitting road block. Retrieved from: http://www.japantimes.co.jp/news/2015/11/30/business/japans-plans-fuel-worlds-cleanest-cars-hitting-road-block/#.V1VfceSHhjU.
[547] Nikkei Technology. (2014). Honda sets up Compact Hydrogen Station in Japan. Retrieved from: http://techon.nikkeibp.co.jp/english/NEWS_EN/20140923/378241/.
[548] Yahoo News (2015). Japan's Ambitious Hydrogen-Vehicle Plans Stumble, With Bureaucracy To Blame. Retrieved from https://www.yahoo.com/news/japans-ambitious-hydrogen-vehicle-plans-stumble-bureaucracy-blame-143000863.html
[549] Autoblog. (2015). Honda 'confused and baffled' by Japan's hydrogen delay. Retrieved from: http://www.autoblog.com/2015/12/01/honda-confused-baffled-japan-hydrogen-delay/
[550] Reuters (2015). Japan pushes LNG for transport to help climate, energy security. Retrieved from: http://www.reuters.com/article/japan-lng-transport-idUSL3N0YQ1NI20150618.
[551] DeWit, A. (2016). Japan's "National Resilience" and the Legacy of 3-11. Retrieved from http://apjjf.org/2016/06/DeWit.html.
[552] USDA Foreign Agricultural Service (2015). Biofuels Annual - Market for Liquid Transport Biofuels Remains Steady as Japan Remains Focused on Advanced Fuels. Retrieved from: http://gain.fas.usda.gov/Recent%20GAIN%20Publications/Biofuels%20Annual_Tokyo_Japan_7-13-2015.pdf.
[553] MLIT. (2016).Environmentally Sustainable Transport. Retrieved from: http://www.mlit.go.jp/sogoseisaku/environment/sosei_environment_fr_000061.html.

opment of hydrogen station infrastructure.

In the “Cool Earth – Innovative Energy Technology Program”, it is stated that in addition to emphasizing research and development of fuel cells, it will be necessary to promote demonstrations and standardization in an integrated manner. Furthermore, it is the program's goal to achieve fundamental cost reductions and durability improvements by feeding back the outcomes obtained in demonstrations utilizing hydrogen station to basic research, while promoting active introduction of technologies as public service vehicles. In addition, it is intended to actively participate in discussions on international standards regarding fuel quality and hydrogen stations.[554]

Japan also offers purchase incentives for fuel cell vehicles, such as Toyota's Mirai that are much greater than any offered for battery-electric cars in China, Europe, or the U.S. Buyers in some areas can get about JPY 3 million in subsidies for the Toyota. That amount is more than triple the JPY 950,000 in incentives offered for the Mitsubishi i-MiEV electric car in Japan.[555] [556]

When it comes to biofuel, the Japanese government has identified four different technologies to further push their Biofuel Strategy: Ethanol, Biodiesel, Advanced Biofuels, and Biomass. A number of ministries collaborate on Japan’s biofuels policy, but three ministries – the Ministry of Economy, Trade and Industry (METI), the Ministry of Environment (MOE), and the Ministry of Agriculture, Forestry and Fisheries (MAFF) – play major roles in developing and implementing biofuels policies. MOE’s main concerns are preventing global warming and meeting Japan’s commitment to reduce its greenhouse gas (GHG) emissions. In terms of energy security, METI is interested in biofuels as a supplemental source of fuel and is interested in analysing the cost-benefit of shifting to renewable fuels and their impact on automobiles and infrastructure. METI collaborates with the oil industry to introduce biofuels in the market. MAFF’s goal is to revitalize rural communities by producing biofuels domestically from existing sources (e.g. sugar beets, wheat, and rice). However, its focus has shifted to producing renewable energies (e.g. heat and power) from livestock and wood wastes.[557]

In 2008, the Japanese government introduced tax incentives to encourage the use of bioethanol by amending the Quality Control of Gasoline and Other Fuels Act. The gas tax is usually JPY 53.8 per litre. Under the special measure, if a fuel contains 3 percent bioethanol, the gas tax is lowered by JPY 1.6 per litre. This is a fixed-term special measure which is effective until March 31, 2018.

Also in 2008, the Law to Promote the Usage of Biomass Resources to Produce Biofuels came into force. The legislation includes tax breaks and financial assistance for biofuel manufacturers and farmers producing feedstock, such as agricultural cooperatives and private businesses. The government encourages collaboration of those two groups, and their plans are monitored by MAFF in order to qualify for the benefits. Under the scheme, newly built biofuel facilities that are approved for the program by 2016 will have their fixed property tax reduced by half for three years. The redemption period for interest – free loans for farmers will be extended by two years, to a total of 12 years, for farmers producing feedstock.

Regarding natural gas vehicles, in 2008 there were about 40,000 vehicles running on natural gas, most of them trucks, mini cars and small vans. However, none of them run on LNG. As for the infrastructure there were about 350 refuelling stations.[558]

Since Japan does not have sufficient natural resources to satisfy their domestic demand, almost all of the natural gas is imported. The country is even the world’s largest importer of natural gas, it accounts

[554] Ministry of Economy, Trade and Industry (2008). Cool Earth-Innovative Energy Technology Program. Retrieved from http://www.meti.go.jp/english/newtopics/data/pdf/031320CoolEarth.pdf.
[555] Green Car Reports. (2015). Japan Eases Laws, Boosts Incentives For Hydrogen Fuel-Cell Cars. Retrieved from http://www.greencarreports.com/news/1096324_japan-eases-laws-boosts-incentives-for-hydrogen-fuel-cell-cars.
[556] Hagiwara, Y., Trudell, C. (2015). Japan's Plans to Fuel World's Cleanest Cars Hitting Road Block. Retrieved from http://www.bloomberg.com/news/articles/2015-11-29/japan-s-plans-to-fuel-world-s-cleanest-cars-hitting-road-block.
[557] USDA Foreign Agricultural Service. (2015). Biofuels Annual - Market for Liquid Transport Biofuels Remains Steady as Japan Remains Focused on Advanced Fuels. Retrieved from: http://gain.fas.usda.gov/Recent%20GAIN%20Publications/Biofuels%20Annual_Tokyo_Japan_7-13-2015.pdf.
[558] Sato, M. (2010). NGV (Natural Gas Vehicle) in Japan. Retrieved from https://eneken.ieej.or.jp/data/3094.pdf.

for 35% of the roughly 250 million-ton global LNG market.[559] At the moment there is a 4-step market reform under way that foresees a full liberalization (2016) of the retail market and a full de-control of electricity tariff (2018-2020). The LNG buyers (= utilities) will be exposed to more competition in the domestic market and thus, more pressure for cost reduction.[560]

However, gas makes up less than 1% in the transport sector, being below the OECD average of 2%. The Japan Gas Association estimates that Japan is to have 500,000 vehicles running on LNG or CNG by 2030, about 20% of all trucks. However, the necessary infrastructure still has to be built. After the GEJE the government took measures to eventually achieve 10% of the 300,000 trucks on Japanese roads to switch to LNG from diesel.

LPG accounts for about 5% of primary energy consumption. Especially, since the Great East Japan Earthquake (GEJE) the production of LPG rose exponentially. The majority of Japanese taxis run on LPG.[561] However, the LPG remains a decreasing market that has lost momentum.

There are no subsidies offered by the government for NGVs. On the opposite, there is a plethora of different restrictions for NGVs and CNG stations. This is also mirrored by the industry which does not put any importance on the development of NGVs.[562]

3.5.4.5 SWOT Analysis

Strengths	**Weaknesses**
• Strong government support: tax incentive for biofuels (if fuels contain > 3% bioethanol) effective until 2018, Law to Promote the Usage of Biomass Resources to Produce Biofuels • Established research and demonstration projects for hydrogen infrastructure and successful deployment • Strong cross-sectoral industry engagement • Joint industry efforts to build infrastructure • A lot of innovation by activities in fuel-cell technologies • Lead developer of hybrid vehicles	• Slow uptake of alternative fuels due to lack of economic viability
Opportunities	**Threats**
• A change in perception is seen after the Fukushima catastrophe • National hydrogen market expected to expand to JPY 1 trillion by 2030 • Improvements in airplane fuel efficiency will decrease demand of jet fuel and proportion of biofuels in jet fuel is expected to increase • Improvements in energy efficiency and diversification, especially after the GEJE	• Because of low food self-sufficiency rate there are ongoing discussion on whether to use crops for food or fuel • Natural disasters hamper the development of alternative fuels

[559] Negishi, M. (2016). Japan Steps on Gas in Bid to Reshape LNG Market. Retrieved from http://www.wsj.com/articles/japan-steps-on-gas-in-bid-to-reshape-lng-market-1466325065.
[560] Kutani, I. (2015). Changing Japan's LNG market. Retrieved from http://rei-lng.com/0915PP/IEEJ.pdf.
[561] Japan LP Gas Association. (n.d.) About JLPGA. Retrieved from http://j-lpgas.gr.jp/en/about/index.html.
[562] Sato, M. (2010). NGV (Natural Gas Vehicle) in Japan. Retrieved from https://eneken.ieej.or.jp/data/3094.pdf.

3.5.5 South Korea

3.5.5.1 General Information

South Korea imports 90% of the energy it consumes because the country lacks any substantial natural fuel sources.[563] To reduce its dependence on energy imports and reduce air pollution, the country intends to diversify its energy mix and to push alternative fuels. Biodiesel is the primary choice given the fact that Korea consumes large amounts of diesel (twice the amount of gasoline) and it has the option of producing feedstock domestically. Other than a small amount of ethanol domestically produced for testing purposes, there is no ethanol fuel production in Korea. Most ethanol is imported from Brazil.[564]

It is also part of a wider Korean plan to cut carbon emissions by 11% (3-8 million tons) over the next five years.[565] With respect to cars, the government's goal is to have more than 1 million eco-friendly cars (including BEVs, HEVs, PHEVs, FCEVs) on Korean roads by 2020.[566]

South Korea's energy grid is mostly fossil fuels and nuclear power today, but long-term plans call for 20% to come from a variety of renewable sources, including 10% from fuel cells. Despite familiarity with alcohol technologies and uses, Korea has only recently become interested in exploring their potential as an alternative fuel source for the transportation sector.

In 2013, 33,500 NGVs were registered in Korea.[567]

3.5.5.2 Research, Development & Innovation

As South Korea's energy policy paradigm has focused on the development of green energies, the government has funded several algae biofuel R&D consortia and pilot projects through the Ministry of Science, ICT and Future Planning's Advanced Biomass R&D Center. Three major programs have been launched since 2009: CORE 1 – Novel strain isolation and genetic improvement, CORE 2 – Mass cultivation and harvest of microalgal biomass, and CORE 3 – Conversion of biomass into biofuels and bioproducts. Significant efforts are currently being put on the development of algae-based biofuels.[568]

Environmental engineering researchers at Ulsan National Institute of Science and Technology are working on how to turn human waste into biofuel by breaking it down into a dehydrated and odorless compost-like material. The material is transported to a digestion tank, where a community of microbes convert the waste product into carbon dioxide which is used to feed green algae for biofuel production. Methane, which is released as a by-product, is reserved for use as a heating fuel. Researchers hope to make the system efficient enough to produce a biofuel that is economically competitive.[569]

3.5.5.3 Industry

At the moment, there are two models using fuel cell technology available from Korean car manufacturers: the Hyundai Tucson/ix35 Fuel Cell Car[570] with 600 km range and the Kia FCEV with a 680 km range[571] – the first vehicle to be mass produced in 2013. It sells at about KRW 85 million mainly in Europe and California. The second generation is believed to be released in 2018 for the 2018 Winter

[563] UNICA. (2010). South Korea seeks to quadruple use of biofuels by 2030. Retrieved from: http://www.unica.com.br/news/22711185920333453814/south-korea-seeks-to-quadruple-use-of-biofuels-by-2030/.
[564] EGNRET.(2016). Korea Biofuels Activities. Retrieved from http://www.egnret.ewg.apec.org/Archive/me_korea.html.
[565] Man, I. (2015). South Korea Plans Big Jump in Fuel-Cell Vehicles. Retrieved from http://www.wsj.com/articles/south-korea-plans-big-jump-in-fuel-cell-vehicles-1450152058.
[566] Korean Herald. (2015). Korea promotes sales of hydrogen fuel cell cars. Retrieved from: http://www.koreaherald.com/view.php?ud=20151215001189.
[567] NGV Global News. (2012). Korean Natural Gas Vehicle Numbers on the Rise. Retrieved from: http://www.ngvglobal.com/blog/korean-natural-gas-vehicle-numbers-on-the-rise-0913.
[568] Advanced Biomass R&D. (2016). Company. Retrieved from http://abc.biomass.re.kr/sub020301.
[569] Advanced Biofuels USA. (2016). Scientists Turning Human Waste into Biofuel in South Korea. Retrieved from: http://advancedbiofuelsusa.info/scientists-turning-human-waste-into-biofuel-in-south-korea/.
[570] Hyundai. (2016). ix35 FCEV. Retrieved from http://www.hyundai.at/Showroom/SUV/ix35-FCEV.aspx
[571] KIA (2016). Hydrogen Fuel Cell Cars. Retrieved from: http://www.kia.com/worldwide/about_kia/eco_dynamics/hydrogen_fuel_cell_cars.do.

Olympics in PyeongChang. The new model shall be available for a reduced KRW 60 million.[572]

Beezero, a car-sharing service in Munich, Germany starting in summer 2016, is solely comprised by 50 Hyundai's Tucson/ix35 models. It is run by industrial gases company Linde.[573] In opposition to other international OEMs, Hyundai did not enter any fuel-cell technology partnerships. Moreover, it is facing some disputes with the government since it is solely focusing on FCEVs and not developing any BEV at all.[574]

In mid-2015, the South Korean government decided to boost the biodiesel blend from 2% to 2.5% and to 3% by 2018. Most of the biodiesel produced in the country comes from imported palm oil. Production reached 420,000 tons last year which equals almost a third of total demand.[575] In South Korea, the country's second-largest refiner GS Caltex will invest USD 44 million in a biobutanol plant with construction set to begin later this year. The feedstock was not identified.

GS Caltex, the country's second largest refiner, starts to build a USD 44 million commercial-scale biobutanol facility, during the first half of 2016, based on technology the company has been developing since 2007. For the bio-based production, that has already begun in its pilot facility, GS Caltex's will use corn and cassava as feedstock. The facility is also expected to serve as an incubator for other bio-based start-ups.[576]

3.5.5.4 Market

South Korea already has the world's largest fuel-cell plant, in Hwasung City occupying only 5,1 acres of land but providing 59 megawatts of continuous electricity to the grid. It is managed by POSCO Energy, South Korea's largest independent power producer.[577]

Ulsan, home of Hyundai's complex including its fuel-cell production, is on its way to become South Korea's pilot hydrogen city producing 60% of its hydrogen demand. In 2013, 140 families began using hydrogen to meet all their energy needs. South Korea's federal fuel-cell budget for 2014 was USD 30.9 million. Its annual hydrogen-producing capacity of 1.5 million tons is slightly behind Japan's (1.8 million tons) and far behind the U.S. (21 million tons).[578] At the end of 2015, there were about 50 fuel-cell vehicles on South Korean roads. Considering this comparatively low number, the Ministry of Trade, Industry and Energy has announced plans to increase this number to 9,000 by 2020 and to 630,000 by 2030 which equals one out of ten cars sold annually. To reach these goals the government is putting a purchase incentive in place worth KRW 27.5 million to each buyer, in addition to tax exemptions. Their goal is to bring down the price of each vehicle to KRW 35 million, cut carbon emissions by 4.4 million tons and reduce 5,500 tons of other pollutants.[579]

As for infrastructure, the number of refuelling stations is planned to increase from 10 at the end of 2015 to 80 by 2020 and 520 by 2030.[580] The government will provide KRW 1.5 billion of subsidies per station. The time it needs for refuelling is about three minutes. [581]

[572] Pulse. (2016). Korea to up incentives to be powerhouse in hydrogen, electric vehicle. Retrieved from: http://pulsenews.co.kr/view.php?year=2016&no=488893.
[573] Autoblog. (2016). The world's first fuel cell car sharing program launches in Germany. Retrieved from: http://www.autoblog.com/2016/04/10/world-first-fuel-cell-carsharing-program/
[574] Hybrid Cars. (2016). Hyundai Going Solo on Hydrogen Fuel Cell Vehicles. Retrieved from: http://www.hybridcars.com/hyundai-going-solo-on-hydrogen-fuel-cell-vehicles/.
[575] Biofuels Digest. (2016). Biofuels Mandates Around the World: 2016. Retrieved from: http://www.biofuelsdigest.com/bdigest/2016/01/03/biofuels-mandates-around-the-world-2016/.
[576] Biofuels Digest. (2016). South Korea's GS Caltex to start construction on USD 44 million biobutanol plant in H1. Retrieved from: http://www.biofuelsdigest.com/bdigest/2016/03/24/south-koreas-gs-caltex-to-start-construction-on-44-million-biobutanol-plant-in-h1/.
[577] Fuel Cell Cars. (2016). South Korea's Ambitious Plans for Hydrogen—Power Plants and Cars. Retrieved from: http://www.fuelcellcars.com/south-koreas-ambitious-plans-for-hydrogen-power-plants-and-cars/.
[578] Fuel Cell Cars. (2016). South Korea's Ambitious Plans for Hydrogen—Power Plants and Cars. Retrieved from: http://www.fuelcellcars.com/south-koreas-ambitious-plans-for-hydrogen-power-plants-and-cars/.
[579] Korean Herald. (2015). Korea promotes sales of hydrogen fuel cell cars. Retrieved from: http://www.koreaherald.com/view.php?ud=20151215001189.
[580] Man, I. (2015). South Korea Plans Big Jump in Fuel-Cell Vehicles. Retrieved from http://www.wsj.com/articles/south-korea-plans-big-jump-in-fuel-cell-vehicles-1450152058.
[581] Korean Herald. (2015). Korea promotes sales of hydrogen fuel cell cars. Retrieved from http://www.koreaherald.com/view.php?ud=20151215001189.

Hydrogen-fuelled bus will be available by early 2017.[582] The government targets the shipment of 10,000 hydrogen fuelled cars for public transportation with longer mileage, such as buses and taxies, for domestic supply and another 14,000 units for exports.[583]

When comparing the most relevant alternative fuels, South Korea is the world's fourth biggest market for vehicles running on LPG technology with 2.3 million and almost 150,000 newly registered LPG cars in 2014 accounting for 9% of total new registrations.[584] Also, about 95% of all taxis run on LPG accounting for 40% of the total auto-gas consumption. However, most cars introduced ten years ago with the first wave of LPGs are phasing out and are not replaced with new LPGs. This is mainly due to price disadvantages over other fuels. Therefore, the LPG market has been experiencing a slow decline over the past few years. However, in 2017 a new system, the LPG Direct Injection engine system, developed within the Eco-Star Project is expected to be launched.[585]

The country is also catching up on hydrogen technology. However, it is neither a global market leader yet nor is the topic high on the government's agenda. Most of the efforts are undertaken by the industry without governmental support.[586]

Korea's transport sector makes up 2.6% of the domestic gas demand. Out of the around 43,000 registered CNGs there are about 30,000 buses, accounting for 78% of all CNG vehicles, of which 10,000 are deployed in Seoul.[587] In March 2016, the government expressed plans to phase out all 30,000 CNG and replace them by FCVs over the next 15 years.[588] There are about 2,235 CNG hybrid busses currently in operation in Seoul. Compared to conventional compressed natural gas buses, CNG hybrid buses can reduce the fuel cost by 34.5% and carbon emissions by 30%.[589]

3.5.5.5 SWOT Analysis

Strengths	**Weaknesses**
• Strong industrial efforts by major OEMs • First mass produced FCEV • Academic research in yet unknown fields • World's largest fuel-cell plant • Government pushing fuel-cell technologies with subsidies, purchase incentives and tax exemptions • Increasing usage of biogas blends and LPG (direct injection) for public short- and long-distance buses	• No domestic ethanol production • Energy grid is mostly fossil fuels and nuclear power • Despite experience with alcohol technologies, Korea has become aware of potential only recently; there is no support from the government

[582] Pulse. (2016). Korea to up incentives to be powerhouse in hydrogen, electric vehicle. Retrieved from http://pulsenews.co.kr/view.php?year=2016&no=488893.
[583] Pulse. (2016). Korea to up incentives to be powerhouse in hydrogen, electric vehicle. Retrieved from http://pulsenews.co.kr/view.php?year=2016&no=488893.
[584] International Energy Agency (2015). Hybrid and Electric Vehicles – The Electric Drive Delivers. Annual Report of the Implementing Agreement for Co-operation on Hybrid and Electric Vehicle Technologies and Programmes, p. 234
[585] Auto-Gas.net (n.d.) Strategies for growing the Autogas market in Korea. Retrieved from http://auto-gas.net/newsroom/strategies-for-growing-the-autogas-market-in-korea/.
[586] European Commission. (2016). Alternative Fuels and Infrastructure in Seven Non-EU Markets. Retrieved from http://ec.europa.eu/transport/themes/urban/studies/doc/2016-01-21-alternative-fuels-and-infrastructure-in-seven-non-eu-markets.pdf.
[587] NGV Global News (2012). Korean Natural Gas Vehicle Numbers on the Rise. Retrieved from http://www.ngvglobal.com/blog/korean-natural-gas-vehicle-numbers-on-the-rise-0913.
[588] Walker, A. (2016). South Korea ditches gas vehicles for fuel cells. Retrieved from http://interfaxenergy.com/gasdaily/article/20061/south-korea-ditches-gas-vehicles-for-fuel-cells.
[589] 5678 Seol Metropolitan Rapid Transit Corporation. (2016). Organization. Rerieved from http://www.smrt.co.kr/main/publish/view.jsp?menuID=002005005.

Opportunities	Threats
• Dependency on energy imports is a strong driver for energy diversification; about 90% are imported • Government to boost biodiesel blend to 3 % by 2018	• Huge dependency on energy imports: 90 % of demand is imported

3.5.6 United States of America

3.5.6.1 General Information

In 2014, greenhouse gas emissions from transportation were considered the second largest factor of U.S. greenhouse gas emissions, beyond the electricity sector. Greenhouse gas emissions from transportation have increased nearly 17% since 1990, mainly due to increased demand for travel.[590]

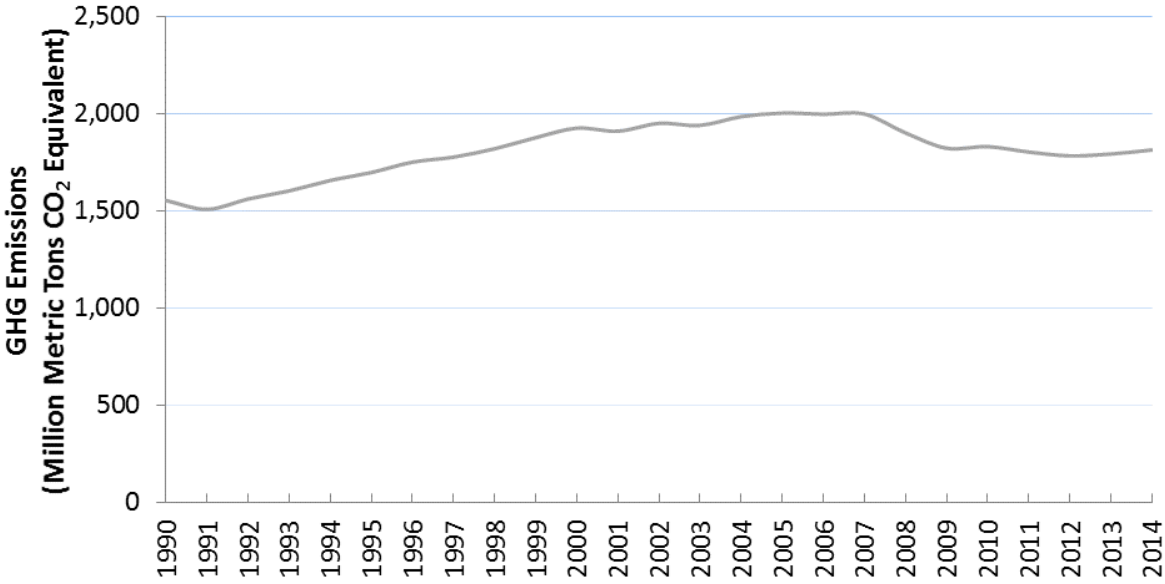


Figure 31: Greenhouse gas emission from Transportation in USA *(Note:* Emissions involved in the consumption of electricity for transportation activities are included above, but not shown separately (as was done for other sectors). These indirect emissions are negligible, accounting for less than 1% of the total emissions shown in the graph. Note: All emission estimates from the Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2014.)

EPA's vehicle greenhouse gas rules will save consumers USD 1.7 trillion by 2025 and eliminate six billion metric tons of GHG pollution. EPA and the National Highway Traffic Safety Administration (NHTSA) are taking coordinated steps to promote and enhance the production of a new generation of clean vehicles from the smallest cars to the largest trucks.

The agencies finalized standards to extend the light-duty vehicle GHG National Program for model years 2017-2025. Together, the final standards are projected to result in an average industry fleet-wide level of 163 grams/mile of carbon dioxide (CO2) in model year 2025, which is equivalent to 54.5 miles per gallon (mpg) if achieved exclusively through fuel economy improvements. The program is projected to:

- Cut 6 billion metric tons of GHG over the lifetimes of the vehicles sold in model years 2012-2025
- Save families more than USD 1.7 trillion in fuel costs
- Reduce America's dependence on oil by more than 2 million barrels per day in 2025

[590] United States Environmental Protection Agency (2016). Sources of Greenhouse Gas Emissions. Retrieved from: https://www3.epa.gov/climatechange/ghgemissions/sources/transportation.html.

As part of the 2017-2025 standards rulemaking, EPA made a commitment to implement together with NHTSA and the California Air Resources Board, a Midterm Evaluation of the longer-term standards for model years 2022-2025.[591]

EPA is also responsible for the development of regulations, in order to ensure that transportation fuels sold in the United States contains a minimum amount of renewable fuel. The Renewable Fuel Standard (RFS) regulations were developed in collaboration with distillers, renewable fuel producers and many other stakeholders. The RFS program, which was authorized under the Energy Policy Act of 2005 and expanded under the Energy Independence and Security Act of 2007, sets the foundations for major reductions of GHG emissions from the use of renewable fuels, for the reduction of the imported petroleum, and for the development of USA renewable fuels sector.[592]

3.5.6.2 Research, Development & Innovation

On June 6, 2016, the Energy Department (DoE) announced USD 22 million investment for the support of research, development, and demonstration of innovative plug-in electric vehicle (PEV) and direct injection propane engine technologies, as well as community-based projects for the adoption of vehicles that operate on fuels such as biodiesel, electricity, E85, hydrogen, natural gas, and propane, as well as the fuelling infrastructure needed to support them. [593]

Led by community-based partnerships and key private sector stakeholders, these projects will help promote and develop alternative fuel use nationwide through the collection and sharing of best practices and lessons learned.[594]

As aforementioned in the “Infrastructure” focus area, the Federal Highway Administration invited state and local officials from all over the US to suggest routes in their areas where drivers can charge up electric vehicles and those that run on other alternative fuels, as these vehicles are developing part of US transportation network.

The Fixing America’s Surface Transportation (FAST) Act requires DoT to designate national corridors along major highways for charging facilities, i.e. electric vehicle charging, as well as for hydrogen, propane and natural gas fuelling.

The use of alternative fuels is a major issue for the US as it has committed to reduce greenhouse gas emissions by up to 28% by 2025, and 80% or more by 2050. So, with the promotion of lower-emitting vehicles, alternative fuel and zero-emission corridors will help to reduce vehicle exhaust – a significant contributor to U.S. emissions.[595]

3.5.6.3 Industry

Besides government policies and actions for the development and promotion of alternative fuels in USA and, in parallel, U.S. Environmental Protection departments and agencies, there are also non-governmental organizations addressing fuel-related trends and issues. Many of these organizations represent the Transportation Industry sector. For example, the American Coalition for Ethanol, which is a national organization representing ethanol producers, farmers, commodity organizations, suppliers of goods and services to the industry, rural electric cooperatives, and others supportive of the increased production and use of ethanol.

Regarding hydrogen production and distribution, the major producing states are California, Louisiana, and Texas. Up until now, nearly all of the hydrogen produced in the USA is used for refining petrole-

[591] United States Environmental Protection Agency. (2016). Regulations & Standards: Light-Duty. Retrieved from: https://www3.epa.gov/otaq/climate/regs-light-duty.htm.
[592] United States Environmental Protection Agency. (2016). Regulations & Standards. Retrieved from: https://www3.epa.gov/otaq/climate/regulations.htm.
[593] ENERGY.GOV - Office of Energy Efficiency & Renewable Energy. (2016). DOE Announces USD 22 Million in Funding to Accelerate the Development of Plug-In Electric Vehicles and Use of Other Sustainable Transportation Technologies. Retrieved from: http://energy.gov/eere/articles/doe-announces-22-million-funding-accelerate-development-plug-electric-vehicles-and-use.
[594] ENERGY.GOV - Office of Energy Efficiency & Renewable Energy. (2016). DOE Announces USD 22 Million in Funding to Accelerate the Development of Plug-In Electric Vehicles and Use of Other Sustainable Transportation Technologies. Retrieved from: http://energy.gov/eere/articles/doe-announces-22-million-funding-accelerate-development-plug-electric-vehicles-and-use.
[595] Nadeau, G. (2016). Signs of Things to Come. Retrieved from: https://www.transportation.gov/fastlane/signs-things-come.

um, treating metals, producing fertilizer, and processing foods. So, the primary challenge for hydrogen production is reducing the cost of production technologies to make hydrogen cost competitive with conventional transportation fuels. Both the government and US industry are working on this, by also funding and participating in research and development actions for the reduction of the cost and the environmental impacts of hydrogen production technologies. Hydrogen manufacturing research and development is important to help the United States move from today's components and systems to high-volume, commercially manufactured products.

Industry is also being involved in legislation configuration concerning issues of alternative fuels. For example, the Air Resources Board (ARB) is responsible for conducting rulemakings concerning the adoption and amendment of regulations covering various areas. These rulemakings are brought to the responsible board for consideration and an archive of these "formal" rulemaking documents is retained by rulemaking action.

3.5.6.4 Market

The Alternative Fuels Data Center (AFDC), which is a resource of the U.S. Department of Energy's Clean Cities program, is a source of information about advanced transportation technologies, while also offering transportation decision makers information and tools related to the deployment of alternative fuels and advanced vehicles. The AFDC serves Clean Cities stakeholders, fleets regulated by the Energy Policy Act, businesses, policymakers, government agencies, and the general public. According to the AFDC there are 21,715 alternative fuelling stations available in the USA.[596]

Federal and State governments and alternative fuel providers (natural gas, electricity and propane providers) have legislative and regulatory requirements related to petroleum reduction and the environment. Consequently, government constitutes the largest market for alternative fuels other than electrification. Of the government fleets, the Federal government continues to be the largest user of alternative fuelled vehicles with nearly 190,000 vehicles in the fleet in 2014. Of these vehicles, 97% were light-duty E85 [597] flexible fuelled vehicles consuming just over 12.8 million gasoline equivalent gallons of E85.[598]

Most fleets acquire flexible fuelled E85 vehicles because of their availability and a growing refuelling infrastructure, but the overall majority of alternative fuel consumption remains in the transit agency sector where just over 10,000 heavy duty passenger buses consumed 115 million gasoline-equivalent gallons of natural gas in 2014.

The Federal fleet also consists of vehicles fuelled by ethanol (E85), electricity, natural gas, propane, and hydrogen. In 2012, the U.S. Postal Service phased out a segment of their natural gas fleet, replacing them with more cost-effective E85 flexible fuelled vehicles.[599]

[596] US.DoE. (2016). Alternative Fuels Data Center. Retrieved from: http://www.afdc.energy.gov/.
[597] E85 (or flex fuel) is a term that refers to high-level ethanol-gasoline blends containing 51%-83% ethanol, depending on geography and season (see Fuel Properties and E85 Specifications). It can be used in flexible fuel vehicles (FFVs), which are available from domestic and foreign automakers
[598] US.DoE. (2016). http://www.afdc.energy.gov/fuels/laws/ELEC/US.
[599] U.S. Energy Information Administration. (n.d). 2014 Alternative Fuel Vehicle Data. Retrieved from: http://www.eia.gov/renewable/afv/.

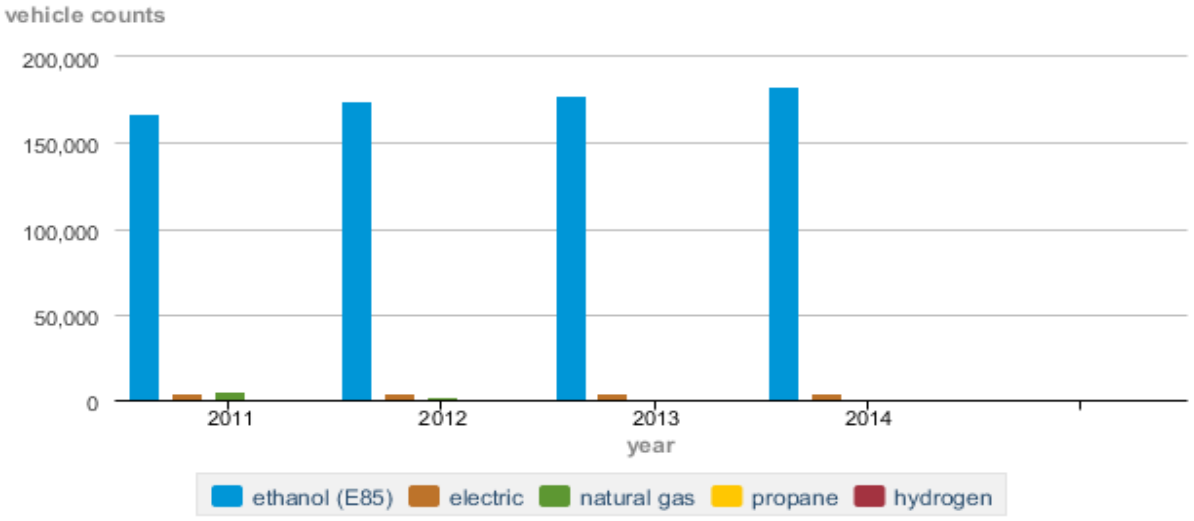


Figure 32: Federal fleet AFV inventory by fuel type *(Source: US Energy Information, EIA-886 Survey; Federal Automotive Statistical Tool)*[599]

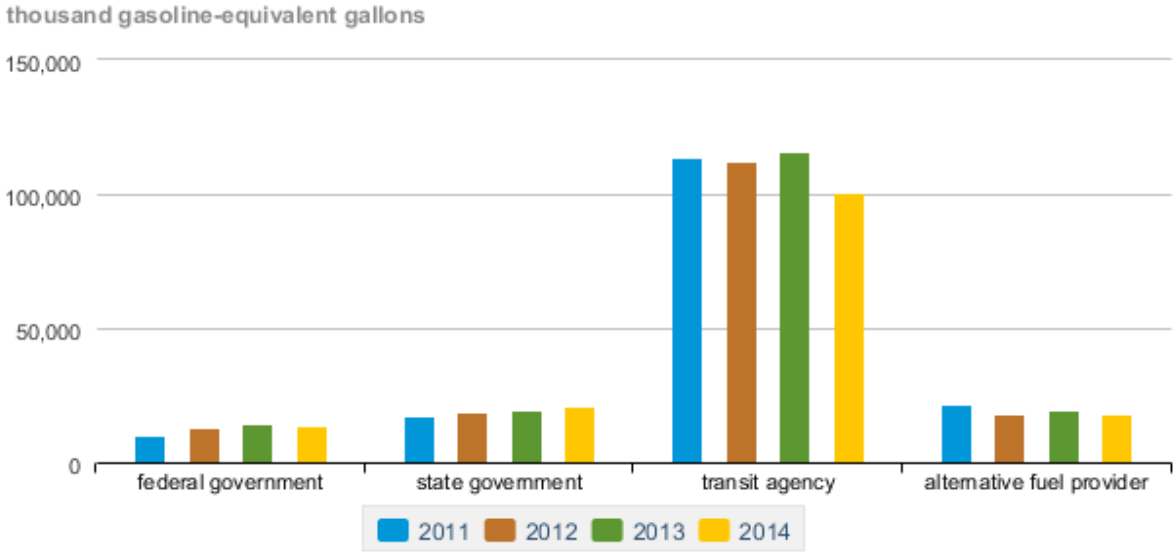


Figure 33: Total alternative fuel consumption by fleet *(Source: US Energy Information, EIA-886 Survey; Federal Automotive Statistical Tool)*[599]

The alternative fuels market in the United States for 2015 is shown in the table below.

Fuel Type	Automobiles	Vans & Minivans	Pickup Trucks	Light Duty Trucks & SUVs	Medium and Heavy Duty Trucks	Other On Road	Total
Compressed Natural Gas (CNG)	0	w	w	0	w	0	**6,805**
Electricity (EVC)	68,234	0	0	w	w	w	**68,560**
Ethanol, 85 Percent (E85)[1]	438,849	w	w	366,601	0	0	**1,652,980**

Fuel Type	Automobiles	Vans & Minivans	Pickup Trucks	Light Duty Trucks & SUVs	Medium and Heavy Duty Trucks	Other On Road	Total
Hydrogen (HYD)	0	0	0	0	0	0	**0**
Liquefied Natural Gas (LNG)	0	0	0	0	0	0	**120**
Liquefied Petroleum Gas (LPG)	w	w	102	0	w	0	**3,119**
Diesel-Electric Hybrid (DSL)[2]	0	0	0	0	0	0	**545**
Gasoline-Electric Hybrid (GAS)[3]	w	0	w	w	0	0	**343,022**
Total	**829,791**	**354,506**	**496,622**	**384,536**	**6,136**	**14**	**2,075,151**

The U.S. Department of Energy's (DoE's) Clean Cities program is supporting actions for the elimination of petroleum use in transportation. With almost 100 local coalitions involved in the Clean Cities program, consisted of businesses, fuel providers, vehicle fleets, state and local government agencies, community organizations etc. nearly 15,000 stakeholders participate the program and through their collective efforts are contributing to Clean Cities' goals and accomplishments.

Clean Cities coalitions and stakeholders have saved more than 7.5 billion gallons of petroleum since the beginning of this initiative in 1993. They have also helped deploy hundreds of thousands of alternative fuel vehicles, fuelling stations as well as facilitate the entry of new transportation technologies into the marketplace. Clean Cities' efforts connect state, local and national collaborations. Over the years, partnerships and projects have significantly increased the availability of alternative fuels and infrastructure, and enabled a growing number of fleets to choose alternative fuel vehicles (AFVs).

The program has awarded nearly USD 400 million through the U.S. Department of Energy funding programs, providing resources to help communities take over more than 500 alternative fuels and vehicle projects. Close to 260 million people (82% of the total U.S. population) live inside the boundaries of Clean Cities coalitions.[600]

3.5.6.5 SWOT Analysis

Strengths	Weaknesses
• Favorable legislation • Abundant domestic supplies of natural gas • Very strong standard setting, e.g. by the California Air Resources Board • Many efforts put in diversification of energy grid	• The absence of a national infrastructure that can support public and private use of the full portfolio of alternative fuel is not good for cross-state operation • U.S. Government sector is the only robust market for alternative fuels such as natural gas • The marketplace is stagnant for vehicles using alternative fuels, other than electrification • Consumer lack understanding of the advantages of using alternative fuels other than electrification • Most government and private resources are focused on electrified vehicle investments • Excessive transport and processing costs for biofuels thereby restricting the size of biofuel markets

[600] US DoE. (2016). Clean Cities. Retrieved from: https://cleancities.energy.gov/

Opportunities	Threats
• Alternative Fuels Data Center providing information (on costs, impact, etc.) for citizen information in use • Right approach for the truck business, long distance coaches (logistics)	• Electrification of vehicles is the primary focus of private capital investment, thereby preventing other alternative fuels from gaining traction • Alternative fuels suffer from an image problem in comparison to electrification

3.6 Maturity Degree

Through the state-of-play analyses as well as the SWOT analyses the maturity degree of an integrated transport system could be assessed for each Focus Area in each country under study. An estimation of Europe's state of transport integration was undertaken in addition in order to be able to gain a comprehensive understanding of the global state of Focus Areas under study.

The advancement in each Focus Area was graded on a 5-point scale, reaching from very poor to very good. This approach enables an easy comparison of the state of affairs of all Focus Areas in all countries. All results are accumulated in the following illustration:

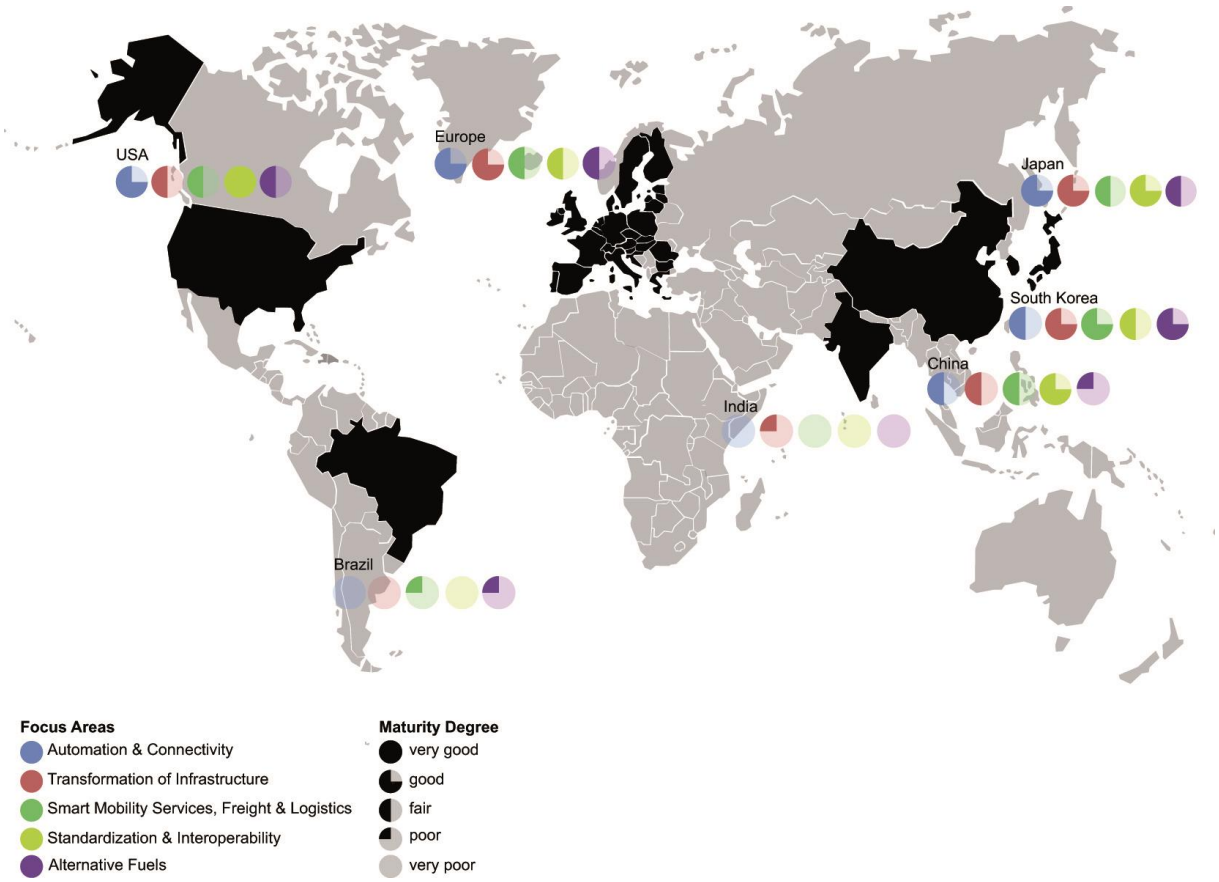


Figure 34: Degree of maturity of the integrated transport system along the focus areas in six countries and in Europe

3.7 Porter's 5-Forces Analysis

The Porter's 5-Forces Analysis is a well-established methodology for studying value chain dynamics. It has been undertaken within one focus area for each country. It analyzes the rivalry among incumbents as well as threats from outside, consisting of new market entrants as well as from potential substitutes. Furthermore, it takes the bargaining power of both suppliers and buyers into account. Through this approach a characterisation of the changes in relevant industries and underlying dynamics shall be achieved.

Figure 35: Porter's 5-Forces Analysis[601]

3.7.1 Brazil: Biofuels Value Chain

Brazil is the one of the largest producer of ethanol fuel and its fuel program is based on the most efficient agricultural technology of sugarcane cultivation in the world[602] as it uses modern equipment, cheap sugarcane as feedstock and reuses residual waste (bagasse) for producing heat and power. Also the processing of sugarcane into ethanol is remarkably efficient yielding more energy compared to standard ethanol plant.[603] The low cost of sugarcane and the initiative by The National Alcohol Program – Pró-Álcool – (Portuguese: 'Programa Nacional do Álcool'), launched in 1975 by the government to phase out automobile fuels derived from fossil fuels, such as gasoline, in favor of ethanol produced from sugar cane – increased ethanol production. The state of São Paulo is the main producer of ethanol and other producers are Goiás, Minas Gerais, Mato Grosso do Sul, Paraná, Mato Grosso, Alagoas, Pernambuco, Paraíba and Espírito Santo[604]. The problems in Brazil's ethanol sector have started since 2009. Climate changes, investment reduction, high production costs, among other reasons, led to a decrease in total production by almost 12% from 2009 to 2011. But in 2013, the initiative and the awareness raising programme emphasized the importance of ethanol consumption in terms of joint creation and economic movement in the country increased the ethanol use.[605]

3.7.1.1 Rivalry Amongst Competitors

Due to its early development and 40-year long experience, the biofuel industry is quite competitive. Most ethanol is produced in the state of São Paulo which is responsible for 51% of the national pro-

[601] Tylenda, E. (2014). Sustainability and the Five Forces Model. Retrieved from: http://www.sasb.org/five-forces/
[602] Garten Rothkopf (2007). "A Blueprint for Green Energy in the Americas". Inter-American Development Bank. 2008-08-22. See chapters Introduction (pp. 339–444); Pillar I: Innovation (pp. 445–482)
[603] Brazil Institute. (2007). The Global Dynamics of Biofuels. Retrieved from: https://www.wilsoncenter.org/sites/default/files/Brazil_SR_e3.pdf
[604] Farah, A.(2015). Ethanol Market in Brazil. Retrieved from: http://thebrazilbusiness.com/article/ethanol-market-in-brazil.
[605] Farah, A.(2015). Ethanol Market in Brazil. Retrieved from: http://thebrazilbusiness.com/article/ethanol-market-in-brazil

duction – 15 billion liters in 2009 and 11.8 liters in 2011.[606] The state of São Paulo is followed by Goiás (11.7%), Minas Gerais (9,1%), Mato Grosso do Sul (7.1%), Paraná (6.1%), Mato Grosso (3.5%), Alagoas (3.4%), Pernambuco (1.6%), Paraíba (1.43%) and Espírito Santo (0.86%).[607]
Sao Martinho Group in Brazil is one of the largest producers of hydrous and anhydrous ethanol. Biosev also produces hydrous and anhydrous ethanol (along with sugar) and supply to large clients from diverse sectors such as Petrobras, Raízen and Ipiranga. Other producers include Cooperativa de Produtores de Cana-de-Acucar, Acucar e Alcool do Estado de Sao Paulo (Copersucar), Odebrecht Agroindustrial (previously ETH Bioenergia), Raízen, Cosan, Biosev Bioenergia (Dreyfus), Bunge, GranBio, Petrobas (state-run), BP Biofuels, and Sao Martinho.[608]

3.7.1.2 Threat of New Entrants

Substitute of traditional biofuel includes different production technologies by different companies. GranBio and Rhodia are producing bio n-butanol, made from sugar cane straw and bagasse, the same raw material that is used to manufacture second-generation ethanol and which is abundant in Brazil. Similarly, Cobalt Technologies and Rhodia also announced the joint development and operation of a biobutanol demonstration facility in Brazil. [609] A factory of Biofuel from seaweed in Brazil is planning to be set up by Austrian firm SAT on a sugar cane plantation that yields ethanol and produces 1.2 million liters of algae-based biofuels annually.[610] Corn ethanol is also available in Brazil by Alden, Iowa-based Summit Agricultural Group that started construction of the few corn-based ethanol plants in Lucas do Rio Verde in Mato Grosso, an agricultural state in west-central Brazil. The 60-million-gallon plant is expected to start production sometime in 2017.[611] Cellulosic ethanol [612], an ethyl alcohol produced from cellulose (the stringy fiber of a plant) rather than from the plant's seeds or fruit, is also produced in Brazil. Raizen plans to invest USD 102 million in the add-on cellulosic ethanol plant that will be attached to its Costa Pinto facility in Piracicaba.[613] It is a joint venture between Shell and Cosan, is the world's biggest producer of cane ethanol and Brazil's fifth largest company by revenue.[614]

3.7.1.3 Threat of Substitutes

New entrants for bio-fuel in Brazil are those which try to replace its use through electric or gas vehicles. Electric vehicles (EV) could also be an option for the sustainable urban transport in Brazil, but it is still immature and has lower demand. Renewable Natural Gas (RNG) in Brazil is harvested from waste product and wastewater, contributing to emissions reduction and with potential generation and application in a decentralised manner, which is also suited to rural and other off-grid fuelling of local fleets. The company CIBiogás (International Centre for biogas) supplied more than 40 vehicles of Itaipu Binacional and intends to double capacity by end of 2016. Biomethane vehicles was received under the GNVerde brand in Rio Grande do Sul. With the support of the State Gas Company (Sulgás), it has being tested in vehicles since 2013, but the distribution company was awaiting the decision of the ANP (National Agency of Petroleum, Natural Gas and Biofuels) to start selling this alternative fuel. E-Bio Fuel-Cell cars by Nissan are also available in Brazil.

3.7.1.4 Bargaining Power of Suppliers

Considering that suppliers to bioethanol producers are farmers and crop owners, their bargaining power is considerably low. They have hardly any influence on prices or who to deliver to.

[606] Farah, A.(2015). Ethanol Market in Brazil. Retrieved from: http://thebrazilbusiness.com/article/ethanol-market-in-brazil
[607] http://thebrazilbusiness.com/article/ethanol-market-in-brazil.
[608] Conectas. (2016). Retrieved from: http://www.conectas.org/.
[609] Biofuel Digest. (2013). Brazil's Big Six in advanced biofuels & chemicals: who's doing what now? Retrieved from: http://www.biofuelsdigest.com/bdigest/2013/09/16/brazils-big-six-in-advanced-biofuels-chemicals-whos-doing-what-now/
[610] Phys.Org. (2012). Brazil to build first algae-based biofuel plant. Retrieved from: http://phys.org/news/2012-07-brazil-algae-based-biofuel.html.
[611] Govenors´ Biofuel Colation. (2016). Iowa company breaks ground in Brazil on corn ethanol plant. Retrieved from: http://www.governorsbiofuelscoalition.org/?p=16815
[612] Biofuels Digest. (2014). Raizen, Iogen commence cellulosic ethanol production in Brazil. Retrieved from: http://www.biofuelsdigest.com/bdigest/2014/12/17/raizen-iogen-commence-cellulosic-ethanol-production-in-brazil/.
[613] Biofuels Digest. (2013). Brazil's Big Six in advanced biofuels & chemicals: who's doing what now? Retrieved from: http://www.biofuelsdigest.com/bdigest/2013/09/16/brazils-big-six-in-advanced-biofuels-chemicals-whos-doing-what-now/.
[614] Ethanolproducer.com. (2016). Retrieved from: http://www.ethanolproducer.com/.

3.7.1.5 Bargaining Power of Buyers

Carmakers in Brazil that use hydrous ethanol fuels are Fiat, Volkswagen, GM, Ford. The availability at different blend levels of ethanol has had a strong impact over consumer choices and technologies offered in the market by manufacturers.[615] Traditionally, drivers choose ethanol to fuel their cars when it is below 70 % of the price of gasoline, as the biofuel extracted from sugar cane yields about 30 % less energy per liter.[616] Until the 2000s, sales of gasoline or ethanol vehicles were driven primarily by fuel prices, with ethanol vehicles dominating sales in the 1980s, and very strong sales of gasoline engines in the 1990s.[617] As a response, in 2003 flex-fuel vehicles (use of ethanol-gasoline mix) was introduced in the market, in order to fulfill consumers' desire to use a cheaper fuel. Also the Brazilian government made mandatory to blend ethanol fuel with gasoline.

The car sales of flex-fuel vehicles keep increasing [618], currently all light commercial vehicles produced in Brazil have the bi-fuel technology, and at least 17 new models imported from Argentina, China, Mexico, Korea and Thailand were adapted with this system in order to adapt the Brazilian need.[619] Between 1979 and 2011, Brazil substituted around 22 million pure gasoline-powered vehicles with 5.7 million neat ethanol vehicles, 14.8 million flex-fuel vehicles and almost 1.5 million flex motorcycles.

3.7.1.6 Conclusion

Brazil's bioethanol industry is extremely dynamic and can look back on a long history. Its success is mainly because of the government's early intervention setting targets for blending traditional gasoline with bioethanol. Further reasons for the industry's success can be attributed to a multitude of different beneficial factors, including fertile soil, suitable water, available land, and low labor costs. However, the industry is also extremely vulnerable to a variety of external influences. The recent economic crisis and the climate change has had a huge impact on the industry.
There are a handful of corporations, both domestic and international, engaging in tough competition. There are a few new entrants who cannot yet compete with the established players. Also, incumbents are the major force behind new technologies developed such as cellulose-based or algae-based ethanol production. As for substitutes, gasoline poses the biggest threats. Other propulsion systems such as battery electric or fuel cell vehicles do not play a role since there is hardly any market for them in Brazil. Suppliers, being farmers and crop owners, do not have a big bargaining power since the huge established companies have the power to dictate the price. Similarly, the bargaining power of buyers is very low, too. The only influencing force seems to be the government regulating the ethanol market.

[615] http://www.theicct.org/sites/default/files/publications/Brazil%20PV%20Market%20Statistics%20Report.pdf.
[616] Freitas Jr., G. (2016). Sugar-Cane Fuel Wins in Brazil as Cheap Ethanol Beats Gasoline. Retrieved from Bloomberg: http://www.bloomberg.com/news/articles/2016-03-01/sugar-cane-fuel-wins-in-brazil-as-cheap-ethanol-beats-gasoline
[617] Theicct.org. (n.d.). Retrieved from: http://www.theicct.org/sites/default/files/publications/Brazil%20PV%20Market%20Statistics%20Report.pdf.
[618] Unica. (n.d.) Retrieved from: http://www.unica.com.br/noticias/show.asp?nwsCode=83CC5EC9-8E69-4C11-9F0E-CBDF9B849AE2.
[619] The Brazil Business. (2016). Ethanol Market in Brazil. Retrieved from http://thebrazilbusiness.com/article/ethanol-market-in-brazil.

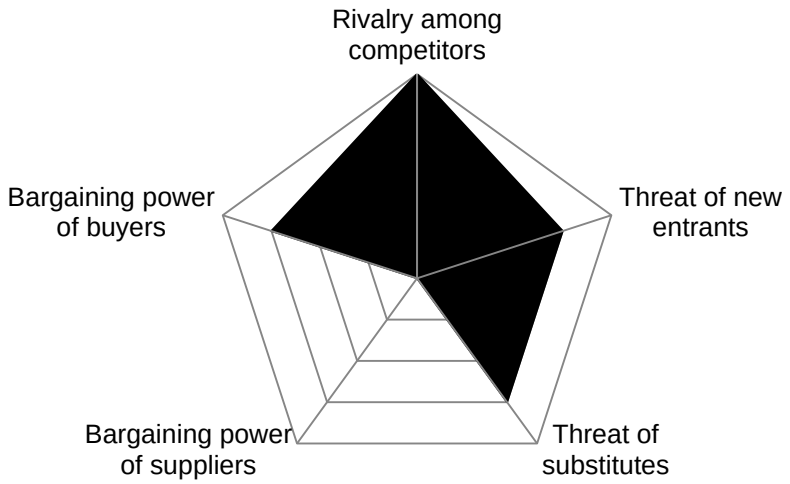


Figure 36: Porter's 5-Forces Analysis on the Biofuels Value Chain in Brazil

3.7.2 China: Smart Logistics Service Value Chain

China is focusing on the development of smart mobility in the transportation sector and mostly in the freight and logistics area. The widespread adoption of the Internet of Things (IoT) applications in China started as early as 2010, with the Smart Cities initiative being a major example. Chinese governmental bodies, such as the National Development and Reform Commission (NDRC), support the development of Smart Mobility and the central government promoting the development of such technology in national policy and investing in the very strong internationally Chinese electronic industry.
Another factor which promotes the adoption and use of smart mobility technologies in China stems from the very intense pollution and congestion problems that exist in the country, which makes it imperative for solutions that will bring relief to the problem. Only for Beijing, the costs of congestion and air pollution are estimated at 7%-15% of the country's GDP. Efficient transport systems (i.e. bus rapid transit) can significantly reduce air pollution and greenhouse gas emissions, help reduce congestion and improve traffic safety.

3.7.2.1 Rivalry Amongst Competitors

There is still high competition to smart mobility by manual labour and traditional operations, due to the current low level of wages. However, the emerging long distance multimodal transport chains (i.e. Silk Road) and the constantly growing urban development of China pushes towards smart mobility solutions.

3.7.2.2 Threat of New Entrants

The threat of new entries is quite big concerning imported know-how, services and products from Europe and (to a lesser extend) USA and Japan. Protection measures from government (that request local cooperation) are in place to control this threat.

3.7.2.3 Threat of Substitutes

C-ITS and IoT constitute currently de facto international standards and it is highly unlikely to be substituted by new, non-compatible technologies. New technologies will build upon those layers. Still, there is always the chance of a new invention/technology in these rapidly evolving technological fields.

3.7.2.4 Bargaining Power of Suppliers

Together with local businesses, many foreign enterprises, mainly IT companies and telecommunication operators, have already started to strongly involve themselves in the field, recognizing the opportunity and demand and entering partnerships with local companies and key player.

3.7.2.5 Bargaining Power of Buyers

The bargaining power is also very high, mainly because such smart logistics solutions are mainly used by big (international) logistics companies and enterprises, which recognize the need and stiff competition coming from abroad. On the other hand there are the municipalities and citizens in major urban centers (i.e. Shanghai, Beijing) that face serious mobility problems (traffic jams, bad air quality) and have enough funds to invest in and use such solutions. The rural part of China is, however, still lacking relevant funds and incentives.

3.7.2.6 Conclusion

Even though manual labour is still quite cheap in China and smart logistics services are quite a new market, it has already been widely diffused and adopted across China. It is mainly driven by China's need to cope with its increasing urbanization and needs to decrease the heavy pollution. The rivalry among smart logistics service providers is still quite, low if not taking the manual labour into consideration. However, there is increasing threat of new entrants from abroad against which the government tries to establish protection. Since it is quite a new market itself, there is no threat of substitution at this point. As for suppliers, their bargaining power is increasing since they recognized the market potential and enter into co-operations with main players. Some buyers have a big bargaining power (logistics companies).

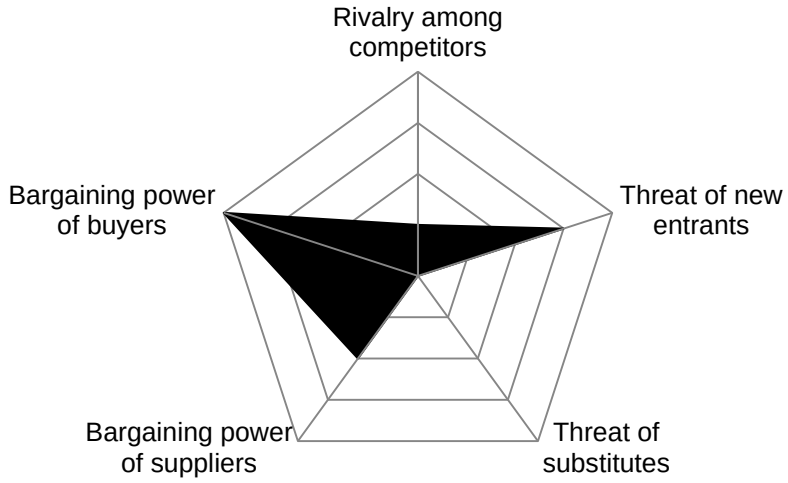


Figure 37: Porter's 5-Forces Analysis on the Smart Logistics Services Value Chain in China

3.7.3 India: Smart Cycle and Auto Rickshaw Hailing Services Value Chain

Rickshaw transportation plays a big role in Indian cities. With respect to auto-rickshaws, Tier-I cities in India (with population greater than 4 million) typically have more than 50,000 vehicles, while in Tier-II cities (with population between 1 and 4 million) have between 15,000 and 30,000 vehicles on average. It is mainly used for inner-city transportation, to make up for the first- and last-mile connectivity to public transportation or to replace private motorized transportation.[620]

[620] World Resource Institute. (2016). Sustainable Urban Transport in India. Retrieved from: http://wricitieshub.org/sites/default/files/sustainable_urban_transport_india_2.pdf.

The rickshaw system is mainly based on individuals rather than on fleet companies. This has resulted in a highly chaotic system that relies on hailing an empty rickshaw from the roadside. This is now about to change because of several start-ups offering smart mobility services. These new GPS-based services have significantly reduced passengers' waiting time, fare negotiation to hail autos or staying on-hold on phone while booking cabs.[621] The increased use of smartphones coupled with low mobile tariffs and mobile internet the market becomes increasingly attractive.[622]

3.7.3.1 Rivalry Amongst Competitors

The main service providers are Pooch-O and G-Auto who cover most of the network of auto rickshaws with their services or apps. Similarly to Ecocab (cycle rickshaw) services, auto rickshaw drivers are registered with their telephone numbers which is used to order their service. Whereas Pooch-O is run by the Delhi government and only available in Delhi, G-Auto is also offered in Gujarat.

3.7.3.2 Threat of New Entrants

From 2011-2016, the taxi-app sector has gained huge popularity owing to the many start-ups (international and domestic) that have entered the Indian market.[623] Besides car sharing, an Indian online transportation network company named Ola is also providing taxi sharing service in 100 Indian cities.[624] Ola has started a pilot on-demand auto rickshaw services too in Bangalore. Users can select cars of their choice.[625]

3.7.3.3 Threat of Substitutes

The substitute for cycle and auto rickshaw hailing services can be the use of public transportation apps – TRAFI. It is the international public transport app that helps people plan city journeys and encourages users to modify their mobility behaviour by giving options to walk or to take train when streets are congested saving time.[626] It gives options for buses, suburban trains, bike and metros and gives route suggestion based on convenience and speed.[627]
Another substitution threats comes from the increasingly popular ride sharing services, such as Uberpool[628] that is already offered in many Indian cities (such as New Delhi, Pune, Mumbai, Chennai and Jaipur etc). After unsuccessful attempts, the company decided to revamp its business and design it similar to Pooch-O by dismissing its 20% commissions imposed on drivers. However, opposed to Pooch-O, Uber imposes fees on users. Uber applied to become a radio-taxi operator. Uber services are offered in 18 cities.[629]

3.7.3.4 Bargaining Power of Suppliers

Since the introduction of mobile rickshaw hailing services, the number of empty trips on the parts of the operator has decreased enormously and improved the overall efficiency of the system. Rickshaw operators have also increased their income by 25-30% and the number of orders by 1 to 2 calls per day and saved the waiting time for customers. Thus, the developers of smart rickshaw service apps are highly dependent on drivers using their service. To keep its drivers, G-auto offers them subsidized

[621] Gadgets 360°. (2015). Delhi Government to Relaunch PoochO App, Cover 90,000 Auto Rickshaws. Retrieved from: http://gadgets.ndtv.com/apps/news/delhi-government-to-relaunch-poocho-app-cover-90000-auto-rickshaws-748216
[622] Move-Forward. (2016). How Mobility Apps are Transforming the Urban Transportation in India. Retrieved from: https://www.move-forward.com/how-mobility-apps-are-transforming-the-urban-transportation-in-india/.
[623] Move-Forward. (2016). How Mobility Apps are Transforming the Urban Transportation in India. Retrieved from: https://www.move-forward.com/how-mobility-apps-are-transforming-the-urban-transportation-in-india/.
[624] Russell, J. (2015, October 13). India's Ola Announces Carpooling Service That Matches Customers Within Social Groups. Retrieved from Techcrunch network: https://techcrunch.com/2015/10/13/indias-ola-announces-carpooling-service-that-matches-customers-within-social-groups/.
[625] Ola (2016).Retrieved from: https://www.olacabs.com/fares
[626] Deloitte (2015). Transport in the Digital Age Disruptive Trends for Smart Mobility. Retrieved from: http://www2.deloitte.com/content/dam/Deloitte/tr/Documents/public-sector/transport-digital-age.pdf
[627] Gadgets now. (2016). Public transportation app Trafi unveiled in Bengaluru and Mumbai. Retrieved from: http://timesofindia.indiatimes.com/tech/apps/Public-transportation-app-Trafi-unveiled-in-Bengaluru-and-Mumbai/articleshow/51822582.cms
[628] Uber. (2016). UberPool. Teile deine Fahrt mit anderen. Retrieved from: https://www.uber.com/ride/uberpool/
[629] https://inc42.com/buzz/uber-resumes-operations-revamped-business-model/

healthcare, insurance and education of their wards.[630] Ecocab offers rickshaw drivers several benefits, such as free health check-ups, accidental insurance and access to credit financing schemes of leading banks. However, they are also provided with work uniforms and have to a follow code of conduct, which, if not followed, can lead to the confiscation of their rickshaw license.[631]

3.7.3.5 Bargaining Power of Buyers

Although cycle rickshaw was a preferred mode of travel in Indian cities, especially for shorter distances, and also served as an affordable means of travel with environmental benefits,[632] problems such as inaccessible residential areas and unorganized network of cycle rickshaws existed.[633] The user of cycle rickshaw using Ecocab services benefit from an organised, intermediate, public transport system at affordable price and saves fuels and time.[634] The compact and flexible design of the cycle rickshaws allows them to comfortably pass through narrow lanes where generally other public transport modes find it difficult to reach.[635]

3.7.3.6 Conclusion

Rickshaws are the most important means of transportation in Indian cities. Therefore, it is no surprise that competition is quite fierce on the market. What was a highly chaotic system seems to change along with innovations such as mobile rickshaw hailing services. Even though the market is oligopolistic, the main providers are in a fierce battle with each other. This has influences on both the bargaining power of suppliers, rickshaw drivers, who benefit from many services offered by the providers to bind them. On the other hand, customers benefit from reduced prices and increased service, thus their bargaining power is high as well. Also the threat of new entrants is really big, since the Indian market is quite attractive in consideration of their increasing middle class and rising wealth. Only the threat of substitute is comparably low. This can be ascribed to the fact that the market is quite new itself.

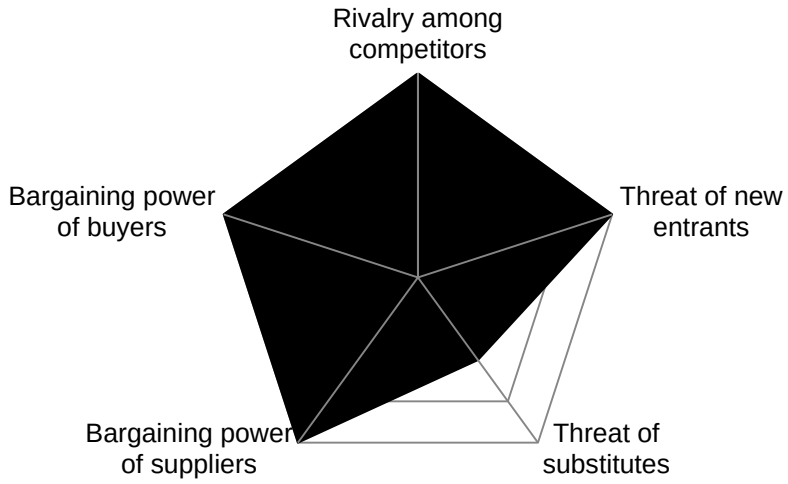


Figure 38: Porter's 5-Forces Analysis on the Mobile Rickshaw Hailing Service Value Chain in India

[630] Times of India. (2016). IIM graduate who drives autorickshaw business. Retrieved from: http://timesofindia.indiatimes.com/city/nagpur/IIM-graduate-who-drives-autorickshaw-business/articleshow/19027194.cms.
[631] The City FX (2012). Fazilka Ecocabs Offers New Paradigm for Non-Motorized Transport in Indian Cities. Retrieved from: http://thecityfix.com/blog/fazilka-ecocabs-offers-new-paradigm-for-non-motorized-transport-in-indian-cities/
[632] Ecocabs (2016). Ecocabs - World's first dial-a-rickshaw scheme...where technology meets tradition. Retrieved from: http://www.ecocabs.org/about/.
[633] Codatu XV. (2016). Fazilka Ecocabs: First “Dial - a - Rickshaw” facility (India). Retrieved from: http://www.codatu.org/wp-content/uploads/ASIJA-Fazilka-Ecocabs_World’s-First-Dial-a-Rickshaw-Service_CODATU.pdf.
[634] Codatu XV. (2016). Fazilka Ecocabs: First “Dial - a - Rickshaw” facility (India). Retrieved from: http://www.codatu.org/wp-content/uploads/ASIJA-Fazilka-Ecocabs_World’s-First-Dial-a-Rickshaw-Service_CODATU.pdf.
[635] Ecocabs (2016). Ecocabs - World's first dial-a-rickshaw scheme...where technology meets tradition. Retrieved from: http://www.ecocabs.org/about/.

3.7.4 Japan: High-speed Train Value Chain

When Japan National Railways (JNR) was privatized in 1987, it was divided into seven independent regional railway companies, together known as Japan Railways Group (JR Group). It comprises JR Central, JR West, JR East on Honshu island, JR Hokkaido, JR Shikoku, JR Kyushu, and JR Freight. Due to privatization, the companies became competitors. This had immediate effects on the operation efficiency, service level and ticket prices. The JR Group runs almost all intercity rail services and the majority of commuter rail services. Shinkansen are only operated by JR and run on separate tracks and platforms (except from the Akita and Yamagata Shinkansen) on Honshu, Kyushu and Hokkaido islands. The Shinkansen network connects Tokyo with most of the country's major cities. In total, there are seven Shinkansen lines.

3.7.4.1 Rivalry Amongst Competitors

Apart from the JR Group there are 16 major private railways run by financially independent companies. Thus, the national high-speed rail market is an oligopoly with minimal competition between the former JNR and private companies that cannot compete with them. As for Shinkansen, JR is the only operator with no competition at all.

3.7.4.2 Threat of New Entrants

The JR Group not only profits from its history of government ownership but also from their long experience. Due to the extreme costs of establishing the necessary infrastructure to run high-speed trains, there are no new entrants in the foreseeable future. Thus, the market structure is very unlikely to change both on the short and on the long run.

3.7.4.3 Threat of Substitutes

Recently, airlines achieved major economical efficiencies and thus show a cost advantage in origin-destination pairs over 500 km. Even though new innovations, such as car sharing, ride sharing, etc. are increasing their market share, they do not pose a threat to Shinkansen trains since they would only offer a more flexible alternative for short distances in urban areas where Shinkansen trains do not run. On medium distances there is no threat either since Shinkansen trains still offer the best value for money.

Regarding freight transportation, railway makes up only 4% of the overall freight market. Trucks and ships remain the most used means of freight transportation. So, neither for the passenger nor for the freight market there are considerable substitutes.

3.7.4.4 Bargaining Power of Suppliers

The JR Group recently made some efforts to extend their supplier base internationally. However, the suppliers bargaining power is very low due to the oligopolistic market and the concentrated power within the JR Group.

3.7.4.5 Bargaining Power of Buyers

Shinkansen trains are very competitive. Thus, railway is one of the most used means of passenger transportation. Especially when owning the Japan Rail Pass Shinkansen trains are very cost-effective. The cost per kilometer is around JPY 20 for short distances, and decreases to under JPY 10 for long distances. For high-speed trains, such as Shinkansen, a supplement fee has to be paid in addition to the base fare; they range from around JPY 800 for short distances to around JPY 8,000 for long distances. Nonetheless, the bargaining power is quite high, mainly due to the citizens' price sensitivity. If there was a considerable alternative, consumers would compare alternatives and opt for the most economic alternative.

3.7.4.6 Conclusion

The formerly state-owned JR group was divided into seven privately owned enterprises allocated to different geographical areas. So, even though they were privatized they are not perceived as competi-

tors. Apart from the JR Group there are 16 train companies. However, the JR Group is the only one operating Shinkansen trains. So, there is an oligopolistic high-speed train market and a monopolistic Shinkansen market. Since it is extremely expensive to both build the necessary infrastructure as well as the trains themselves, the only possibility for new entrants would be to operate services on existing tracks owned by the JR group. Hence, there is no real threat from new entrants. As for substitutes, there is only a threat in long distances due to air fares becoming cheaper. For medium distances Shinkansen are still the most competitive means of transportation. Whereas the suppliers' bargaining power is quite low because of the JR groups standing, the buyers' bargaining power is comparably high due to them being very price sensitive and open to switching to substitutes.

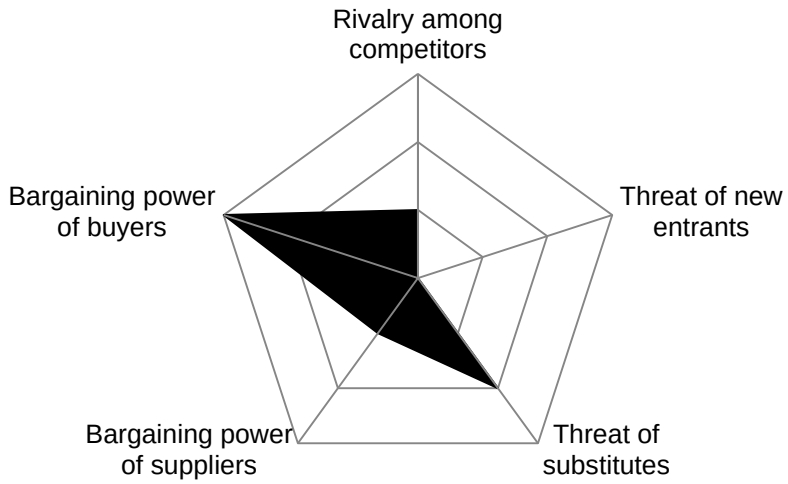


Figure 39: Porter's 5-Forces Analysis on the High-speed Train Value Chain in Japan

3.7.5 South Korea: Smart Mobility Platform Value Chain

South Korea benefits from different factors. First, the country is quite small. Thus, ride and car sharing alternatives are also competitive in inter-city travelling. Second, the coverage of smart devices (such as smartphones) is really high. Third, the country's population has a huge affinity towards new and innovative technologies. Fourth, South Korea has a strong IT and electronics industry. Fifth, it does not have many cultural differences within the country. These are all reasons pushing innovation towards smart mobility. The main actor in that business is the Kakao Corporation which has been mostly known for their communication app KakaoTalk. When Uber faced some legal problems in South Korea, Kakao Corp. started to enter the smart mobility market and managed to outlaw Uber by only granting licensed taxi drivers (Uber did not care at that point) the right to register as drivers. However, in 2016, Kakao Driver, a service exactly like Uber's, was introduced together with Kakao Pay easing the financial handling of rides.

3.7.5.1 Rivalry Amongst Competitors

The communication service provider Kakao Talk extended its product portfolio by different mobility services such as Kakao Navi, Kakao Metro, Kakao Maps, Kakao Bus, and Kakao Taxi. They thus became a huge competitor of Uber on the South Korean market. One of the reasons for Kakao's success is their understanding of the Korean market and their customers who tend to prefer national brands.

Kakao has a multitude of different competitors comprising mainly international messenger applications, especially from China (Tencent WeChat) and Japan (Line). However, when it comes to mobility services Kakao Corp. enjoys a huge share on the Korean market, especially after the company successfully acquired many other services such as SeoulBus. Another influential company in South Ko-

rea, Naver (the company has the biggest share in online searches), also offers mapping services and thus, enters into competition with Kakao Corp. However, their product portfolio on the smart mobility market is limited to mapping services.
Since there is only competition in specific fields (Uber in ride sharing and Naver in mapping services) the rivalry is quite low. The market is dominated by Kakao Corporation which offers a multitude of different services in one single platform easing the usability and increasing the attractiveness of its services.

3.7.5.2 Threat of New Entrants

Because of the particularity of the Korean market where customers prefer local brands, it is very hard for new entrants from abroad to establish business in Korea. This can be seen by Uber facing major legal difficulties. An even more prominent example is Line, the Japanese subsidiary of the Korean brand Naver that is not perceived as Korean. Hence, there is no threat of new entrants in the foreseeable future.

3.7.5.3 Threat of Substitutes

To this point, there are no substitute services to the smart mobility services. Since such services have not been on the market for too long themselves, the likelihood of substitutes in the mid- to long-term future is quite high though.

3.7.5.4 Bargaining Power of Suppliers

Mobile application mobility services seem to disrupt the entire passenger transportation industry. However, suppliers – in this case taxi drivers (Kakao Taxi) and private ride share providers (Kakao Driver) – seem to not get a big say. Even though Kakao Taxi only allowed licensed taxi drivers to register as drivers and thus protected the taxi industry, the application Kakao Driver works exactly against this business model. Private drivers are not only increasingly exploited but also push down prices since they engage in ultimate competition with other drivers and are not required to pay corporate and service taxes.

3.7.5.5 Bargaining Power of Buyers

As with the majority of new mobile application-based services, consumers have a very high bargaining power. This is mainly due to the mobile online-to-offline applications services being very sensitive to usage behavior and the comparably fast response rate of technology developers to react on it. So, users rejecting or not accepting the services (for whatever reasons) will change the whole development of the service. Thus, the bargaining power is extremely high.

3.7.5.6 Conclusion

Because the smart mobility service market is a quite young market it might be expected to be quite dynamic. However, even though Korea has the highest density of smartphones and a huge affinity towards new technology it seems to not hold true for its market. This is mainly due to its citizens preferring local brands. Kakao Corporation, a company that became quite popular based on their mobile communication applications successfully turned this into a business opportunity and outlawed international competitor Uber. Even though Uber is still on the market and Naver poses some threat in the mapping service market, Kakao Corporation benefits from its all-in-one platform covering car and ride sharing services as well as payment services. Out of all these reasons it is quite hard for both domestic and international companies to enter the market. Since the smart mobility service market is relatively young, there are no substitutes so far. How this develops remains to be seen. As for bargaining power of suppliers and buyers Kakao Corporation is in a similar position as car and ride sharing service providers in other countries. They have a dictating role towards their suppliers but are very sensitive to their users' behavior. Thus, an almost inexistent bargaining power of suppliers opposes a huge bargaining power of buyers.

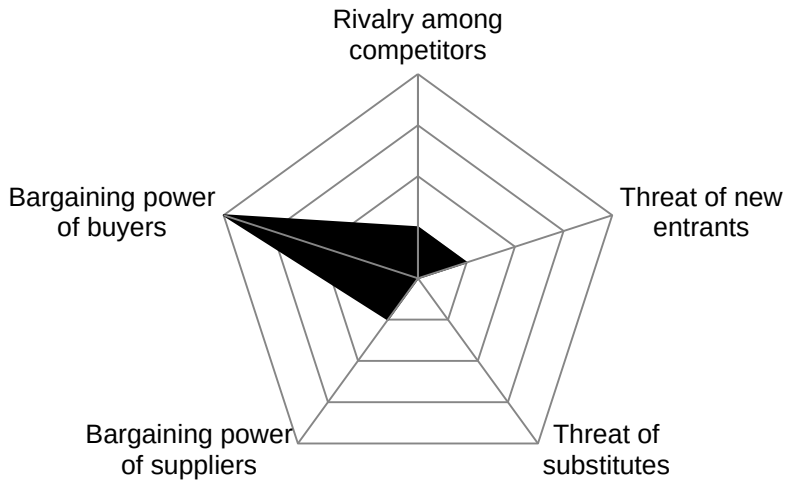


Figure 40: Porter's 5-Forces Analysis on the Smart Mobility Platforms Value Chain in South Korea

3.7.6 USA: Automated Driving Value Chain

The US automotive industry has a long history with many powerful companies and well-established competition. The development towards automation seems to question the established and known value chain due to the entrance of new players and substitute products. Especially in light of developments towards mobility as a service there is a multitude of substitutions. The incumbents comprise of the established automotive manufacturers (OEMs) such as GM, Chrysler, and Ford. Since these companies are continuously innovating their products, their developments towards vehicle automation seem logical. New entrants mainly comprise IT industries such as Google and Apple disrupting the existing value chain. Substitutes are ride-sharing services as well as public transportation providers. Suppliers play a critical role in the evolution of vehicle automation. Even though manufacturers push brand-specific quality and performance with in-house engineering, automotive suppliers have played and still play a big role in the advancements of driver assistance systems necessary for vehicle automation. Buyers of automated vehicles are either individuals or car fleet operators including logistics companies. Both groups do not only seem to have high expectations towards this new technology but also benefit from increasing choice of companies.

3.7.6.1 Rivalry Amongst Competitors

Because of the highly competitive environment in the automotive industry, existing OEMs are constantly striving for competitive advantages. The development of state-of-the-art technology is certainly only one them, albeit the most important. Therefore, their efforts for early deployment are quite strong. Their biggest challenges are to critically balance competitive advantage with first deployment risk, to keep new entrants off the market, and to cope with the immense rivalry among established players.

3.7.6.2 Threat of New Entrants

New entrants, comprised of IT companies and startups, are targeting the personal mobility market because of the industry’s high profitability. Even though these companies do not have any expertise in car manufacturing there involvement is expected to have a huge impact on the automotive industry by shaking up their interlocked technology paths. Moreover, IT industries have massive financial resources to draw from.

3.7.6.3 Threat of Substitutes

The threat of substitutes grows to the same degree as technology for automated driving develops. New mobility services, such as ride sharing, are offered by the hour. Both the widespread use of complementary devices, such as smartphones, as well as changing consumer behavior, such as preferring using over owning, will further increase their threat. Incumbents will have to find a unique selling proposition to be able to counter the threat. Apart from mobility services, public transportation poses another substitution risk. However, public transport use in the US is generally very low. Therefore, the threat of substitutes is perceived to be in mid-range based on huge threat of new mobility services but only little threat from public transportation.

3.7.6.4 Bargaining Power of Suppliers

Suppliers are perceived to be key enablers in the field of automated driving since it is them who have the expertise in necessary recognition and decision-making technology, such as sensors, cameras, radars, etc. However, similar to the current situation their bargaining power is expected to remain unchanged unless they manage to become more prominently recognizable among the whole value chain.

3.7.6.5 Bargaining Power of Buyers

Because automated driving disrupts the entire mobility behaviour there is not only high expectations from the consumer side but also huge interest by the media. Furthermore, the car is a very emotional product (because of the very fact that it tackles the basic need for mobility) resulting in purchase decisions that might not always be fully rational. Eventually buyers will decide over success or failure of automated driving. Because buyers will react very sensitively if expectations are not met and emotions are not satisfied, they have considerable bargaining power.

3.7.6.6 Conclusion

The established value chain of the automotive industry has been stuck in path-dependent trajectories until now. Advances in automated driving technologies are changing these developments since it has impacts on various levels. The incumbents (OEMs) do not only have to compete against their rivals but also to keep of new entrants and substitute products which are increasingly entering the automotive market because of their expectations of high industry profitability. Whereas the bargaining power of suppliers seems to remain unchanged, the bargaining power of buyers is quite high since they will eventually be the ones to decide if the technology will gain market coverage and who will be the leading force. Their emotional stake in questions of mobility adds to this fact.

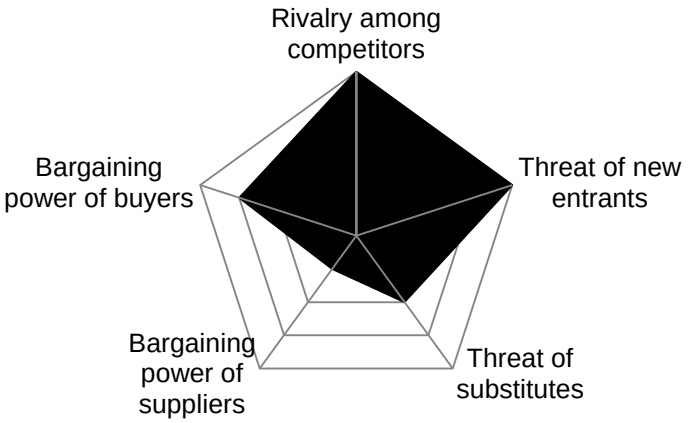


Figure 41: Porter's 5-Forces Analysis on the Automated Driving Value Chain in USA

4 Best Practices

Through the state-of-play as well as the Porter's 5-Forces analyses it was possible to identify best practices and lessons learned that show a lot of potential to overcome existing barriers within Europe. Best practices were identified in all countries under study. These are complemented by further best practices as identified in the course of undertaking this study in countries outside of this study's scope. They were included as they represent valuable input for the further derivation of action plans.

The identified best practices do not only span across all Focus Areas but also across the entire value chain. This was only possible by constantly keeping the eye on the whole supply chain. To fully understand each of these best practices and to see whether it is feasible for the European Union to transfer them to the local context, each of the best practices and lessons learned was examined on whether or not a potential transfer is feasible. By presenting the best practices to experts during the 1st Validation Workshop they further elaborated, enhanced as well as complemented with new ones. In the following all of them are described in detail as well as illustrated in a world map to allow for an easy understanding and comparison.

4.1 Focus Area 1 – Connected Driving and Automation of Transport

4.1.1 Brazil/South Korea/USA: Test Beds for Vehicle Automation

4.1.1.1 Characterisation

In three of the six countries under study successful demonstration projects at national universities could be identified. Seoul National University (South Korea), University of Sao Paulo (Brazil) and Michigan University (USA) are demonstrating autonomous and connected driving technologies on their campuses.

South Korea's project, called Snuber (SNU + Uber), is undertaken on the Seoul National University campus testing different technologies of its autonomous vehicle prototype. The Brazilian project CARINA, the Intelligent Robotic Car for Autonomous Navigation (Carro Robótico Inteligente para Navegação Autônoma), was first tested at Sao Paulo's University campus in 2013. Together with the Michigan Department of Transportation, Michigan University has designed a 13-hectar test field in Ann Arbor, Michigan, for autonomous and connected vehicles. Together with OEMs, students and researchers of Michigan University will further develop vehicle automation as well as V2V and V2I connectivity. The test field was opened in July 2015.

These demonstration projects have been chosen as best practices since the closed and manageable campuses, with low complexity, make it easy to develop related technologies. Their controlled environment allows self-driving cars to be further developed before being deployed in real-life circumstances. No such integrated university research, testing and demonstration area has been implemented in Europe so far.

Method of Implementation

The South Korean team at the Intelligent Vehicle IT Research Center at Seoul National University has been working on vehicle automation for more than a year before its autonomous vehicle was deployed in mid-2015. The project is led by Professor Seung-Woo Seo from the Vehicle Intelligence Laboratory in the Department of Electrical and Computer Engineering. [636]

In Brazil the University of Sao Paulo's Mathematics & Computer Science Institute (ICMC) and the same university's São Carlos School of Engineering are responsible for the CARINA project. They receive support from FAPESP and the National Scientific & Technological Development Council

[636] Jiwon, Y.(2015). SNU Demonstrates Korea's Firs Automated Taxi Service. Retrieved from: http://en.snu.ac.kr/snunews?bm=v&bbsidx=122343.

(CNPq) under the aegis of the National Science & Technology Institute for Critical Embedded Systems (INCT-SEC).[637]

The test site at Michigan University is a collaboration project between Michigan University and the Michigan Department of Transportation. It was acquired by the university itself and is managed by the university's Mobility Transformation Center. Its users comprise researchers, students and industry. The Ford Motor Company was the first company to use the new facility.

Financing

The USD-10 million testing field was purchased by Michigan University from a former Pfizer facility.

Business Models

As soon as the demonstration projects prove to be successful they are scaled up to complex urban situations allowing for knowledge transfer to industrial players and new start-up companies (e.g. originating from the projects) as well as to local decision-makers.

Technologies Employed

On all three sites, vehicle automation as well as V2V and V2I connectivity is being tested and deployed. At Seoul University's 4,109-square meter campus, the connected and automated test vehicle runs with a maximum speed of 30 km/h which is the limit on the university's premises. Although the circulation beltway in the campus is a four-lane road with many curves, SNUber did not only follow all traffic rules, but also showcased fairly smooth driving techniques that were not much different from cars with human drivers. Since its launch, technological development has been focussing on the core technologies like sensors (LiDAR), radars, cameras, and dynamic maps (incl. self-generated high-precision 3D mapping) that cover 50-80 metres to the front and rear of the vehicle. However, to use the service, students are also developing smartphone applications in parallel. On average SNUber arrives five minutes after "request a ride" button is pressed on the mobile app.[638]

In Brazil, the focus of the testing and demonstration also lies on core technologies including the development of a continuous mapping system that improves vehicle control and localization as well as route planning and metric maps through its 360° cameras that collect 700,000 data points per second, laser sensors, and a twin-lens stereo vision system.[639]

Mcity at Michigan University has a huge diversity of real-traffic situations including approximately five lane-miles of roads including two, three, and four-lane roads with intersections, bike lanes, roundabouts, tunnels, traffic signs and signals, sidewalks, benches, hydrants, fixed and movable buildings, street lights, and obstacles such as construction barriers. Furthermore, there are various road surfaces (concrete, asphalt, brick, dirt) and curve radii.

Target User Group

The target user group covers students, researchers and scholars at all three universities. On the long term, research results as well as continuously developed technologies are transferred to real-life situation. Additionally, the programs benefit from strong academia-industry collaboration. For example, at Michigan University researchers and students are collaborating with automotive manufacturers and suppliers. Therefore, the results obtained not only benefit the research institutes and the scientific community but also the automotive industry as well as policy makers of local communities, regions and at national levels.

Enabling Framework

MCity in the USA originated out of joint efforts between the Michigan University and the Michigan Department of Transportation. As a private university, Michigan University had the financial resources to

[637] Alisson, E.(2015). Brazilian university tests self-driving taxi service. Retrieved from: http://agencia.fapesp.br/brazilian_university_tests_selfdriving_taxi_service/21758/.
[638] Engineers Australia. (2016). Snuber is Korea's autonomous taxi. Retrieved from: https://www.engineersaustralia.org.au/portal/news/snuber-koreas-autonomous-taxi
[639] Alisson, E. (2015). Brazilian university tests self-driving taxi service. Retrieved from: http://agencia.fapesp.br/brazilian_university_tests_selfdriving_taxi_service/21758/

purchase the premises from Pfizer and is used by e.g. Ford. Thus, the project evolved out of a successful politics-academia-industry collaboration.

Other Aspects

The testing, demonstration and developing on university campuses have a variety of advantages. While the new technology is continuously developed, people can also make use of the service, e.g. physically impaired people benefit from facilitated mobility possibilities. The goal is to develop technology that can be scaled to situations with increased complexity such as real-life urban environments. However, as for South Korea, regulation still does not permit autonomous vehicles on public roads.

4.1.1.2 Feasibility Analysis

Availability of Technologies and Know-how within the Necessary Timeframe

The build-up of a demonstration site that resembles different scenarios of real-life traffic situations does not pose any specific difficulties and could be quickly implemented.

Violation of Legal/Regulatory Framework in the EU

As long as connected and automated driving technologies are only tested on demonstration sites, it does not violate the European legal and regulatory framework. Only when put into real-life traffic, the law requires the driver to be, at least, monitoring the system. Therefore, vehicles with different architecture, e.g. without steering wheels or pedals, are not allowed yet.

Necessary Standardization Compliant to EU Standardization Policy

For the demonstration there is no standardization necessary.

Available Funding Models

In all best practices the demonstration projects are joint undertakings between public, being represented by national, regional and local authorities, industry and academia. These stakeholders are brought together to jointly push technological advancements. In terms of funding models, this would also be a good way for such demonstrations to be financed within Europe.

Public Acceptance due to Cultural Aspects

Demonstration activities, like the ones being deployed in Brazil, South Korea, and the USA, are not open to the public. Only when tested technologies are launched on the consumer market, the general public will be affected.

Availability of Resources/Raw Materials

In all three cases, demonstration sites are in the vicinity of a major university campus. In the case of MCity a former Pfizer site was bought and re-build to the particular needs. This seems also feasible in Europe. However, it has to be made sure that the industrial site is located close to research institutes or universities.

Additional Aspects

Due to the historical evolution the layout of streets in Europe is very complex compared to the planned grid of US cities. This could complicate the launch of autonomous driving. Therefore, the scaling effects guaranteed by these three demonstration projects may not be similarly transferrable in Europe. Furthermore, many European universities are not located on campuses but integrated in their local infrastructure.

All proposed testing and demonstration sits are best practices since they not only foster policy-academia-industry collaboration but also enable new technologies to be tested and demonstrated in a safe environment with reduced complexity. At the same time, developed technologies might be easily scalable to more complex real-life situations. Also, such test beds could allow for strengthening the cross-industrial co-operation between the automotive and IT industry, a terrain in which the European Union lags behind.

4.1.2 Japan/USA: Nissan's Anthropology Research

4.1.2.1 Characterisation

Research on automation and connectivity is undertaken in all of Nissan's research centres in Japan, in India (due to strong IT industry), and in its subsidiary in Silicon Valley. In California, special emphasis is put on the inclusion of ethnography and design anthropology as foundational components of research on autonomous vehicles. In view of the automobile as a deeply and profoundly cultural object that serves the basic need of mobility, the systematic study of human-machine interaction from the viewpoint of the subject, is not neglected as it helps to gain insights into how new technologies might interpret or act on those behaviors.[640] This is why Nissan's activities were chosen as a best practice.

Method of Implementation

Melissa Cefkin, who was employed in 2015 as the lead design anthropologist in Silicon Valley, is pushing the autonomous car research into the complex web of human-machine interaction: within and outside the vehicle, and in the context of the broader culture. The design anthropology team works together with roboticists, computer scientists, and electrical and mechanical engineers.[641]

Target User Group

The design anthropology targets in-house developers to help shape Nissan's autonomous vehicles and adapt them to the users' needs.

Financing

As part of the in-house research team, the design anthropology team is financed by Nissan itself.

Technologies Employed

The main target is to strengthen the involvement of human factors in the development of autonomous cars. To do so, different anthropological methods are being employed. The leading research questions of the design anthropology team is "How do drivers, passengers, pedestrians, and infrastructures together create the complex whole of driving and how might it affect urban infrastructures, personal identities, driving roles, ownership models and socioeconomic systems?[642]

Enabling Framework

For the development of new automotive solutions, Nissan has an in-house R&D department. Looking beyond the technological perspective and incorporating the human factors, including psychological as well as anthropological, ethnological and sociological perspectives, might be unusual but helps build better products with improved user experience.

Other Aspects

The research team does not only focus on interactions between drivers, but also those between vehicles and pedestrians, bicyclists and road features. First results show that drivers, pedestrians and bicyclists often use "eye gaze" and forms of "direct communications," such as a hand wave, "to give off very clear signals about their intentions" in such situations and that Newton's Law of Inertia also applies to pedestrians, skateboarders and scooters. "There seems to be a predominant preference for maintaining some sort of movement and flow," Cefkin says. "So when we've spent time observing people on the road and sidewalk, there is a very subtle selection of pathways and routes that they use to avoid interaction requirements—places where they're going to have to stop and figure out, okay, what do I do." These manifestations of the mysterious human can be at once very subtle and very sudden, and thus difficult for machines to decipher. Worse yet, humans can elicit unpredictable herd

[640] Nissan Insider. (2016). How anthropology is helping autonomous driving. Retrieved from: http://nissaninsider.co.uk/how-anthropology-is-helping-autonomous-driving/
[641] Shade, M. (2015). Melissa Cefkin / A Profile. Retrieved from: https://www.epicpeople.org/melissa-cefkin-a-profile/
[642] Berk, B. (2015). How Nissan's Using Anthropology to Make Autonomous Cars Safe. Retrieved from: http://www.thedrive.com/article/999/how-nissans-using-anthropology-to-make-autonomous-cars-safe

behavior, wherein one person plays the role of what Cefkin calls “sentinel,” leading a charge against the rules or even against everyone’s best interest and others follow or “piggyback” on this behavior. "[643]

4.1.2.2 Feasibility Analysis

Availability of Technologies and Know-how within the Necessary Timeframe

In view of Europe’s long history in anthropological research and availability in most European universities, there is no lack of know-how. However, there are not a lot of efforts in combining it with technological research, let alone in industrial R&D activities.

A similar EU Project has already been initiated. Its title is “HFAuto – Human Factors of Automated Driving”. Similarities and differences as well as potentials for advancing it could be further assessed based on this identified best practice.[644] In the context of this project a thorough analysis on the public opinion on automated driving based on an international questionnaire which was answered by 5,000 was undertaken.[645]

Violation of Legal/Regulatory Framework in the EU

The best practice does not violate the legal or regulatory framework in the EU.

Necessary Standardization Compliant to EU Standardization Policy

There is no standardization necessary.

Available Funding Models

As this is an industry activity, no public funding is needed.

Public Acceptance due to Cultural Aspects

There are no perceived obstacles regarding public acceptance due to cultural aspects. In fact, integrating the anthropological perspective will even increase user acceptance of automated driving and connected transportation since it will evoke a demand-sided pull of technological progress rather than a technology push. Thus, technologies will be better suited to users’ needs.

Availability of Resources/Raw Materials

There are no physical resources or raw materials needed.

Additional Aspects

From the viewpoint of the European Union the integration of anthropological research can only be fostered through funding schemes. As in the case of Nissan, the inclusion of anthropology in in-house R&D departments of automotive OEMs might rather originate out of intrinsic organizational motivation. This will only happen if companies see a competitive advantage.

4.1.3 Japan: SIP-ADUS

4.1.3.1 Characterisation

The Innovation of Automated Driving for Universal Services (ADUS) has been defined as one of ten key themes in the JYP 2.45-billion Cross-Ministerial Strategic Innovation Promotion Program (SIP)[646]. It is implemented from 2014 to 2018 to influence R&D until 2030. The goal of the program is to reach level 2 automation by mid-2010s, level 3 by early 2020s and level 4 by 2030. Furthermore, the pro-

[643] Berk, B. (2015). How Nissan’s Using Anthropology to Make Autonomous Cars Safe. Retrieved from: http://www.thedrive.com/article/999/how-nissans-using-anthropology-to-make-autonomous-cars-safe.
[644] HFauto (2014). HFauto – Human Factors of Automated Driving. Retrieved from http://hf-auto.eu/
[645] Kyriakidis, M. et al (2015). Public Opinion on Automated Driving: Results of an International Questionnaire among 5000 Respondents. Retrieved from http://www.sciencedirect.com/science/article/pii/S1369847815000777
[646] Cabinet Office. (2016). SIP (Cross-Ministerial Strategic Innovation Promotion Program). Retrieved from http://www8.cao.go.jp/cstp/english/sip/elevenissues.pdf.

gram seeks to establish and harmonize standards, nourish social acceptance, and show the rest of the world what a level 3 automated transport system looks like at the Olympic Games in 2020.[647]

With this program, the Japanese government aims at developing and verifying automated driving systems, develop basic technologies to reduce traffic fatalities and congestion, foster international co-operation, and deploy next-generation urban transportation. As for the development and verification of automated driving, the program makes a distinction between driver and vehicle. When it comes to the driver, it funds research in all stages including recognition, judgment and operation of self-driving technologies; for the vehicle it focuses on recognition and leaves judgment and operation to industrial competition.[648]

The program is perceived as a best practice because of its holistic approach by uniting research, testing and demonstration as well as implementation in one single governmental programme and thus manages to bring together a multitude of different stakeholders.

Method of Implementation

The programme was launched in 2014 in a joint undertaking between the Council for Science, Technology and Innovation; the Cabinet Office; the Government of Japan, and industrial partners. The programme director is Seigo Kuzumaki from Toyota Motor Corporation.

Target User Group

SIP-ADUS fosters not only R&D at all stages including academia and industry but also testing and demonstration and implementation. It thus covers technological development from the early stage through to market penetration. Another target is to push international co-operation. Therefore, it seeks constant interaction and communication with other governments and stakeholders outside of Japan.

Financing

Out of the JPY 50-billion Cross-Ministerial Strategic Innovation Promotion Program (SIP) programme, ADUS receives JPY 2.45 billion financed by the aforementioned responsible actors.

Technologies Employed

In order to reach the goal of reducing traffic fatalities and congestion and to evoke a shift towards next-generation urban transportation, the programme funds different technologies. Technologies that shall be Dynamic Map, Connected Vehicles, Security, Impact Assessment, Human Factors, Next Generation Transport.[649] It differentiates between technologies from the driver's perspective and the vehicle's perspective. As for the driver perspective, it funds research on system security and the driver model. As for the vehicle it limits funding to the development of technologies on recognition. Technologies that shall be developed in this regard cover dynamic maps, predicting information by ITS, and sensing capability enhancement. As for technologies to be developed for the reduction of traffic fatalities, the programme foresees a push of micro data analyses and simulation technologies as well as emission visualization technologies. For the development of next-generation urban transport it takes the systemic level into perspective.[650] [651]

Other Aspects

Participants of the 1st Validation Workshop of this study raised some further critique on this best practice. According to them, the program is very road-focused and does not differentiate between auto-

[647] Kuzumaki, S. (2015). SIP Automated Driving System, Retrieved from https://www.ituaj.jp/wp-content/uploads/2015/07/nb27-3_web-05-SIP.pdf.

[648] Cabinet Office (2016). Research on technical Requirements for Human Machine Interference (HMI) Related to Safety of Automated Driving Systems, Retrieved from http://www8.cao.go.jp/cstp/english/sip_adus/.

[649] Mashiko, T. (2016). Autonomous driving technology and IST. Retrieved from: https://docbox.etsi.org/Workshop/2016/201603_ITS_WORKSHOP/S04_TWDS_ACCIDENT_FREE_AUTOMATED_DRIVING/AUTONOMOUS_DRIVING_TECHNO_AND_ITS_MIC_MASHIKO.pdf.

[650] Amano, H. (2016). Latest development in SIP-adus and related activities in Japan: Retrieved from: https://higherlogicdownload.s3.amazonaws.com/AUVSI/14c12c18-fde1-4c1d-8548-035ad166c766/UploadedImages/documents/Thurs/0830-0845%20Amano.pdf.

[651] Kuzumaki, S.(2016). SIP „Automated Driving System" – Mobility Bringing Everyone a Smile. Retrieved from: http://mic-its-conference-2015.net/data/pdf/05_en.pdf.

mated and autonomous driving. Furthermore, the SIP-ADUS program does not take ethical, liability and regulatory issues (also for airborne transportation) sufficiently into consideration, namely issues related to cybersecurity. However, “Cybersecurity for Critical Infrastructures” is another key theme of SIP.[652]

4.1.3.2 Feasibility Analysis

Availability of Technologies and Know-how within the Necessary Timeframe

The Know-how is available, the challenges lies in the integration of different funding schemes in one single program. To be able to do it, the European Commission would have to think across Directorates General and look for synergies. More collaboration between and within Directorates Generals is needed.

Violation of Legal/Regulatory Framework in the EU

The best practice does not violate the legal or regulatory framework in the EU.

Necessary Standardization Compliant to EU Standardization Policy

There is no standardization necessary.

Available Funding Models

Since the EU already funds research and innovation, testing and implementation of vehicle automation and transport connectivity, it would not need to allocate new funds but rather ensure a better alignment and integration of the funds being provided.

Public Acceptance due to Cultural Aspects

There are no perceived obstacles regarding public acceptance due to cultural aspects.

Availability of Resources/Raw Materials

The European Union already puts a major part of the overall R&D&I expenditure into realizing connected and automated road transport, and given its importance for EU industry funding should not be reduced.

Additional Aspects

In the saturated European automotive market, profits can only be gained by ongoing innovations. Automation and connectivity play an important part in the future of automotive vehicles. However, European OEMs are also slow to react to trends and changing user demand. Therefore, the government can influence technological progress by funding technologies that are not yet sufficiently pushed by the industry itself or where it anticipates other countries to take over the market lead in certain technologies. This can, for example, be evidenced in the realm of electric mobility where Europe is slowly been overtaken by China and the USA. Another such example are certain technologies within the automotive automation and connectivity domain. As can be seen in the best practice, Japan only funds research for “judgement” and “operation” within vehicles and leaves “recognition” to industrial R&D. automated driving will be realized integrating on-board technologies on one side and co-operative assist (precise digital map, data acquisition through radio communication and global positioning) on the other side. On-board technologies are already in product level competition and car manufacturers are demonstrating their technologies. Therefore, the scope of SIP-ADUS does neither include on-board technologies nor the development of prototype automated cars. It focuses on areas of co-operation, such as dynamic map, connected vehicles, human factors, impact assessment, next generation transport, security and international cooperation.

The funding scheme was set up in a way that allows different stakeholders to pull the same string. The program is based on a public-private collaboration in which ITS-related ministries and five car manu-

[652] Cabinet Office. (2016). SIP (Cross-Ministerial Strategic Innovation Promotion Program). Retrieved from: http://www8.cao.go.jp/cstp/english/sip/elevenissues.pdf.

facturers (Toyota, Nissan, Honda, Mazuda, Subaru) participate to foster advancements of vehicle automation and connectivity.

Based on the experience in different funding mechanisms and the multitude of PPPs in Europa, a funding programme based on both public and private investment – similar to Japan's SIP-ADUS – seems feasible for the European Union. Not only does Europe have the necessary resources and know-how but there are also no regulatory or standardization obstacles.

4.1.4 Japan/USA: Variable Message Signs (VMS) and Runway Status Lights (RWSL)

4.1.4.1 Characterisation

The technological affinity of the Japanese has led to an early and widespread use of Variable Message Signs (VMS) and Dynamic Message Signs (DMS) on roads to facilitate traffic. This holds also true for aviation: Tokyo International Airport (RJTT, Haneda Airport) was the first Japanese airport to introduce the Variable Message Sign (VMS) and Runway Status Lights (RWSL) in 2012. VMS and RWSL are autonomous in-pavement lights on runways and taxiways. They tell pilots and vehicle operators to stop when runways are not safe. Embedded in the pavement of runways and taxiways, the lights automatically turn red when other traffic makes it dangerous to enter, cross, or begin take-off. The lights provide direct, immediate alerts and require no input from controllers. Other airports soon followed suit. In Japan, the technology is currently installed at New Chitose Airport, Tokyo International Airport, Osaka International Airport, Fukuoka Airport.[653] In the USA, 17 airports were already equipped with the technology. The first European airport to introduce VMS and RWSL is Charles de Gaulle in Paris.

Even though such system has already been deployed in Europe, it can still be perceived as a best practice since Japan managed to develop such technology earlier than any other country. It took Europe quite long to also implement these technologies. A wide-scale deployment in Europe is still missing.

Method of Implementation

In 2007, the Runway Incursion Prevention Review Committee was set up by the Japan Civil Aviation Bureau (JCAB). In 2008 research and testing activities were started at Dallas Forth Worth and San Diego in co-operation between the Federal Aviation Administration (FAA) and Japan Civil Aviation Bureau (JCAB).[654] In 2009 the development of light fixtures with phased trial operations started which became operational in Tokyo in 2012. Fukuoka followed in 2013 and 2014.[655]

Target User Group

The technology is mainly developed for the smooth and automated operation of planes on landing strips. Therefore the user groups are airport stakeholders such as pilots and air traffic control personnel.

Technologies Employed

The system consists of LCD panel boards on one or both sides of the runway which light up to indicate how the pilot should proceed. It is a system where Runway Entrance Lights (REL) or Take-off Hold Lights (THL) are illuminated or extinguished, automatically and independent of air traffic control instructions based on dynamic surveillance capabilities (multi-lateration).[656] Runway Status Lights integrates airport lighting equipment with approach and surface surveillance systems to provide a visual signal to pilots and vehicle operators. Airport surveillance sensor inputs are processed through light

[653] MLIT Civil Aviation Bureau of Japan (2015). JANS installs automated lightning system to prevent runway incursion, Retrieved from http://www.mlit.go.jp/en/koku/koku_fr13_000007.html.
[654] IFALPA. (2016). Runway Status Lights. Retrieved from: http://www.ifalpa.org/downloads/Level1/Briefing%20Leaflets/Airport%20Issues/16AGEBL01%20-%20Runway%20Status%20Lights%20(RWSL).pdf.
[655] MLIT Civil Aviation Bureau of Japan (2015).Runway Status Lights (RWSL) in Japan. Retrieved from: http://www2010.icao.int/APAC/Meetings/2015%20VisualAids/RWSL%20JAPAN.pdf
[656] Federal Aviation Administration (2013). Runway Status Lights System Description. Retrieved from: https://www.faa.gov/air_traffic/technology/rwsl/description/

control logic that commands in-pavement lights to illuminate red when there is traffic on or approaching the runway. Airport Surface Detection Equipment, Model X surveillance data is used to determine vehicle and aircraft locations. ASDE-X systems use surface radar, multilateration, and in some cases ADS-B (Automatic Dependent Surveillance-Broadcast). Runway Status Lights processes this data using complex software algorithms with adjustable parameters to control airfield lights in accordance with Air Traffic operations, including anticipated separation. Air traffic control operations do not change when RWSL is introduced. Additional protocols are added to ensure effective use of RWSL system.[657]

Also, strategies for system failure have been thought of such as a potential mismatch between the clearance and RWSL system pilots.

Enabling Framework

The technology has been developed in a way that it is compatible with existing procedures at airports. Therefore, they cannot be perceived as disrupting innovations evoking systemic change but rather as an evolutionary change of the airport infrastructure.

Other Aspects

There is still cross-national harmonization necessary. Thus, it is inevitable that countries (and their agencies - FAA - EUROCONTROL, JCAB) have to work together. Provisions to be included in the ICAO PANS ATM document will provide international guidance on the harmonization of the RWSL procedures, referred to by ICAO as autonomous runway incursion warning systems (ARIWS). They will become applicable in November 2016.[658]

4.1.4.2 Feasibility Analysis

Availability of Technologies and Know-how within the Necessary Timeframe

After VMS and RWSL were successfully installed at many airports in Japan and the US, the airport Charles de Gaulle in Paris soon followed suit. However, the airport remains the only airport in Europe so far with this technology. Nonetheless, the knowledge is available, it just needs to be deployed on a wider scale.

Violation of Legal/Regulatory Framework in the EU

The best practice does not violate the legal or regulatory framework in the EU.

Necessary Standardization Compliant to EU Standardization Policy

No specific standardization has to be developed.

Public Acceptance due to Cultural Aspects

Since the general public is not affected by the technology, the question whether the technology is publicly accepted is not of importance in this case. Automation in airborne transportation looks back on a long history; therefore the deployment of such systems seems to be a logical progress.

Additional Aspects

Since the technology described here as a best practice has already been deployed at Charles de Gaulle in Paris, the feasibility of the technology itself is not of relevance. However, Paris is the only example in Europe so far. Therefore, the challenge lies in the wide-spread diffusion of the innovation that would increase all airports efficiency and improve operational proceedings. Since the integration of VMS and RWSL is quite expensive, its diffusion is rather a question of financing which could be established through joint efforts between the European Commission, member states, local municipalities as well as airport owners and operators.

[657] IFALPA (2016). Runway Status Lights (RWSL). Retrieved from: http://www.ifalpa.org/downloads/Level1/Briefing%20Leaflets/Airport%20Issues/16AGEBL01%20-%20Runway%20Status%20Lights%20(RWSL).pdf.

[658] IFALPA. (2016). Runway Status Lights (RWSL). Retrieved from: http://www.ifalpa.org/downloads/Level1/Briefing%20Leaflets/Airport%20Issues/16AGEBL01%20-%20Runway%20Status%20Lights%20(RWSL).pdf

4.1.5 USA: California's Regulatory Framework

4.1.5.1 Characterisation

Whilst Nevada became the first state to pass legislation on automated vehicles, California became the second in September 2012. California SB 1298 created California's Vehicle Code (VC) 38750, establishing definitions and authorizing and requiring the California Department of Motor Vehicles (DMV) to adopt regulations for the testing and deployment of "autonomous vehicles" on public roads by 1 January 2015.[659] The actors involved are the Department of Motor Vehicles (DMV), having set up a committee with California Department of Insurance, California Department of Transportation (Caltrans) and California Highway Patrol (CHP).[660]

The Californian law which defines terms such as "autonomous technology," "autonomous vehicle," and "operator" presently does not prohibit or specifically regulate the operation of autonomous vehicles". It permits current operation under certain conditions; imposes additional oversight on the operation of vehicles without a human in the driver's seat; and requires that the "manufacturer of the autonomous technology installed on a vehicle shall provide a written disclosure to the purchaser of an autonomous vehicle that describes what information is collected by the autonomous technology equipped on the vehicle."[661] [662]

In view of a legislative and judicial decision-making that seems to be always left behind by economic and technological developments, California's regulatory framework was chosen as a best practice as it is amended in parallel with technological progress. Thus, it manages to establish up-to-date jurisdiction and reduce judicial inefficiencies.[663]

Method of Implementation

California was the first state to conduct an in-depth study of the issues that need to be addressed in developing regulations for automated vehicle testing and public operation and achieved the most robust regulation of autonomous car development in the country which attracts many companies to settle because of the friendly legal environment. Future regulatory packages are anticipated each year based on what is learned about forthcoming manufacturer plans and from experiences with the testing and deployment permit application program as implemented.[664]

Target User Group

The California legal framework described here addresses mainly academia and industrial R&D. Also, end users benefit from such a regulatory framework since it prospectively also covers liability and ethical questions.

Enabling Framework

Once Google announced its automated driving program in 2010, automated car research became publicly visible. The first national automated driving program, launched in 1991, and demonstration project, initiated in 1997, paved the way for road vehicle automation and the political framework as described above.[665]

[659] The Center for Internet Society (2016). Automated Driving: Legislative and Regulatory Action. Retrieved from: http://cyberlaw.stanford.edu/wiki/index.php/Automated_Driving:_Legislative_and_Regulatory_Action.
[660] Nowakowski, C., Shladover, S., Chan, S., Tan, H. (2014). Development of California Regulations to Govern the Testing and Operation of Automated Driving Systems. Retrieved from: http://docs.trb.org/prp/15-2269.pdf.
[661] Vehicle Code Section 38750, Retrieved from http://www.leginfo.ca.gov/cgi-bin/displaycode?section=veh&group=38001-39000&file=38750.
[662] Nowakowski, C., Shladover, S., Chan, S.,Tan, H. (2014). Development of Carlifornia Regulations to Govern the Testing and Operation of Automated Driving Systems: Retrieved from http://docs.trb.org/prp/15-2269.pdf.
[663] Soriano, B et al. (2015). Regulations for Testing Autonomous Vehicles in California. In: Road Vehicle Automation, Meyer, G., Beiker, S. (eds.).
[664] Nowakowski, C. et.al (2014). Development of Carlifornia Regulations to Govern the Testing and Operation of Automated Driving Systems. Retrieved from: http://docs.trb.org/prp/15-2269.pdf.
[665] Nowakowski, C. et al. (2014). Development of Carlifornia Regulations to Govern the Testing and Operation of Automated Driving Systems. Retrieved from: http://docs.trb.org/prp/15-2269.pdf.

Other Aspects

There are still a number of issues that need to be clarified in the course of technology development that are not sufficiently covered yet by the California regulation. This is partly because the DMV has limited history in regulating technology-intensive issues because automotive safety regulations have been a federal responsibility, managed through NHTSA, so far.

Additionally, California's legislation should be implemented on a national level in order to avoid the need for adaptation to different state legislations. So far, California has acted as an important standards and legislation setting actor in the past due to its early efforts and manifold experiences.

4.1.5.2 Feasibility Analysis

Violation of Legal/Regulatory Framework in the EU

The best practice does not violate the legal or regulatory framework in the EU.

Necessary Standardization Compliant to EU Standardization Policy

There is no standardization necessary.

Available Funding Models

No specific funding is needed.

Public Acceptance due to Cultural Aspects

There are no perceived obstacles regarding public acceptance due to cultural aspects.

Availability of Resources/Raw Materials

There are no physical resources or raw materials needed.

Additional Aspects

The feasibility analysis of implementing a regulatory framework such as California's turns out positive. Even though the European codification-based law is much slower to be changed than the case-based American common law, the early legal coverage of ongoing technological progress is not impossible.

4.1.6 USA: Connected Vehicle Deployment Program & SPY Car Act

4.1.6.1 Characterisation

The Connected Vehicle Pilot Deployment Program is a national effort to deploy, test, and operationalize cutting-edge mobile and roadside technologies and enable multiple connected vehicle applications. These technologies and applications have been brought together in innovative ways to have an immediate impact: save lives, improve personal mobility, enhance economic productivity, reduce environmental impacts, and transform public agency operations. USD 45 million was foreseen to initiate the design/build/test phase of the Connected Vehicle Pilot Deployment Program. Selected in 2015, the Connected Vehicle Pilot sites include Wyoming, New York City, and Tampa.[666]

The three pilot sites include using connected vehicle technologies to improve safe and efficient truck movement along I-80 in southern Wyoming, exploiting vehicle-to-vehicle (V2V) and intersection communications to improve vehicle flow and pedestrian safety in high-priority corridors in New York City, and deploying multiple safety and mobility applications on and in proximity to reversible freeway lanes in Tampa, Florida.[667]

To create a system in which connected driving and automation of transportation is fully enabled a lot of data is generated. The Security and Privacy in Your Car (SPY Car) Act was developed after a re-

[666] Hartmann, K. (2014). The Connected Vehicle Pilot Deployment Program. Retrieved from: http://www.its.dot.gov/presentations/pdf/CV_PilotWorkshop_Session2.pdf.
[667] Hartmann, K. (2016). Technical Assistance Events for Concept Development Phase. Retrieved from http://www.its.dot.gov/pilots/technical_assistance_events.htm#phase1.

port on the danger of cyber threats to safety and the collection and storage of driving data (i.e. location, driving history, and user data) was published. It requires the NHTSA and the FTC to implement cybersecurity standards for vehicle system and driving data security including hacking protection and mitigation, a "cyber dashboard" display label describing the vehicle's compliance with cybersecurity and privacy requirements, certain privacy standards including providing notice and choice regarding the use and collection of data, and limiting the use of driving data by manufacturers.[668]

The bill shall protect consumers from security and privacy threats to their motor vehicles, and for other purposes. Its goal is to (1) create more secure vehicles, and (2) better inform consumers about vehicle cybersecurity and the use of driving data. The bill foresees to establish three categories of cybersecurity standards for vehicles—anti-hacking, data security, and threat detection. It sets goals for protecting cars against hacks incl. real-time detection and response mechanisms; sets the expectation of secure storage of data in all parts of the data pipeline, from on-board and off-board storage to the transmission in between; protects consumer privacy interests; prohibits manufacturers from strong-arming consumers into accepting data collection by withholding features from consumers.[669]

Methods of Implementation

The Connected Vehicles Deployment Program runs from 2014 to 2020. The 1st phase of the programme was dedicated to the concept development. After this initial 12-month period, the second phase, lasting for 20 months, foresees the design, deployment and testing of technologies. In a third stage of 18 months, developed technologies that were proven successful shall be maintained and further operated. After the three phases technologies shall be routinely operated. The programme is managed by the Intelligent Transportation Systems Joint Program Office (ITS JPO) at the Department of Transportation (DOT) and city authorities of pilot cities chosen (Tampa, NYC, Wyoming).[670]

The SPY Car Act was negotiated between 2015 and 2016. The earliest possible date for enactment is in 2017. The proposed regulation will take 18 months to formulate, and additional 18 months to reach their final forms.

Target User Group

The actors involved in the Connected Vehicles Deployment Programme span from the US government to the Commerce, Science, and Transportation Committee of the Senate, the Federal Trade Commission (FTC), the US Congress and the NHTSA. Target user groups are users of automated vehicles with high automation levels as well as municipal governments and communities responsible for the local transport infrastructure.

Financing

The three pilot cities will receive up to USD 42 million to pilot next-generation technologies.

Technologies Employed

The three cities chosen as pilot cities within the Connected Vehicle Deployment Program will focus on different technologies. New York City will install Vehicle to Vehicle (V2V) technology in up to 10,000 city-owned vehicles; including cars, buses, and limousines, that frequently travel in Midtown Manhattan, as well as Vehicle to Infrastructure (V2I) technology throughout Midtown. In Tampa the focus lies on the reduction of peak rush hour congestion in the downtown area and on protecting pedestrians by equipping their smartphones. Additionally, Tampa will measure the environmental benefits. Wyoming

[668] Congress.Gov (2015). A Bill Information (Except Text) for S. 1806 – SPY Car Act of 2015. Retrieved from: https://www.congress.gov/bill/114th-congress/senate-bill/1806/all-info.

[669] Crowell morning. (2015). Senator Markey Introduces the spy car act to regulate automotive cybersecurity. Retrieved from: https://www.crowell.com/NewsEvents/AlertsNewsletters/all/Senator-Markey-Introduces-the-SPY-Car-Act-to-Regulate-Automotive-Cybersecurity

[670] Hartmann, K. (2016). Technical Assistance Events for Concept Development Phase. Retrieved from: http://www.its.dot.gov/pilots/technical_assistance_events.htm#phase1.

concentrates on freight since the I-80 east-west corridor is dominated by heavy-duty commercial vehicles.[671]

As foreseen by the SPY Car Act, motor vehicles shall be equipped with a "cyber dashboard" with a standardized graphic to inform consumers about the extent to which the vehicle protects individuals' cybersecurity and privacy beyond the minimum requirements.

Enabling Framework

Similar to the Smart City Challenge (see Focus Area 3) the Connected Vehicle Deployment Program is a funding scheme based on competition organized by the Department of Transportation.

Other Aspects

According to the Connected Vehicle Deployment Programme, the US relies on the usage of Wi-Fi instead of a 5G network for an infrastructure enabling connected driving.
In the SPY Car Act there are still many details to be clarified. If regulations are only an enumeration of certain implementation, then the act poses a danger of making the automobile industry lazy and lulling consumers into a false sense of security simply because the cars they purchase met the minimum standards at a certain point of time. The act would have to be designed in a way that allows for continuous and easy updating. Additionally, regulations need to be broad and able to capture the complexity of cyber-attacks.[672]

4.1.6.2 Feasibility Analysis

Availability of Technologies and Know-how within the Necessary Timeframe

The implementation of a funding programme similar to the Connected Vehicle Deployment Program does not pose a big challenge for the European Union. It is more a matter of what fund to take the money from and how to organize it.

Violation of Legal/Regulatory Framework in the EU

The best practice does not violate the legal or regulatory framework in the EU.

Necessary Standardization Compliant to EU Standardization Policy

No specific standardization has to be developed.

Available Funding Models

To finance such a programme different already known funding models can be used. These include governmental funding, EC-member state shared funding, PPPs between the European Commission, member states and industry, etc.

Public Acceptance due to Cultural Aspects

In consideration of the positive effects that V2V and V2I connectivity in both passenger as well as freight transportation will bring, public acceptance is expected to be quite high of the technology itself. As for the test period the general public will not be affected. Thus, the implementation shall not be a problem from a cultural point of view.

Additional Aspects

Similar to the Smart City Challenge (see Focus Area 3) the Connected Vehicle Deployment Program has the potential of having a huge leverage effect on other cities. Demonstration cities were chosen according to each cities' particularities, so that different technologies can be developed in the best

[671] US.DoT (2016). U.S. Department of Transportation Announces up to USD 42 Million in Next Generation Connected Vehicle Technologies. Retrieved from: https://www.transportation.gov/briefing-room/us-department-transportation-announces-42-million-next-generation-connected-vehicle

[672] U.S. Department of Transportation (2015). U.S. Department of Transportation Announces up to USD 42 Million in Next Generation Connected Vehicle Technologies. Retrieved from: http://www.cs.tufts.edu/comp/116/archive/fall2015/ofarooqui-supporting.pdf

possible context and scenario. Since the difference among European cities is also really big, this could also be a suitable approach for Europe.

4.1.7 USA: Energy Impact Assessment of Connected and Automated Transport

4.1.7.1 Characterisation

This forward-looking programme initiated by the US DOE is based on the assumption that automated and connected driving has large potential impacts and uncertainties triggered by the potential disruption of travel patterns, vehicle use, ownership and design. It seeks to refine bounds on potential energy consumption implications, at national level, by assessing specific scenarios and implementing national-level aggregation methods. A further goal is to identify key considerations for encouraging beneficial energy outcomes and for mitigating adverse energy outcomes. In opposition to today's transportation systems, future transportation has to be perceived on a system-level rather than a vehicle level. It will be a connected, automated system that works in concert across all modes. [673]

The goal of this multi-national laboratory project is that funded consortia design and execute robust analytical and foundational efforts to define and build-up constituent parts and frame DOE priority opportunities and identify opportunities for focused technology demonstrations in conjunction with cities or states to spur commercialisation and inform future activities across DOE's transportation technology portfolio. It follows a multi-scale approach (single vehicles, small network, region and nation) and is currently expanded to be part of Smart Mobility which will include decision science, infrastructure, multi-modal and urban in addition to CAVs.[674]

Method of Implementation

The programme runs from 2015 to 2019, so far more than 10 % were completed. In 2015 and 2016 foundational efforts were taken at DOE National Labs in Argonne, Idaho and Oak Ridge as well as at the National Renewable Energy Laboratory (NREL). In 2017 these efforts were ramped up with partners at participating labs. As of 2018, the aim is to have a large-scale implementation with multiple performers.

The programme is based on five pillars or so called Focus Areas: (1) Mobility Decision Science, (2) Connectivity and Automation, (3) Multi-Modal, (4) Urban Science, (5) Vehicles and Infrastructure. Additionally, it is organized along three tasks: (a) Energy Impacts at the Individual Vehicle Level, (b) Energy Impact at the Macro Level, and (c) Secondary Energy Impact. All of these three tasks run in parallel over the total programme period.

Target User Group

The programme funds multi-lab consortia consisting of key stakeholders, including the DOT, key universities with transportation research centres and major cities or regions with ongoing DOT-funded efforts on mobility

Financing

The total project funding amount to USD 3 million of which 100 % are financed by the US DOE.

4.1.7.2 Feasibility Analysis

Availability of Technologies and Know-how within the Necessary Timeframe

The know-how is available. Similar to the DOE's laboratories, the EU also has its own Joint Research Centers that could take on this work. The programme not only fosters the collaboration between research laboratories but also between the DOE and DOT by drawing on previous programmes. To design a similar programme, the EC would have to think across DGs and look for synergies. More collaboration between and within the relevant DG would be required.

[673] Gonder, J. et al. (2016). Assessing the Energy Impact of Connected and Automated Vehicle (CAV) Technologies. Retrieved from http://www.nrel.gov/docs/fy16osti/65743.pdf
[674] Rousseau, A. et al. (2016). Connected and Automated Vehicles. Retrieved from https://energy.gov/sites/prod/files/2016/06/f33/van022_rousseau_2016_p_web.pdf

Violation of Legal/Regulatory Framework in the EU

The best practice does not violate the legal or regulatory framework in the EU.

Necessary Standardization Compliant to EU Standardization Policy

There is no standardization necessary.

Available Funding Models

Having a lot of experience with funding models, this new model can be considered an evolution and does not require knew knowledge.

Public Acceptance due to Cultural Aspects

There are no perceived obstacles regarding public acceptance due to cultural aspects.

Availability of Resources/Raw Materials

The European Union already puts a major part of the overall R&D expenditure into connected and automated cars. Given that R&I resources are already available and recognizing that the combat against climate change is a top priority for the EU, funding research on how to save energy and reduce harmful pollutants is in line with the EU's goals.

Additional Aspects

A funding programme similar to this one seems feasible for the European Union. Not only does Europe have the necessary resources and know-how but there are also no regulatory or standardization obstacles. Such a programme could help assess the energy balance if new technologies are implemented.

4.1.8 USA: Venture Capital Environment

4.1.8.1 Characterisation

Venture Capital (VC) is defined as equity or equity-linked investments in, where the investor is a financial intermediary. Venture Capital is short-term money invested in high risk, start-up companies and usually based on high equity returns from the companies financed. Banks are limited by law in terms of interests they can charge on loans, mainly because they require the loans charged to be secured against hard assets. Since start-ups in today's information-based economy are usually high-risk undertakings with little or no hard assets it is very hard for them to receive loans from banks. As an alternative, private financiers, also known as business angels, are willing to invest in expectance of high returns.[675]

Method of Implementation

The United States has a long history of venture capitalism. What started first on the east coast is now an established industry yielding most profits in technology-driven Silicon Valley. Venture Capital has developed as the major boost behind innovation because of its increased flexibility, the capability of rapidly shifting resources among sectors and the possibility to drive innovation. The US maintains the lead in global venture capital investments with about 70% of global investments in any year, driven by Silicon Valley, Massachusetts, Southern California and NYC. In US, there is more than double the level of venture investment in Europe, China, India and Israel combined in 2014.[676] [677]

Target User Group

The target user group of venture capital investments is start-up companies, including spin-offs, from universities or bigger industrial corporations that penetrate the market with new innovations.

[675] Zider, B. (2016). How Venture Capital Works, Retrieved from https://hbr.org/1998/11/how-venture-capital-works
[676] Ernst & Young (2013). Globalizing venture capital. Retrieved from: http://www.ey.com/Publication/vwLUAssets/Globalizing_venture_capital_VC_insights_and_trends_report_CY0227/USDFILE/Globalizing%20venture%20capital_VC%20insights%20and%20trends%20report_CY0227.pdf.
[677] Tyabji, H., Sathe, V. (2011). Venture capital firms in Europe vs. America: The under performers. Retrieved from: http://iveybusinessjournal.com/publication/venture-capital-firms-in-europe-vs-america-the-under-performers/

Financing

Venture capitalists, usually independent from financial or governmental institutions, are willing to put money into high-risk companies expecting high returns. All costs and financing is borne by private investors.

Business Models

Since the success of disruptive innovations brought forward by young companies is hard to estimate, venture capitalists or business angels invest with expectation of high returns. While business owners of these high-risk start-up companies benefit from easier access to capital in comparison to bank loans, investors yield high returns in case the company and its innovations become successful.

Technologies Employed

The venture capital investor needs to have financial know-how and knowledge of the financial as well as the specific market that they invest in. Furthermore, it is inevitable to have a good overview of the global market of start-ups and available technologies.

Enabling Framework

The prerequisite for the establishment and growth of a venture capitalist environment is a deregulated political, economic and financial system. The more deregulated the national economic system, the more willing are investors to invest in high-risk projects, as can be evidenced in the US. Cultural and social aspects play an important role in creating such a deregulated system and positive venture capitalist environment. In the US, for example, companies that fail are not ascribed to personal failure and are rather treated as lessons learned and things to avoid in upcoming undertakings. Furthermore, US citizens tend to be more willing of undertaking initiatives with higher risks than their counterparts in Europe. Lastly, they are used to a deregulated economic system with venture capitalism being deeply rooted. However, venture capitalism is on the rise in other parts of the world too as mentioned before.

Other Aspects

Different drivers, such as globalisation and the accelerated technological progress, push the development towards more deregulated, high-risk, financial undertakings such as venture capitalism. Interestingly, it seems that there is a correlation between countries that show an increased rate of venture capital investments and the creation of new start-ups and innovations brought forward. Other than the US, the highest rates of venture capital are yielded in China, India and Israel.

4.1.8.2 Feasibility Analysis

Availability of Technologies and Know-how within the Necessary Timeframe

Venture capital is already available in Europe, however it is not as commonly used as in the US.

Violation of Legal/Regulatory Framework in the EU

Since the EU is a free market economy there is no violation to the European legal or regulatory framework due to venture capital invested.

Available Funding Models

Private European investors do not lack the monetary power to invest in start-up companies. However, it seems that they prefer to opt for more traditional saving options.

Public Acceptance due to Cultural Aspects

Cultural aspects, habits, values as well as systemic lock-ins play an important role in the creation of a venture capitalist environment. One prerequisite is the willingness to take huge risks. Europeans tend to be more conservative when it comes to money investment.

Additional Aspects

The establishment of a venture capitalist environment is not a question of monetary availability. It is rather one of culture, values, mind-set and social acceptability of failure. With respect to the increasing globalization more and more international investors, including venture capitalists from the US, are coming to Europe when new businesses present themselves. This might either result in local investors being motivated and willing to invest or the buy-out of local companies to the investors' countries of origin. Building up a local venture capital culture is thus not only good means for pushing start-ups but also to prevent a brain drain to other countries.

4.2 Focus Area 2 – Transformation of Infrastructure

4.2.1 Brazil/India: Curitiba Bus Rapid Transit (BRT) System

The bus system of Curitiba, Brazil, is a model Bus Rapid Transit (BRT) system, and plays a large part in making this a livable city. Curitiba has one of the most heavily used, yet low-cost, transit systems globally. It offers many of the features of a subway system (i.e. vehicle movements seamlessly by traffic signals and congestion, fare collection prior to boarding, quick passenger loading and unloading, etc.) but it is above ground. Around 70% of Curitiba's commuters use the BRT to transfer to work, reaching the result of congestion-free streets and pollution-free air for the 2.2 million citizens of Curitiba.[678]

In India, the modal shift from automobile travel to BRT and NMT (Non-Motorised Transportation) is in process and has started in major cities. BRTs projects are running in Pune, Delhi, Ahmedabad, Indore, Mumbai, Hyderabad, Bangalore, Chennai, Coimbatore, Jaipur, Madurai, Nagpur, Vijayawada and Visakhapatnam.

4.2.1.1 Characterisation

Method of Implementation

Curitiba's bus system is composed of a hierarchical system of services. Minibuses, routed through residential neighborhoods, transfer passengers to conventional buses in non-perimetral routes around the central city and intermediate routes. The backbone of the system is composed of the Bus Rapid Transit, operating on the five main arteries leading into the center of the city. Buses running in the dedicated lanes stop at cylindrical, tube stations with turnstiles, steps, and wheelchair lifts. Passengers pay their fares (single fare equivalent to about 40 cents (U.S.) for travel throughout the system, with unlimited transfers between buses at terminals) as they enter the stations and wait for buses on raised platforms. Instead of steps, buses have extra wide doors and ramps that extend out to the station platform when the doors open. The tube stations provide shelter from the elements, while also facilitating the concurrent embark and disembark of passengers, including wheelchairs, efficiently. Ten private bus companies are paid by the distance traveled to allow a balanced distribution of bus routes. All ten bus companies earn an operating profit. The city pays the companies about 1% of the bus value per month and after 10 years, the city takes control of the buses and uses them for transportation to parks, or as mobile schools[679].

The most important component of the transit system is known collectively as the "Rede Integrada de Transporte" (RIT, "Integrated Transport Network"). This was established in 1980. Some bus services are not considered part of the RIT. There are currently 21 terminals ("Terminais"), where passengers may transfer between routes. The different categories are designed to complement one another, but the overall network resembles the classic "trunk-feeder" pattern and is not set up to maximize the number of "oneseat" trips. The RIT, once confined mostly to the city proper (Smith and Hensher) now serves eight surrounding municipalities, and carries 250,000 passengers each day who either live or

[678] Joseph Goodman, Melissa Laube & Judith Schwenk (2007). Curitiba Bus System is Model for Rapid Transit. Retrieved from: http://www.reimaginerpe.org/book/export/html/344

[679] Joseph Goodman, Melissa Laube & Judith Schwenk (2007). Curitiba Bus System is Model for Rapid Transit. Retrieved from: http://www.reimaginerpe.org/book/export/html/344

work outside of Curitib inctive "tube" stations (Estações-Tubo) that provide high-platform boarding[680]. In India BRT systems with different designs can be found:

Existing BRT Systems with segregated lanes: Ahmedabad BRTS: 13 operational lines with 126 BRT stations and a few cabins (all are wheelchair - accessible except two) covering almost 89 km. Fleet of 220 buses; Delhi BRTS was the 2nd BRT system in India. Currently uses Tata Marcopolo Bus, some with AC and some without. The project is now scrapped by AAP Government; Jaipur BRTS is similar to Bhopal BRTS, also uses Marcopolo buses; Indore BRTS currently uses Corona XL buses (AC, automatic doors, Intelligent Bus System - iBus) running on 10 corridors; Pune BRTS currently uses Tata Marcopolo buses was 1st BRTS in India; in Rajkot is one line operational and two lines are under construction; Surat BRTS is operational since early 2014; Bhopal BRTS currently uses Tata Marcopolo buses.

Existing BRT Systems without segregated lanes: Bombay and Mumbai BRTS currently uses King-Long, Mercedes and Tata buses; these buses are high capacity and thus government has characterized them as BRTS.

Under construction: Bhubaneswar BRTS (2 corridors), Hyderabad BRTS (2 corridors), Visakhapatnam BRTS (2 corridors), Bhopal BRTS (3 corridors), Hubli-Dharwad BRTS (1 corridor), Amritsar BRTS (7 corridors in phase 1), Vijayawada BRTS (6 corridors).

Planned: Chennai BRTS (1 corridor planned), Chennai RBTW (15 corridors planned), Coimbatore BRTS (10 corridors planned), Hyderabad Bus Rapid Transit System (2 corridors planned)

Target User Group

Commuters, citizens and tourists.

Financing

In Brazil, private bus operators have paid for the creation of the initial infrastructure (in the 1970s), with the agreement to provide the vehicles and run the service in exchange. With this trade in place, the first rapid bus lanes ended up costing 50 times less than rail. Thus, it was an early PPP scheme.

Curitiba's transit system is managed by the "Urbanização de Curitiba" (URBS, = "Urbanization of Curitiba"), owned privately but managed publicly. URBS administers publicly-owned transport infrastructure, contracts with private companies that operate the buses and monitors their performance. URBS establishes schedules and service standards, sets fares, collects revenues and distributes payments to the private companies.

The government has taken a lead role in promoting sustainable urban development in recent decades. Recognizing the considerable economic, environmental and social benefits of this approach, they have promoted investment by cash-poor municipal governments using strong financial incentives[681].

Business Models

According to the information provided in "financing", the business model applied in the implementation and operation of the Curitiba BRT system is a PPP-type scheme.

Technologies Employed

Integrated dedicated bus lanes along the city's main arteries, with stations placed on medians along the routes. This allows buses to run at speeds comparable to light rail, while dramatically reducing the cost[682].

[680] Leroy W. Demery, Jr (2004). Bus Rapid Transit in Curitiba, Brazil - An Information Summary. Retrieved from: http://www.publictransit.us/ptlibrary/specialreports/sr1.curitibaBRT.htm

[681] Rizvi A. (2013). Alternative Approaches to Economically Sustainable Mobility in India: Comparing Ahmedabad Bus Rapid Transit and Delhi Metro Systems. Retrieved from: http://unhabitat.org/wp-content/uploads/2013/06/GRHS.2013.Case_.Study_.Janmarg-Delhi.India_.pdf

[682] The Guardian (2015). How Curitiba's BRT stations sparked a transport revolution – a history of cities in 50 buildings, day 43. Retrieved from: https://www.theguardian.com/cities/2015/may/26/curitiba-brazil-brt-transport-revolution-history-cities-50-buildings

Enabling Framework

By 1960, the population of Curitiba was beginning to grow significantly and within 20 years it had increased from 120,000 to 361,000. Planners began wondering how to cope with this growth. Realizing the need for mass transit, planners called for the development of subway lines, as well as widened streets for cars – but construction would be costly and time consuming. This is why emphasis was given to bus transportation. The initial plan was to create a system that gave buses as many of the functional advantages of urban train systems as possible. It was thus proposed to integrate dedicated bus lanes along the city's main arteries, with stations placed on medians along the routes, to enhance speed and reduce cost[683]. The transit system in Curitiba has attracted worldwide attention for its noteworthy accomplishments with limited resources.

BRT systems are rapidly developing in India due to the great congestion problem that the country faces, leading also to worsening urban air and noise quality, abysmal traffic safety records (Singh, 2005), and contributed to increasing energy use and declining mobility and productivity in urban centres.

Other Aspects

The construction of the Curitiba Bus Rapid Transit (BRT) system started in 1971 and lasted for 4 years. However, since then, is constantly upgrading and extending.

The Curitiba Bus rapid transit (BRT) system is pioneered with high-quality stations, overland bus transport and real-time information systems, as well as dedicated lanes for buses and high-capacity vehicles. Curitiba's BRT has made a huge impact on a modal shift from automobile travel to bus travel and plays a large part in making this a livable city. It has been estimated that the introduction of the BRT had caused a reduction of about 27 million auto trips per year, saving about 27 million liters of fuel annually.

4.2.1.2 Feasibility Analysis

Availability of Technologies and Know-how within the Necessary Timeframe

BRT systems provide faster operating speeds, a rise of passengers' reliability and quality of service. In order to meet these goals, BRT are based on some upgrades of system performance such as exclusive bus lanes, busways, signal preference or coordination, traffic management improvements and new technologies for increasing the boarding/alighting time rates.

Since respective bus rapid transit systems already exist in some European cities (i.e. Paris-France, Leeds-UK, Dublin-Ireland, Stockholm-Sweden, etc.) there is no issue concerning either the availability of technologies and know-how.

Violation of Legal/Regulatory Framework in the EU

The best practice does not violate the legal or regulatory framework in the EU.

Necessary Standardization Compliant to EU Standardization Policy

There is no standardization necessary.

Available Funding Models

Usually PPP models are being adopted and used.

Public Acceptance due to Cultural Aspects

There are no perceived obstacles regarding public acceptance due to cultural aspects.

[683] The Guardian (2015). How Curitiba's BRT stations sparked a transport revolution – a history of cities in 50 buildings, day 43. Retrieved from: https://www.theguardian.com/cities/2015/may/26/curitiba-brazil-brt-transport-revolution-history-cities-50-buildings

Availability of Resources/Raw Materials

Since respective bus rapid transit systems already exist in some European cities (i.e. Paris-France, Leeds-UK, Dublin-Ireland, Stockholm-Sweden, etc.), resources are available.

Additional Aspects

BRT systems do not cause high infrastructure costs because bus routes generally run along the same platform of private cars. The concept of BRT was created in dense populated cities of South America in the early '80s, where budget constraints did not allow constructing heavy rail lines in the demand corridors.

Both BRT and Light Rail Transit (LRT) lines are able to carry 20,000pax/h and their associated commercial speed is estimated to be 25 km/h (up to 80km/h in special implementations such as highways or guided systems). However, the unit construction cost per distance in BRT lines is less than five times the associated value in LRT lines[684].

The BRT systems are in direct competition with networks of urban and regional railroads and LRT that present a great development mainly in Northern Europe, as well as with the great use and reliance on private cars that is a characteristic mainly of Southern Europe.

4.2.2 China: Maglev/High-Speed Trains

4.2.2.1 Characterisation

Method of Implementation

The Changsha Maglev, or Changsha Maglev Express (is a medium-low speed magnetic levitation, or maglev line in Changsha, China). This is China's second maglev line, after Shanghai Maglev, and the first domestically built maglev line that uses indigenous technology. The line stretches over 18.55 kilometers and runs between Changsha Huanghua International Airport, Langli station and the high-speed railway station Changsha South Railway Station. Its rolling stock is designed for a speed of up to 120 km/h, currently however it is running with a maximum speed of 100 km/h.

Target User Group

Commuters of Changsha, as well as tourists arriving by plane to the Changsha Huanghua International Airport.

Financing

Construction started in May 2014, the first trial run was done on 26 December 2015, and trial operations were started on 6 May 2016. Since the beginning of construction in May 2014, the project has received an estimated investment of CNY 4.6 billion.

Technologies Employed

Magnetic levitation, maglev, or magnetic suspension is a method by which an object is suspended with no support other than magnetic fields. Magnetic force is used to counteract the effects of the gravitational acceleration and any other acceleration.

The two primary issues involved in magnetic levitation are *lifting forces*: providing an upward force sufficient to counteract gravity, and *stability*: ensuring that the system does not spontaneously slide or flip into a configuration where the lift is neutralized.

Enabling Framework

The need of Changsha citizens commuting using Public Transport with low cost fare.

[684] Canales C., Estrada M., Thorson L., Robuste F. (2006).
Public Transport Policies in Europe: Implementing Bus Rapid Transit Systems in major European Cities.

4.2.2.2 Feasibility Analysis

Availability of Technologies and Know-how within the Necessary Timeframe

Available expertise and know-how already exists. For example, Transrapid 05 was the first maglev train with longstator propulsion licensed for passenger transportation, while also the world's first commercial maglev system was a low-speed maglev shuttle that ran between the airport terminal of Birmingham International Airport and the nearby Birmingham International railway station between 1984 and 1995.

Violation of Legal/Regulatory Framework in the EU

The best practice does not violate the legal or regulatory framework in the EU.

Necessary Standardization Compliant to EU Standardization Policy

There is no standardization necessary.

Available Funding Models

What makes the case of the Changsha Maglev Express in China different and maybe worth duplicating in Europe, is the combination of advanced technology application (such as the maglev levitation) and the end offer of an affordable product to the public by controlling some other parameters, such as the speed of train. In this case also, the main – if not the only – problem is probably the lack of sufficient financial resources.

Public Acceptance due to Cultural Aspects

There are no perceived obstacles regarding public acceptance due to cultural aspects.

Availability of Resources/Raw Materials

There is no obstacle concerning the availability of resources.

4.2.3 Japan: Demand-responsive Infrastructure Development

4.2.3.1 Characterisation

As an answer to demographic change, which is an increasing problem in Japan, more and more importance is put on paratransit mobility. It refers to demand-responsive, door-to-door transport services not only for the elderly but also for the physically handicapped. Paratransit transportation, e.g. minibuses, acts as a gap filler between public buses and private automobiles. It fosters the inclusion of people with a lack of agility, including the elderly and the physically impaired and additionally poses a solution for the last-mile problem.

Method of Implementation

Demand Responsive Transport (DRT) is a public transport system, which provides the user with the advantages of both public transport and taxi services. More than 200 of the 1700 local governments in Japan have introduced the DRT, using mainly mini buses.

Target User Group

Mainly people with a lack of agility, i.e. elderly or physically impaired, without excluding all citizens.

Financing/ Business models

Public-private partnerships.

Technologies Employed

Development of Information and Communication Technologies (ICT) services for citizens and fleets administrators.

Enabling Framework

The aging of Japan is thought to outweigh all other nations, as the country is purported to have the highest proportion of elderly citizens. According to 2014 estimates, 33.0% of the Japanese population is above age 60, 25.9% are aged 65 or above, 12.5% are aged 75 or above.

4.2.3.2 Feasibility Analysis

Availability of Technologies and Know-how within the Necessary Timeframe

There is no problem concerning the availability of expertise in the field of ICT technologies or know-how concerning the management of corresponding DRT systems, as it is already a practice used in some European countries and expanding.

Violation of Legal/Regulatory Framework in the EU

There are no perceived obstacles regarding public acceptance due to cultural aspects.

Necessary Standardization Compliant to EU Standardization Policy

There is no standardization necessary.

Available Funding Models

Public-private partnerships

Public Acceptance due to Cultural Aspects

There are no perceived obstacles regarding public acceptance due to cultural aspects.

Availability of Resources/Raw Materials

No issues occur regarding the availability of resources.

Additional Aspects

The most important issue for the further development of DRT systems in Europe is to ensure the ration between its cost for the users and its operation and bringing together in PPP's all the necessary actors.

4.2.4 Japan: National Resilience & Disaster Risk Management System

4.2.4.1 Characterisation

Private-sector national resilience spending was mainly undertaken for earthquake-proofing of building and equipment, reinforcement of transport systems (roads and railroads), disaster-relief robotics, communications resilience, and training of specialist leadership.

Method of Implementation

To be better suited for future disasters, Japan introduced a disaster risk management (DRM) system after that, roads are increasingly developed to serve as damage mitigation by acting as secondary barriers or dikes and, thus, preventing debris from flowing into inland urban areas. The Great East Japan Earthquake (GEJE) has made Japan a world leader in building resilience in critical energy, water, transport and other lifeline infrastructures.

Private sector National Resilience spending was mainly undertaken for earthquake-proofing of building and equipment, reinforcement of transport systems (roads and railroads), disaster-relief robotics, communications resilience, and training of specialist leadership.

Target User Group

All citizens and tourists.

Financing

Public-Private financing

Technologies Employed

- Earthquake-proofing of building and equipment;
- Reinforcement of transport systems (roads and railroads);
- Disaster-relief robotics;
- Communications resilience.

Enabling Framework

Japan is a highly earthquake prone country, often affected by such disasters resulting in the loss of many human lives and the destruction of infrastructures.

4.2.4.2 Feasibility Analysis

Availability of Technologies and Know-how within the Necessary Timeframe

Resilience of Infrastructure is a major issue also in EU, currently developing and evolving, while a set of guidelines are being now developed through the RESOLUTE project[685]. Thus, this is a rapidly emerging area already in Europe, meaning that expertise and relevant technologies are already developed or in progress.

Violation of Legal/Regulatory Framework in the EU

The best practice does not violate the legal or regulatory framework in the EU.

Necessary Standardization Compliant to EU Standardization Policy

There is no standardization necessary.

Available Funding Models

Public-private Partnerships

Public Acceptance due to Cultural Aspects

There are no perceived obstacles regarding public acceptance due to cultural aspects.

Availability of Resources/Raw Materials

There are no issues regarding the availability of resources.

4.2.5 Japan/South Korea: Transit-oriented Development

Transit oriented development (TOD) is generally defined as “moderate to high-density residential development that also includes employment and shopping opportunities and is located within easy walking distance of a major transit stop” (Parker, McKeever, Arrington, & Smith-Heimer, 2002). Planners hope that TODs will enhance transit use, increase housing opportunities, promote walking and bicycling, and facilitate neighborhood revitalization[686].

Transit-oriented development (TOD) is a very important focus point in the development roadmap of Asian cities. TOD is expected to make a big difference in the long-term sustainability of urban living, focusing also on energy efficiency. In South Korea, one urban project is centred on the Multi-Mode-COEX-Station that is integrating different transport modes. In the past, two-dimensional road planning for surface roads or raised highways was more emphasized but recently the focus has been put on three-dimensional urban planning reducing transfer congestion by adding underground and high-rise walkways. In Japan, one successful transit-oriented development project is the Shibuya Hikarie area centred on railway lines. The goal was to build an “urban core” integrating culture, entertainment, commerce, transportation, work, and housing.

[685] Resolute (2016). Resilience Management Guidelines and Operationalization Applied to Urban Transport Environment. Retrieved from: http://www.resolute-eu.org/

[686] Lund, H. (2007). The Reasons for Living in a Transit-Oriented Development, and Associated Transit Use. Retrieved from: http://www.tandfonline.com/doi/pdf/10.1080/01944360608976757

4.2.5.1 Characterisation

Method of Implementation

A ToD is ideally an integral part in a city's effort to determine a hierarchy of urban centers integrated with the transport network. A successful ToD system often includes the integration and access to the transit station, supports the proper use of land, while also ensures and promotes the development of an environment that allows people to comfortably walk around it[687]. For example, the Shibuya Hikarie project in Japan is one of the first Redevelopment Projects. Shibuya is a central area located in a valley with several railway stations. Hikarie redevelopment project hasn't just built an "urban core" to connect public spaces located on different levels, but has also become Shibuya's new cultural, entertainment, and commercial hub, as it integrates features, like the ones listed below (indicatively):

- Multi-use Theater that serves as a cultural information dispatching;
- Sky Garden that serves as a public interactive open space;
- Vertical Pedestrian Connector.[688]

Another very important example of ToD development, is also the BRT system of Curitiba in Brazil, which is described in details above.

Target User Group

The target user group covers the commuters of each city (i.e. the commuters of the Shibuya area, as well as their tourists.

Financing

Use of public investments or investments based on PPP schemes. In particular, the Shibuya Hikarie project is a PPP project, integrating 3 project types:

- Rail/Station Construction & Improvement;
- Infrastructure Improvement and
- Real Estate Development.[689]

Technologies Employed

Technology is playing an increasing role in enriching ToD and making it more appealing to future generations. Technology-driven ToD provides the passengers real choices in real time so that they can make informed transportation decisions. Under this perceptive, information can be considered as the biggest currency of technology in TOD[690].

Enabling Framework

The growing problems regarding traffic congestion, long commutes, air pollution, greenhouse gas emissions, foreign and domestic oil prices and availability and various other problems that plague mainly and usually urban areas are at the basis of the further development and expansion of ToD systems.

4.2.5.2 Feasibility Analysis

Availability of Technologies and Know-how within the Necessary Timeframe

The Know-how is available regarding the development of such ToD systems in Europe. European players have the required technology and expertise already developed - in a great extent- not only for

[687] Huang, C., Mehndiratta, S. (2015). Transit-oriented development — What does it take to get it right? Retrieved from: http://blogs.worldbank.org/transport/transit-oriented-development-what-does-it-take-get-it-right
[688] http://www.nikken.co.jp/en/solutions/tod.html
[689] Nakawake, T. (2016). Rail-integrated Urban Development Japanese Experience and Its Implications. Retrieved from: https://www.bcj.or.jp/en/what/src/srilanka01_04.pdf
[690] Raine, A., (2010). Technology-Driven Transit-Oriented Development. Retrieved from: http://web1.ctaa.org/webmodules/webarticles/articlefiles/Tech-Driven_TOD.pdf

development of ToD systems but also for their enrichment with "smart solutions" and "smart technologies" that will make the infrastructure more accessible to young people and future generations.

Violation of Legal/Regulatory Framework in the EU

The best practice does not violate the legal or regulatory framework in the EU.

Necessary Standardization Compliant to EU Standardization Policy

There is no standardization necessary.

Available Funding Models

It is widely viewed that TOD can lower infrastructure costs over the long term but the initial ToD infrastructure cost can be considerable and can require extensive investment. So, probably a number of funding sources are required. This means that where the use of public investments is not enough, investments can be made based on PPP schemes.

Public Acceptance due to Cultural Aspects

There are no perceived obstacles regarding public acceptance due to cultural aspects.

Availability of Resources/Raw Materials

Urban public transport development falls under the subsidiarity principle and thus is within the responsibility of the European Union's member states and local governments. Considering that it is the backbone of European cities a major part of their overall expenditure is already put into the development and progress of public transport. Considering the high urbanisation rate and the trend towards a higher share of public transport, there are, however, still big market opportunities attracting private investment.

4.2.6 South Korea: Gyeongin Ara Waterway Project

4.2.6.1 Characterisation

To further evoke a modal change, the Gyeongin Ara Waterway Project was initiated by K-Water. The 19 km long and 80 km wide water way connects the Han River and the West Sea and enables transportation of 250 containers in one shipping; thus, reducing environmental costs compared to road and railway. The project further aims to prevent the Gulpo River from flooding and to create leisure space for local residents. This shall be achieved by involving experts of tourism and culture from the planning stage. Eight spectacular waterfront sceneries are being created and at the entire 19 kilometer Ara Waterway will become a bicycle road, inline road and pedestrian walk.

Method of Implementation

The Gyeongin Ara Waterway Project consists of several sub-projects concerning container, steel, sand, vehicle and passenger port, logistics complex and waterside place, etc. It is a large-scale national project that aims to contribute to the national economy by securing national competitiveness[691].

The Waterway will connect Han River with the Gulpocheon Bangsuro with 80m width and 14km length, which was built for prevention of damages from frequent floods of the areas near Gulpocheon. It is expected to resolve the logistics problem of the metropolitan area and reduce the transportation costs by transporting cargos and passengers from the West Sea to Han River via the Waterway.

The implementation of this project started in 1995, but once delayed as civil groups raised issues about its economic feasibility. However, the DHV of Holland, the advanced organization with expertise in waterways, has reviewed the plan since 2004. The results of the review stated that the plan was economically feasible. During the process of the project implementation based on the results of the review, KDI re-evaluated the plan in 2008, proving that the plan was economically feasible.

[691] K-water (2016). GyeongIn Ara Waterway Projects. Retrieved from http://english.kwater.or.kr/eng/busi/project01Page.do?s_mid=1190

Target User Group

Logistics companies and organizations, as well as citizens, from surrounding areas.

Financing

Governmental financing

Technologies Employed

Development of technologies related to the logistics and constructions field; technologies related to water resources management system (K-Water project).

Enabling Framework

The region where the Waterway is located suffers from growing logistics costs due to traffic congestions. The project will save the logistics costs by improving the logistics and transportation system that is concentrated only on roads, and develop near-sea transportation from Seoul to China and Japan.

In addition, the Waterway will serve as the new water leisure space in the metropolitan area, as it will complete the network of culture, tourism, and leisure connected to the Han River Renaissance Initiative.

Additionally, as issues such as the global warming and the environmental pollution are gaining higher attention, the GYEONG-IN Waterway Development Project also has eco-friendly meanings, as it will reduce 74,000 tons of CO_2 emission per year in 2020.

In general, it will significantly contribute to the nation's overcoming the economic crisis by creating the production promotion effect worth KRW 3 trillion, and creating 25,000 jobs and is expected to stimulate the economy**.**

4.2.6.2 Feasibility Analysis

Availability of Technologies and Know-how within the Necessary Timeframe

There is no problem concerning the availability of expertise in the field of relevant technologies and know-how in the European area.

Violation of Legal/Regulatory Framework in the EU

The best practice does not violate the legal or regulatory framework in the EU.

Necessary Standardization Compliant to EU Standardization Policy

There is no standardization necessary.

Available Funding Models

Governmental or EC funding;

PPP schemes.

Public Acceptance due to Cultural Aspects

There are no perceived obstacles regarding public acceptance due to cultural aspects.

Availability of Resources/Raw Materials

No issues regarding the availability of resources.

4.2.7 South Korea: Urban Traffic Improvement Promotion Act

4.2.7.1 Characterisation

Urban Traffic Improvement Promotion Act issued in 2010 sets the goals of ensuring smooth traffic and to promote convenience in urban areas, improving traffic facilities and increasing efficiency. The act states that anyone who intends to undertake any project within an urban traffic improvement district or within a traffic zone of an urban traffic improvement district shall formulate a traffic impact analysis and improvement plan.[692]

Method of Implementation

If projects larger than a certain size are planned, a Traffic Impact Assessment is conducted to analyze various traffic facilities and traffic volume in and around business sites or diagnose various problems in anticipation of expected transportation needs within one year, five years, and ten years. Thus, a smooth, pleasant, and safe urban travel can be secured based on appropriate traffic measures and an improved transportation environment.[693] Other measures include: Transportation Impact Assessment System, Financial Traffic Penalty System[694], establishment of a mass transit-oriented urban traffic system, and an aggressive vehicle demand management.

Target User Group

The intended final recipient of this effort is the citizens of the country, as the objective of this procedure is to take appropriate measures and precautions, to put in place projects that will not cause traffic problems and inconvenience to the residents.

Financing

Public financing

Enabling Framework

Due to the heavy traffic system in South Korea's urban areas, the Urban Traffic Improvement Promotion Act is imperative in order to avoid additional loading of the traffic network as well as the creation of further sources of discomfort for the citizens such as infrastructural problems.

4.2.7.2 Feasibility Analysis

Availability of Technologies and Know-how within the Necessary Timeframe

There is no need of any particular technologies or expertise involved in applying this Act, except the specific expertise required by the actors who need to prepare and submit the Traffic Impact Assessment, in order to be able to make a complete analysis of the project that they want to implement and to conduct the assessment of its expected impacts.

Violation of Legal/Regulatory Framework in the EU

The best practice does not violate the legal or regulatory framework in the EU.

Necessary Standardization Compliant to EU Standardization Policy

There is no standardization necessary.

Available Funding Models

For enabling and implementing such a process, the mobilization of mainly the state apparatus of the country (and throughout Europe) is required. In this respect, the funding of such a process mainly concerns the respective country.

---

[692] Ministry of Land, Infrastructure and Transport (2010). Urban Traffic Improvement Promotion Act. Retrieved from http://elaw.klri.re.kr/kor_service/lawView.do?hseq=18768&lang=ENG

[693] Hwang, S. and Kim, G. (2014). 50 Praxes for Better Transport in Korea, The Korea Transport Institute, Gyeonggi-do, 411-701, Republic of Korea, p. 31

[694] Hwang, S. and Kim, G. (2014). 50 Praxes for Better Transport in Korea, The Korea Transport Institute, Gyeonggi-do, 411-701, Republic of Korea, p. 21.

Public Acceptance due to Cultural Aspects

There are no perceived obstacles regarding public acceptance due to cultural aspects.

Availability of Resources/Raw Materials

The resources needed for the organization and implementation of such a procedure is part of the budget and the organization plan of each government.

4.2.8 USA: Beyond Traffic 2045

4.2.8.1 Characterisation

Beyond Traffic is an invitation to the American public—including the users, developers, owners, and operators of the transportation network and the policy officials who shape it—to have a frank conversation about the shape, size, and condition of that system and how it will meet the needs and goals of our nation for decades to come.

In a Google Fireside Chat, Anthony Foxx (the U.S. Secretary of Transportation) and Eric Schmidt (Google Chairman) discussed a new analysis from the U.S. Department of Transportation's draft Beyond Traffic framework, which anticipates the trends and choices facing US transportation system over the next three decades.[695]

Method of Implementation

Beyond Traffic is a draft framework for the future; it's not prescriptive. It does not aim to reach concrete policy solutions. Instead, it focuses on the critical decision points that the US face, through the analysis of data-driven, research, expert opinions, and public participation.

It is the start of a national conversation where big questions are being asked, big trends are examined, big answers are trying to be inspired.

Beyond Traffic was launched in early 2015 to foster a national dialogue about the shape, size, and condition of US transportation system and how it will need to meet the needs and goals of the nation for decades to come.[696]

Target User Group

The purpose of this process is to identify in depth the needs of the US Transportation system and to provide guidelines for the required actions in the next decades, while of course to ensure the engagement of all relevant actors for common actions. The successful outcome of this initiative will benefit all actors constituting the US Transportation system, from legislators to the end users.

Financing

Co-operation between public and private actors.

Technologies Employed

Non applicable

Enabling Framework

The dramatic population growth anticipated in *Beyond Traffic* (70 million more people living in the U.S. by 2045) will occur in 11 rapidly expanding metropolitan areas, where transportation infrastructure already struggles to cover the current demand. In this context, the dialogue initiated by the "Beyond Traffic 2045" will allow citizens, elected officials, Metropolitan Planning Organization executives, transportation industry partners, business owners, and community leaders to bring their region-specific

[695] U.S. Department of Transportation (2015). Beyond Traffic: US DOT's 30 Year Framework for the Future. Retrieved from: https://www.transportation.gov/BeyondTraffic

[696] U.S. Department of Transportation (2015). U.S. Department of Transportation Announces Beyond Traffic Megaregion Forums. Retrieved from: https://www.transportation.gov/briefing-room/us-department-transportation-announces-beyond-traffic-megaregion-forums

experience to discussions about the challenges identified and potential solutions to those challenges. [697]

4.2.8.2 Feasibility Analysis

Availability of Technologies and Know-how within the Necessary Timeframe

No particular technology is needed for the implementation of this initiative. The only thing required is the collection of the expertise of transport experts - from all relevant transportation sectors - as well as the valuable contribution of end users and citizens.

Violation of Legal/Regulatory Framework in the EU

The best practice does not violate the legal or regulatory framework in the EU.

Necessary Standardization Compliant to EU Standardization Policy

There is no standardization necessary.

Available Funding Models

Public financing or application of PPP schemes

Public Acceptance due to Cultural Aspects

There are no perceived obstacles regarding public acceptance due to cultural aspects

Availability of Resources/Raw Materials

The resources needed for the organization and implementation of such an initiative are part of the budget and the organization plan the corresponding national authorities.

4.2.9 USA: Livability Initiative

4.2.9.1 Characterisation

Livability is about connecting the quality and location of transportation facilities to wider opportunities, like access to good jobs, affordable housing, quality schools and safer streets. The FHWA supports livable communities through the funding of transportation related projects, such as Context Sensitive Solutions, and public involvement initiatives that help people to live closer to jobs, save households' time and money and reduce pollution[698].

Method of Implementation

The FHWA supports livable communities through a long-standing Sustainable Communities partnership[699] together with the U.S. Department of Housing and Urban Development (HUD), the U.S. Department of Transportation (DoT) and the U.S. Environmental Protection Agency (EPA). In 2009, these agencies started cooperating in an effort to help communities nationwide to improve access to affordable housing, increase transportation options, and lower transportation costs while also protecting the environment.

The FHWA livable communities' initiative is pursuing coordinated, place-based policies and investments that increase transportation choices and access to public transportation services for all Americans. The FHWA Livability Initiative has the following objectives:

- Provide more transportation choices to decrease household transportation costs, reduce our dependence on oil, improve air quality and promote public health.

[697] U.S. Department of Transportation (2015). U.S. Department of Transportation Announces Beyond Traffic Megaregion Forums. Retrieved from: https://www.transportation.gov/briefing-room/us-department-transportation-announces-beyond-traffic-megaregion-forums

[698] USDoT – Federal Highway Administration (2016). Livability Initiative – What is Livability? Retrieved from: http://www.fhwa.dot.gov/livability/

[699] The Partnership for Sustainable Communities works to coordinate federal housing, transportation, water, and other infrastructure investments to make neighborhoods more prosperous, allow people to live closer to jobs, save households time and money, and reduce pollution. The partnership agencies incorporate six principles of livability into federal funding programs, policies, and future legislative proposals.

- Expand location- and energy-efficient housing choices for people of all ages, incomes, races and ethnicities to increase mobility and lower the combined cost of housing and transportation.
- Improve economic competitiveness of neighborhoods by giving people reliable access to employment centers, educational opportunities, services and other basic needs.
- Target federal funding toward existing communities – through transit-oriented and land recycling – to revitalize communities, reduce public works costs, and safeguard rural landscapes.
- Align federal policies and funding to remove barriers to collaboration, leverage funding and increase the effectiveness of programs to plan for future growth.
- Enhance the unique characteristics of all communities by investing in healthy, safe and walkable neighborhoods, whether rural, urban or suburban.

The goal of adopting these principles is the coordination of the distribution of transportation funding in a way that will enhance the livability of States and communities across the United States.

Target User Group

States, communities and regional jurisdictions, citizens.

Financing

Livability is one of the 5 strategic priorities for the US Department of Transportation, which helps communities succeed such aims by issuing grants to eligible recipients for planning, vehicle purchases, facility construction, operations, etc. DoT administers this financial assistance according to the federal transportation authorization, which was launched at 2012. There is a large number of programs and grants within the Department of Transportation that support projects enhancing or related to livability[700].

Many Federal livability funding programs require matching funds from recipients that range from 10% to 50%.

For example, on December 4, 2015, the President signed the Fixing America's Surface Transportation (FAST) Act into law (Pub. L. 114-94). The FAST Act amended the Surface Transportation Program (STP) contained in 23 U.S.C. 133, and changed the program name to the Surface Transportation Block Grant Program (STBG). The FAST Act funds many Livability transportation programs.

The Federal share is governed by 23 U.S. Code § 120. It is generally 80%. The Federal share for projects on the Interstate System is 90%, unless the project adds lanes that are not high-occupancy-vehicle or auxiliary lanes. For projects that add single occupancy vehicle capacity, that portion of the project will revert to the 8o% level. An upward sliding scale adjustment is available to States having public lands. States may use a lower Federal share on Federal-aid projects as provided in 23 U.S. Code § 120.

Business Models

Direct federal investment, as well as funding partnerships with States, communities, and the private sector.

Technologies Employed

Various technologies are being developed and employed in different livability initiatives, such as:

1. 3D Engineered Models: Schedule, Cost and Post-Construction

Using 3D engineered models enables the highway community to effectively connect a project's design and construction phases. EDC-3 promotes the expansion of 3D applications to manage roadway inventory and assets, improve schedule and cost management, and create accurate as-built records.

2. Geosynthetic Reinforced Soil-Integrated Bridge System (GRS–IBS)

[700] US Department of Transportation (n.d.). Grants and Programs. Retrieved from: https://www.transportation.gov/livability/grants-programs

Geosynthetic reinforced soil-integrated bridge system technology can help meet the country's demand for small, single-span bridges by delivering low-cost, durable structures that can be built with readily available equipment and materials. A GRS-IBS project can be built in weeks instead of months, saving time and cutting work zone congestion.

Enabling Framework

Encouraging livable communities—places providing people access to affordable and environmentally sustainable transportation—is a policy shift for DoT. Over the last 50 years, transportation spending has often been poorly coordinated with other infrastructure investments resulting in auto-dependent residential communities, where access to job opportunities and basic amenities is insufficient and costly.

So, the livable communities initiative addresses these and other related issues to show how the US government will pursue coordinated policies and investments that increase transportation choices and access to public transportation services for all US citizens[701].

Other Aspects

There are a number of best practices that the Federal Livability Initiative has highlighted:

Indicative Case Study: Transit-oriented development leads to fewer personal vehicles. Arlington County, VA implemented transit-oriented policies to increase development density along transit lines. While there has been a 1% per year growth in population, VMT has not increased. This equates to a 20-30% percent vehicle miles of travel (VMT) per person reduction from 1980 to 2005. In fact, 47% of commute trips in the county are taken by transit, walking, or biking compared to the regional average of 29%. Newtown Pike Extension Project videos are now available on FHWA's Livability website under the Livability Videos tab. The two videos show how effective transportation planning, project development, and design preserved and enhanced the quality of life in the Davis Park Community.[702]

Indicative Best Practice Livability and Sustainability Tools: U.S. Livability and Sustainability Programs have also developed best practices that pertain to innovative tools that can be used by communities interested in enhancing their communities:[703]

Strategic Highway Research Program (SHRP2): SHRP2 was authorized by Congress to address some of the most pressing issues facing the nation's highway system: safety, infrastructure renewal, reliability, and capacity. SHRP2 is administered by the Transportation Research Board of the National Academies under a Memorandum of Understanding with the FHWA and the American Association of State Highway and Transportation Officials.

Sustainable Highways Tool (INVEST): INVEST (Infrastructure Voluntary Evaluation Sustainability Tool) is a practical, web-based collection of best practices criteria that allow states to evaluate and improve sustainable practices in their transportation projects. The use of the tool is voluntary and can be used by States or other project sponsors to measure the sustainability of their projects.

4.2.9.2 Feasibility Analysis

Availability of Technologies and Know-how within the Necessary Timeframe

Technologies used and developed through projects concerning Livability are not of novelty in Europe. However, some technologies probably need to be updated or adapted to the needs of each initiative.

Violation of Legal/Regulatory Framework in the EU

The best practice does not violate the legal or regulatory framework in the EU.

Necessary Standardization Compliant to EU Standardization Policy

There is no standardization necessary.

[701] US Department of Transportation (n.d.). Livability 101. Retrieved from: https://www.transportation.gov/livability/101
[702] See http://www.fhwa.dot.gov/livability/resources/
[703] http://www.fhwa.dot.gov/livability/fact_sheets/transdevenviron.cfm

Available Funding Models

To realize Livability projects, different funding models could be thought of such as Public Private Partnerships.

Public Acceptance due to Cultural Aspects

Despite the relatively ease of this initiative's implementation, the main barrier existing, to implement such practices in Europe, lies mainly in the urban planning of European cities that is mostly inflexible. Thus, such areas are slow to change, while there is also no homogeneity of business districts in many areas.

Additionally, in most European countries, historic heritages also emerge, often preventing the redistribution of land use.

Such aspects, including issues of public acceptance due to cultural reasons, make difficult the application of such initiatives in Europe.

Availability of Resources/Raw Materials

No issues occur regarding the availability of resources.

4.2.10 USA: MIT Changing Places

4.2.10.1 Characterisation

The "Changing Places Program" of MIT is working on the development of new strategies for cities to meet the major challenges of the future. The aim of the program is to create places where people live and work, connecting these places by building better mobility systems.[704]

Method of Implementation

Through the "Changing Places Program" of MIT new models are being investigated for urban architecture and for personal vehicles to be more responsive to the unique needs of individuals though the application of smart systems.

The idea is that rather than separating systems by function - water, food, waste, transport, education, energy – they should be considered holistically. The cities need dynamic, networked, self-regulating systems, taking under consideration also complex interactions. For this to be successfully realised, the deployment of emerging technologies should take place, in order, to develop a holistic system for cities that will be able to support the stability of their government, energy, mobility, work, and public health networks.

Target User Group

The final application of the currently researched models and technologies is to be used by all citizens who use the country's Transportation system.

Financing

The research and investigation phase – that is the current phase of this initiative – is being financed by the MIT.

Technologies Employed

The goal is the development of technology able to understand and respond to human activity, environmental conditions, and market dynamics. They are interested in finding optimal combinations of automated systems, just-in-time information for personal control as well as interfaces to persuade people to adopt sustainable behaviors.

Enabling Framework

The current methods of city design are considered to be antiquated, as they are based on designs of

[704] Changing Places (2016). Our Mission. Retrieved from http://cp.media.mit.edu/what-we-do/

centralized networks to deliver drinking water, food, and energy. These networks are also used to facilitate transportation.

However, such infrastructure design is becoming increasingly obsolete, resulting in more congested, polluted, and unsafe cities. Citizens are spending more of their time commuting, and communities are becoming increasingly isolated. This leads to a lot of cities not being able to function effectively.

4.2.10.2 Feasibility Analysis

Availability of Technologies and Know-how within the Necessary Timeframe

A basic factor for European actors, who wish to implement and/or apply a relevant program or study in Europe, is the need to consider the adoption of an entirely different way of planning and organizing a city. In order for this to be achieved, optimal combinations of automated systems need to be investigated, just-in-time information for personal control, as well as interfaces to convince people adopting sustainable behaviors.

Violation of Legal/Regulatory Framework in the EU

The best practice does not violate the legal or regulatory framework in the EU.

Necessary Standardization Compliant to EU Standardization Policy

There is no standardization necessary.

Available Funding Models

Public financing could be used or PPP schemes can also be applied.

Public Acceptance due to Cultural Aspects

The implementation of a completely new and innovative redesign of a city may result in public reactions related also to cultural aspects (i.e. reactions due to historical or religious reasons.

Availability of Resources/Raw Materials

The availability of resources concerning the implementation of such a research program does not pose a big problem. However, the implementation of new strategies and models on the redesign of cities need long-term organization and co-operation between a multitude of different stakeholders.

4.3 Focus Area 3 – Smart Mobility Services, Freight, and Logistics

4.3.1 Brazil: Uber for Trucks

4.3.1.1 Characterization

'Uber for Trucks' is the platform that helps Brazilian truckers find cargo for empty trips and find the most efficient routes.[705] The Brazilian logistics firm is using mobile technology to connect companies that need freight services to more than 100,000 independent truck drivers. CargoX, a Brazilian startup, began to operate 'Uber for Trucks' since March 2015 and expects 50 million reais (USD 15.4 million) in revenue in the first year (Business Insider 2016). Brazil reportedly has an excess of between 300,000 and 350,000 vehicles, with trucks running empty 40 percent of the time, so the goal of this app is to reduce the number of empty trucks on the highway, increasing revenue for truckers and reduce costs for freight owners.[706] The firm does not own the trucks but the network. A similar application existed earlier as well in Brazil such as TruckPad, which was created in 2013 and which has more than 481,000 truck drivers active across Brazil but it carries small loads of individuals and small and medium-sized companies/small cargo transport.[707]

Method of Implementation

CargoX has a network of 150,000 trucks. It had raised a total of USD 14 million by July 2016 and intends to use the funds to accelerate technology development and continue scaling the business.[708] In nine months since its operation, TruckPad has enlisted more than 230,000 owner operators. TruckPad provides the smartphone app and infrastructure for Brazil's independent truckers, and it is moving 350,000 shipments and 1B Brazilian Reais (~USD 300M) in shipments per month from 4,000 participating shippers and carriers.[709]

Target User Group

Brazilian independent truck drivers, that represent 55% of truck drivers in Brazil, are the target user group of Uber for Trucks.

Financing

CargoX, as a startup, has raised a total of USD 10 million through Series B financing. The new funding for CargoX was led by Goldman Sachs, with participation from existing investors including Valor Capital Group, Agility Logistics, Lumia Capital and former DHL Express US CEO Hans Hickler and Salazar.[710] The startup Truckpad was supported by 'Abril Plug and Play' and 'Plug and play International Accelerator' (incubators).[711]

Technologies Employed

The mobile application service Truckpad was used and proper infrastructure was developed to operate it.

Other Aspects

TruckPad's smartphone dependency, though, can limit it for applications requiring inter-city satellite connectivity and anti-theft equipment. So far, the limitations of the smartphone did not have a big im-

[705] Demos, T. (2016). Brazilian Logistics Startup Raises USD 10 Million From Goldman, ex-Uber Exec. Retrieved from: http://www.wsj.com/articles/brazilian-logistics-startup-raises-10-million-from-goldman-ex-uber-exec-1469024053.
[706] Ha, A., (2016). Goldman Sachs leads USD 10M investment in Brazilian trucking startup CargoX. Retrieved from: https://techcrunch.com/2016/07/20/goldman-sachs-leads-10m-investment-in-brazilian-trucking-startup-cargox/.
[707] Bastos, T. R. (2016). "Uber dos caminhões" quer revolucionar o transporte de cargas no país. Retrieved from: http://revistagloborural.globo.com/Noticias/Infraestrutura-e-Logistica/noticia/2016/06/aplicativo-quer-revolucionar-o-transporte-de-cargas-no-pais.html.
[708] FIMSMES. (2016). CargoX Raises USD 10M in Series B Funding. Retrieved from: http://www.finsmes.com/2016/07/cargox-raises-10m-in-series-b-funding.html
[709] Lanctot, R. C. (2015). Brazil's Uber for Truck. Retrieved from: https://www.linkedin.com/pulse/brazils-uber-trucks-roger-c-lanctot?trk=v-feed.
[710] Ha, A. (2016). Goldman Sachs leads USD 10M investment in Brazilian trucking startup CargoX. Retrieved from: https://techcrunch.com/2016/07/20/goldman-sachs-leads-10m-investment-in-brazilian-trucking-startup-cargox/
[711] Angel.co (2016). Track Pad. https://angel.co/truckpad

pact on the TruckPad's growth (Lanctot 2015). It has reduced the number of mostly empty trucks travelling the roadways. Beside North America (California and New york) (Graham 2015), its target markets are Mexico, India and the Phillipines.[712] Some of the examples are Uber for Truck India by theKarrier (on demand truck service)[713].

4.3.1.2 Feasibility Analysis

Availability of Technologies and Know-how within the Necessary Timeframe

Know-how is available in Europe but interaction between logistics stakeholders is necessary. The foreseen timeframe of this service's implementation is by 2030.

Violation of Legal/Regulatory Framework in the EU

The best practice does not violate the legal or regulatory framework in the EU.

Necessary Standardization Compliant to EU Standardization Policy

There is little or no standardization necessary in terms of heavy goods vehicles' weight and dimensions.[714]

Available Funding Models

No specific funding is needed and further funding models for a service such as 'Uber for Trucks' need to be explored.

Public Acceptance due to Cultural Aspects

There are no perceived obstacles regarding public acceptance due to cultural aspects.

Availability of Resources/Raw Materials

The resources are already available in terms of infrastructure and ICT.

Additional Aspects

For the efficient freight services and reducing number of empty trucks running on the roads, interaction between logistics stakeholders has to be improved and the horizontal co-operation synergies between stakeholders and companies need to be enhanced. This could be achieved by pushing progress towards the establishment of a common pan-European logistics management platform built on the physical internet in a collaborative economy.

4.3.2 India: Smart Cycle and Auto Rickshaw Services

4.3.2.1 Characterisation

Cycle and auto rickshaws are the preferable public transport for short to medium distance travel in India. Various mobile and web applications has enhanced its use more effectively as well as efficiently.

Method of Implementation

In order to strengthen and promote the existing rickshaw network, a community based initiative was taken with the use of Ecocab service. The rickshaw drivers are registered in the dial-a-rickshaw facility, using Ecocab app or direct web app, with their contact details and can be contacted through the facility. For the longer distance travel within the city Indians use auto rickshaw, but have the hassles of waiting by roadsides. . The network of auto rickshaws are well organised through Pooch-O and G-Auto services or apps. Similar to Ecocab services, auto rickshaw drivers are registered with contact details in Pooch-O and G-Auto, and are accessible by a dial. The Delhi government runs the apps

[712] Lanctot, R. C.(2015). Brazil's Uber for Truck. Retrieved from: https://www.linkedin.com/pulse/brazils-uber-trucks-roger-c-lanctot?trk=v-feed.
[713] Peer, N. (2015). India's Uber for trucks TheKarrier bags USD 230K funding. Retrieved from https://www.techinasia.com/india-thekarrier-funding.
[714] European Commission (2016). Roads: Weights and dimensions. Retrieved from: https://ec.europa.eu/transport/modes/road/weights-and-dimensions_en.

Pooch-O and the backend data of the app is handled by Delhi Integrated Multi-Modal Transit System Ltd.

Target User Group

It is targeted for cycle and auto rickshaw users in small cities.

Financing

Private investors are active in developing and implementing the services.

Technologies Employed

It requires smart phone, mobile and web applications.

Other Aspects

The increased use of cycle rickshaw has reduced the number of empty trips on the parts of the operator and improved the overall efficiency of the system. Rickshaw operators have also increased their income by 25-30% by 1 to 2 calls per day and saved the waiting time for customers. Also the increase in use of rickshaw travel has replaced cars for shorter distances and saved the fuel consumption up to 3 litres a day and related emissions.[715]

4.3.2.2 Feasibility Analysis

Availability of Technologies and Know-how within the Necessary Timeframe

Know-how is available and the initiative such as Smart Cycle and Auto Rickshaw Services is easily applicable which support local mobility innovation hubs.

Violation of Legal/Regulatory Framework in the EU

The best practice does not violate the legal or regulatory framework in the EU.

Necessary Standardization Compliant to EU Standardization Policy

There is no standardization necessary.

Public Acceptance due to Cultural Aspects

There are no perceived obstacles regarding public acceptance due to cultural aspects and public are well aware on NMT and smart mobility services.

Availability of Resources

Resources are available

Additional Aspects

This best practice motivates the initiatives on smart mobility services and the support for the local mobility innovation hubs that answer culture-specific mobility demand.

Bike sharing and car sharing apps are well used. Cycle rickshaws are only used in tourist areas and for shorter distances. The demand for cycle rickshaws can enhance developing own smart mobility services for culture-specific mobility demand.

4.3.3 South Korea: Uiwang ICD Dry Port

4.3.3.1 Characterization

Dry ports are logistics facilities that can carry out inter-modal transportation among roads, rails, ports and airports. Intermodal transport offers door-to-door service through the integration of various modes of transport in the logistics chain, improved coordination and services, and the development of intermodal interfaces. Inland logistics bases are divided into multimodal logistics terminals and inland con-

[715] Arya, S., Nair, A. (2013). IIM graduate who drives autorickshaw business. Retrieved from: http://timesofindia.indiatimes.com/city/nagpur/IIM-graduate-who-drives-autorickshaw-business/articleshow/19027194.cms

tainer bases. One such multimodal logistics terminal was built in five districts in South Korea. The Uiwang Dry Port is the largest dry port in South Korea and is located 25km from Seoul.

Method of Implementation

Uiwang ICD has the capacity of 1.3 million Twenty Foot Equivalent Unit (TEU)[716] and has container yard of 417 m^2.[717] In 2006, more than 2 million (TEU) containers were handled at Uiwang ICD. Further, the road mode share was approximately 75%, except for a drop in 2008. The rail mode share of throughput handled by the ICD was about 25% in 2010, even though the ICD was running over capacity.

Considering the movement of goods in the same single loading unit or road vehicles that successively used rail and road transport modes; and the use of railways for transport from the Uiwang ICD to seaports has helped ease road traffic congestion and reduce vehicle emissions. The role of the Public and Private Infrastructure Investment Management Center (PIMAC) in connecting port and ICD with high-capacity railway can even reduce road congestion. An expansion of the ICD's capacity would further enhance the environmental benefits, as would an increase in the rail mode share of freight.

Target User Group

The Ministry of Land, Transport and Maritime Affairs (MLTM) is the regulatory authority responsible for the planning, construction, and management of dry ports in the Republic of South Korea. MLTM encourages private sector investment in the development of dry ports and logistics centers. Other stakeholders are the Korean Railroad Company and private transportation companies.

Financing

The Korean Railroad Company and private transportation companies have invested in the Uiwang ICD through public-private partnership.

Enabling framework

In 1980, the South Korean government initiated a policy to develop inland logistics centers, also known as dry ports, and Uiwang Inland Container Depot (ICD) dry port was operated in 1993. It includes all necessary functionalities to meet the requirements of trade. It has rail capacity of 36 trains per day along with road transportation. The utilization of its capacity shows that the road mode and rail mode share of throughput handled by the ICD was approximately 75% and 25% respectively.[718]

Other aspects

Some of the success factors of Uiwang ICD are: Relief of Traffic Congestion by large volume of Railroad Transport (Capacity of daily Railroad Transport : 2,600 TEU), Utilization as Clearance Depot for Capital Region's Import/Export Container cargoes (Curtailment of cost and time), Perform the Function of CY/CFS at Inland as Ports (Relief of Accumulated cargo at Ports) and Operate an Information system of transportation logistics for efficient and fast customer (Supplying Logistics Information at real time).[719] Some of other the dry ports in Asia are in Thailand, India, China and Nepal.[720]

4.3.3.2 Feasibility Analysis

Availability of Technologies and Know-how within the Necessary Timeframe

Europe has necessary technologies and know-how available to multi-modal freight services through dry port. The implementation of similar service as 'Uiwang ICD dry port' in Europe could be done by 2020.

[716] Choedhary, H. K. (2014). The role of "Dry Port" in the intermodal maritime transportation network. Retrieved from: http://linershipping24.blogspot.de/2014/12/the-role-of-dry-port-in-intermodal.html
[717] Uiwang ICD (n.d.). Retrieved from: http://unnext.unescap.org/swi-icd.pdf
[718] Chowdhury, H. K. (2014). The role of "Dry Port" in the intermodal maritime transportation network. Retrieved from: http://linershipping24.blogspot.de/2014/12/the-role-of-dry-port-in-intermodal.html
[719] Uiwang ICD. Retrieved from: http://unnext.unescap.org/swi-icd.pdf
[720] Chowdhary, Humayun Kabir 2014. The role of "Dry Port" in the intermodal maritime transportation network. Retrieved from: http://linershipping24.blogspot.de/2014/12/the-role-of-dry-port-in-intermodal.html

Violation of Legal/Regulatory Framework in the EU

The best practice does not violate the legal or regulatory framework in the EU.

Necessary Standardization Compliant to EU Standardization Policy

Common standardisation and interoperability is necessary, which is not a major issue.

Available Funding Models

Like several stages in intermodal transport development, such as in port infrastructure, there might be a potential of overinvestment, duplication and redundancy as many inland locations would like to claim a stake in global value chains. This might happen in Western Europe where an abundance of inland terminals, particularly within the Rhine/Scheldt delta, which indicates an over competitive environment and the ambitions of local and regional authorities to establish logistics hubs for Europe.[721]

Public Acceptance due to Cultural Aspects

There are no perceived obstacles regarding public acceptance due to cultural aspects.

Availability of Resources/Raw Materials

Resources would play a greater role within containerized trade with inland terminals, depending on the regional characteristics. This implies a set of repositioning strategies where inland terminals play a fundamental role. To improve the efficiency of this repositioning, better cargo rotation opportunities are to be provided.[722]

Additional Aspects

A large concentration of dry ports are around the Rhine/Scheldt delta, which is Europe's most important gateway region with a total container throughput of 23.2 million TEU in 2011, and where the function of satellite terminals is prominent. Almost every European port has an inland terminal strategy as a way to secure hinterland traffic and has the strong reliance of more local container volumes on trucks. As road haulage in Europe plays a major role in shaping competition among load centres of the same multi-port gateway region for the immediate hinterland, intermodal transport is slowly but surely acquiring a strategic role as well. In northwest Europe, rail networks and rail-based dry ports are being challenged by barge transport and bimodal barge/truck terminals which are taking up a very prominent role in dealing with gateway traffic, particularly in the Benelux, northern France and parts of Western Germany.[723] Proper location and infrastructure for dry ports in Europe pushes integration of multimodal freight services (e-freight) to increase efficiency and eco-performance.

4.3.4 USA: Smart City Challenge

4.3.4.1 Characterization

The vision of the Smart City challenge in the USA is to bring innovative ideas from cities around the country that include integrated and efficient transportation network. It provided incentive through a funding competition amongst the participating cities.

Method of Implementation

The USDOT Smart City Challenge allowed many stakeholders and companies to come together and collaborate to define and implement country based smart city. 1,400 local officials, companies, academics and non-profit associations joined the first webinar on the smart city challenge. 800 people participated in the Smart City Forum, 300 companies expressed interest in partnering, 78 applications received for the Smart City Challenge, 7 Smart City Challenge Finalists were announced at South by Southwest (SXSW) and 1 Smart City Challenge Winner was crowned.[724] 82% of applicants included

[721] Rodrigue, J., Notteboom, T. (n.d.). Dry Ports in European and North American Intermodal Rail Systems: Two of a Kind? Retrieved from: https://people.hofstra.edu/jean-paul_rodrigue/downloads/RTBM%20Dry%20Ports%20Rodrigue%20Notteboom.pdf
[722] ebd.
[723] ebd.
[724] USDoT (2016). Smart City Challenge. Retrieved from: https://www.transportation.gov/smartcity

vehicle automation concepts as part of their Smart City Vision and many applicants identified opportunities for scaling automated vehicles to connect disadvantaged communities.[725]

Target User Group

Stakeholders for smart city challenge include local officials, companies, academics, and non-profit associations.

Financing

The USDOT has pledged up to USD 40 million to the city which defines the "Smart City' for the country and also fully integrates innovative technologies – self-driving cars, connected vehicles, and smart sensors – into their transportation network.[726] Columbus, the winner of the challenge, was able to grab the prize money. It also received USD 10 million from Paul G. Allen's Vulcan Inc. and additional USD 90 million that the city has already raised from other private partners to carry out the plan.[727] Also, seven Smart City finalists (out of 78 cities) were awarded USD 100,000 to support concept development and planning activities.

Enabling Framework

The U.S. Department of Transport (USDOT) issued the Smart City Challenge in December 2015 to encourage cities to put forward their best and most creative ideas for innovatively addressing their own challenges. 78 cities participated and developed visions and plans addressing how emerging transportation, data, technologies, and applications can be integrated with existing systems in their city. They took into consideration the transportation challenges – including challenges identified by the USDOT in its 2045 Beyond Traffic report. Altogether 7 smart cities finalists - Austin, San Francisco, Portland, Pittsburgh, Kansas, Columbus and Denver were selected in March 2016 and the at the end Columbus won the Smart City Challenge in June 2016.[728]

Other Aspects

The 7 finalists of Smart City Challenge took the initiative to demonstrate that the future of transportation is not just about using technology to make the systems safer and more efficient but using the advanced tools to make life better for all people, especially those living in underserved communities.

The challenge winner, Columbus, plans to work on reshaping the city to harness the power and potential of data, technology, and creativity to reimagine how people and goods move throughout the city. Its collaboration between public, private and nonprofit sectors is the perfect example of how they connect the residents and all communities. Its multimodal transportation system will not only benefit the people of central Ohio, but potentially all mid-sized cities. It plans to deploy three electric self-driving shuttles to link a new bus rapid transit center to a retail district, connecting more residents to jobs, and also use data analytics to improve health care access in a neighbourhood that currently has an infant mortality rate four times that of the national average, that allows them to provide improved transportation options to those most in need of prenatal care.[729]

4.3.4.2 Feasibility Analysis

Availability of Technologies and Know-how within the Necessary Timeframe

Know-how is available in the European cities but direct implementation of the concept as 'US: Smart city challenge' might be difficult in EU level. Business cases for smart city challenges can be formed for one city in a country.

[725] Cronin, B. (2016). Beyond Traffic: The Smart City Challenge. Automation in the Smart City.
[726] Smart City Challenge (2016). New: Secretary Foxx Announces Additional Advanced Transportation Technology Grants at White House Frontiers Conference. Retrieved from: https://www.transportation.gov/smartcity
[727] US Department of Transportation. (2016). U.S. Department of Transportation Announces Columbus as Winner of Unprecedented USD 40 Million Smart City Challenge. Retrieved from: https://www.transportation.gov/briefing-room/us-department-transportation-announces-columbus-winner-unprecedented-40-million-smart
[728] Cronin, B. (2016). Beyond Traffic: The Smart City Challenge. Automation in the Smart City.
[729] US Department of Transportation. (2016). U.S. Department of Transportation Announces Columbus as Winner of Unprecedented USD 40 Million Smart City Challenge. Retrieved from: https://www.transportation.gov/briefing-room/us-department-transportation-announces-columbus-winner-unprecedented-40-million-smart

Violation of Legal/Regulatory Framework in the EU

The best practice does not violate the legal or regulatory framework in the EU.

Necessary Standardization Compliant to EU Standardization Policy

The necessary standardization is available.

Available Funding Models

In order to develop a business case for smart city challenge in Europe, it is required to create funding competition for smart and sustainable city development that triggers leverage effects within the EU and that leads to the establishment of a European transportation platform for mutual learning and exchange of experiences.

Public Acceptance due to Cultural Aspects

There are no perceived obstacles regarding public acceptance due to cultural aspects.

Additional Aspects

Europe requires co-ordination on EU-wide transport related data management and digital services and form a platform where public, private and non-profit sectors collaborate for citizen's efficient mobility. This will lead to strong collaboration among stakeholders to strengthen transportation network.

4.4 Focus Area 4 – Standardization and Interoperability

4.4.1 South Korea: Smart Transportation Card

4.4.1.1 Characterisation

The Smart Transit Cards and Integrated Fare Collection System, also known as T-Money, is a unified fare smart card system used for public transportation. It is an integrated fare collection system that provides nationwide compatibility and allows users to pay for almost all kinds of public transport with a single card. It is based on a re-chargeable series of cards and other smart devices used for paying transportation fares.[730]

Method of Implementation

The T-money card can be used to pay for public transportation, including bus, train, and taxi service, and also as e-money to make purchases such as car sharing, at vending machines, convenience stores, and museums, to pay fines or taxes, and even as a mileage or membership card. As of March 2009, customers used T-money for 30 million public transit transactions per day (15.4 million bus and 14.6 million subway transactions) within the Seoul metropolitan area, 18 million T-money smart cards have been issued, with T-money accepted at the reader terminals of 19,750 buses; over 8,000 subway terminals; 73,000 taxi cabs; 21,000 vending machines; and 8,300 convenience stores, fast food stores, and parking garages.[731] The card users can also build mileage points that can be used to pay fares later on.[732]

Target User Group

The Smart Transit Cards are targeted to everyone. The only prerequisite is a bank account and credit card. Since it can be used for a variety of different services it is not limited to a certain group of the population.

[730] Korea Smart Card Co., Ltd. (2016). Retrieved from http://eng.koreasmartcard.com

[731] Ezell, S. (2010). Explaining International IT Application Leaderhip: Intelligent Transportation Systems. Retrieved from http://www.itif.org/files/2010-1-27-ITS_Leadership.pdf.

[732] Korea4Expats.com. (2016)T-money - Transit Smart Card. Retrieved from http://www.korea4expats.com/article-tmoney-seoul-transit-smart-card.html

Financing

It was developed by Korea Smart Card Co., Ltd., a joint venture spearheaded by The Seoul Metropolitan Government and including LG Group, credit card companies, and smaller telecommunications companies and financially supported by the Asian Development Bank.[733]

Enabling Framework

The T-money card was launched in April 2004 for paying transportation fares in and around Seoul and other cities in South Korea. T-money terminals are installed at stations in the same year and slowly its facilities were extended, such as refilling services and use in shops. Since then it has made substantial progress, it is now useable nationwide and for many other services (as mentioned above).

Other Aspects

As Seoul's subway system has moved from paper tickets to smart cards, it has eliminated the need for 450 million paper magnetic stripe tickets at a savings of KRW 3 billion per year.[734] It thus contributes enormously to the country's sustainability. The successful system was already exported to New Zealand, Malaysia, Mongolia, and Colombia.[735]

4.4.1.2 Feasibility Analysis

Availability of Technologies and Know-how within the Necessary Timeframe

Know-how is available. A similar system has been implemented in the Netherlands, the Dutch Public Transport Smart Card. It works like London's Oyster Card, however, it can be used throughout the entire country. Whereas the South Korean Smart Card is also useable for purchases at vending machines and in shops, the Dutch OV-chipkaart is only useable for public transportation. To establish a single transportation system the challenge for Europe would be to create a single card that is interoperable and useable EU-wide for both transportation, including public transportation as well as individual mobility options such as car sharing, and shopping.

Violation of Legal/Regulatory Framework in the EU

Disparities in national legislations and tax systems might hamper the EU-wide roll-out of such system. Considering that such system would have to be implemented on EU-level, the different regulatory systems would therefore have to be harmonized. Privacy protection laws have been introduced in Austria, Belgium, Denmark, France, Germany, Luxembourg, the Netherlands, Spain and Sweden.[736]

Necessary Standardization Compliant to EU Standardization Policy

Most standardization on intelligent transport systems is undertaken internationally by ISO. For the operation of a smart fare system the "ISO/TC204 Intelligent Transport Systems", and especially the subordinated ISO/IEC 24014 "Public Transport Interoperable fare management system" is applicable.

Public Acceptance due to Cultural Aspects

There are no perceived obstacles regarding public acceptance due to cultural aspects. The easier access of public transportation across Europe would, in fact, facilitate passengers moving across the continent and add to their convenience. However, in comparison to other parts of the world, Europeans tend to be very careful with their data. Handing over their payment details to a company outside of their country might reduce the overall acceptance. Guaranteeing data security is therefore pivotal for such an integrated fare collection system to be rolled out EU-wide.

[733] Hwang, S., Kim, G. (2014). 50 Praxes for Better Transport in Korea, The Korea Transport Institute, Gyeonggi-do, 411-701, Republic of Korea, p. 14.
[734] Ezell, S. (2010). Explaining International IT Application Leaderhip: Intelligent Transportation Systems. Retrieved from http://www.itif.org/files/2010-1-27-ITS_Leadership.pdf.
[735] Sojung, Y. (2016). Korean transport systems gain international recognition. Retrieved from http://www.korea.net/NewsFocus/Business/view?articleId=138090.
[736] OECD (2016). OECD Guidelines on the Protection of Privacy and Transborder Flows of Personal Data. Retrieved from: https://www.oecd.org/sti/ieconomy/oecdguidelinesontheprotectionofprivacyandtransborderflowsofpersonaldata.htm

Availability of Resources

The resources are available since such card does not require different materials as the already used cards with magnetic stripes or chips.

Additional Aspects

Smart transportation with easy and convenient payment services prospectively encourages citizens to use public transportation. This will further strengthen the shift towards sustainable transportation.

4.4.2 USA: NHTSA/SAE Standards

4.4.2.1 Characterisation

The NHTSA standards are a classification system identifying six levels of automated driving, which range from “no automation” up to “full automation”. Similar automation levels were published by SAE in 2014.

The NHTSA standards, first published in 2013 within its Policy on Automated Vehicles, are a classification system identifying six descriptive levels of automated driving which range from “no automation” up to “full automation”. In 2014 similar automation levels were published by SAE. In opposition to standards set by the German Federal Highway Institute (BASt) in 2010 the NHTSA could reach global visibility and influence. It is assumed that the BASt did not manage to make their standards more visible simply because of a timing issue. NHTSA levels of automation played a big role in international SAE standards setting. Jurisdiction orients law-making along the NHTSA levels of automation.

As the auto industry wanted to establish fully autonomous cars as quickly as possible on the roads, NHTSA, SAE and BASt wanted to simplify the path to this goal not only from a technical but also from a legal and commercialisation perspective.[737]

Method of Implementation

On 20 September 2016, the DOT issued a Federal policy for automated vehicles to lay a path for the safe testing and deployment of new auto technologies. This policy should help to harness the benefits of transformative technologies as it provides a framework for how to do it safely.

The policy tries to provide safety assurance and facilitate innovation by means of four key parts. Vehicle performance guidance uses a 15-point Safety Assessment to set clear expectations for manufacturers developing and deploying automated vehicle technologies. Model state policy delineates the Federal and State roles for the regulation of highly automated vehicle technologies as part of an effort to build a consistent national framework of laws to govern self-driving vehicles. Finally, the policy outlines options for the further use of current federal authorities to expedite the safe introduction of highly automated vehicles into the marketplace, as well as discusses new tools and authorities the federal government may need as the technology evolves and is deployed more widely.

This Policy also emphasizes that semi-autonomous driving is too dangerous to realize as drivers are not able to retake control of the vehicle fast enough in safety-critical situations.[738]

Financing

Projects and Researches are financed through Department of Transportation (DOT).

Targeted User Group

Future users of automated cars will be developers, manufacturers, general public, politics and jurisdiction.

Other Aspects

[737] Hars, A. (2016). Fatal Tesla accident exposes fundamental flaws in the levels of driving automation framework.Retrieved from: http://www.driverless-future.com/?cat=9.
[738]NHTSA. (2016). U.S. DOT issues Federal Policy for safe testing and deployment of automated vehicles. Retrieved from: https://www.nhtsa.gov/About-NHTSA/Press-Releases/dot_federal_policy_for_automated_vehicles_09202016

The standards are rather descriptive, not regulatory, and more normative and technical than legal. They have been criticized for favouring a gradual evolution of their systems towards fully autonomous driving and by doing so putting too much focus on the technological perspective while neglecting the human factor. It was also suggested during the 2nd Validation Workshop that the human factor shall be heavily increased in standard setting.

4.4.2.2 Feasibility Analysis

Availability of Technologies and Know-how within the Necessary Timeframe

Considering that similar standards have already been issued by the German Federal Highway Institute in 2010, the expertise within Europe is available. The goal is to take on the lead in international standard setting by building on the existing knowledge.

Violation of Legal/Regulatory Framework in the EU

New standards have to follow the usual standardisation procedures in the EU as well as other (international) binding ratifications such as the Vienna Convention.

Additional Aspects

If there is too much standardization in Europe, companies are discouraged from innovation; too little standardization discourages investment. National protectionism makes it hard to establish international standards; they are in fact used for protectionist reasons. Therefore, the costs and benefits of standardization both in Europe and internationally need to be analysed in each individual case and for each innovation put forward.

4.5 Focus Area 5 – Alternative Fuels Other than Electrification

4.5.1 South Korea: Ulsan Hydrogen

4.5.1.1 Characterisation

Ulsan, home of Hyundai's complex including its fuel-cell production, is on its way to become Korea's pilot hydrogen city producing 60% of Korea's hydrogen demand for power plant, residential use, transportation and portables, mainly through petrochemical complex to renewable sources.

Method of Implementation

Using the advanced and developed petrochemical industry in Ulsan, it is supporting green industries by utilizing by-product gases (CO2, H2) from petrochemical complex to renewable sources.

Target User Group

Citizens of Ulsan at first and then expanded in the whole country.

Technologies Employed

Petrochemical complex to renewable sources. Collection, purification and transfer of by-product gas and percolation to:

- Green Polymers and
- Green energy

Enabling Framework

Petrochemical industry covers 55% of the total industrial output in Ulsan.

Other aspects

Conformity of by-product H2Industry:

- Recycling
  - Reutilization of by-product H2as Eco-friendly Energy source;

- Transformation of by-product CO2to Eco-friendly product.

- CO2 reduction
  - Innovative and ultimate route to reduce CO2
  - Profits as CERs(certified emission reductions)
- Conformity (Policy)
  - Compatibility to Nation's policy "Low carbon & green growth"
  - Achievement of original technology based on by-product gases
  - Upgrade chemical industry by a higher value-added technologies
- Ulsan's condition
  - Hub of petro-chemistry and transportation industries
  - Regional merits to get by-product gases with large industrial complex
  - Representative city to lead nation's new energy and high value industries

4.5.1.2 Feasibility Analysis

Availability of Technologies and Know-how within the Necessary Timeframe

There is some lack of expertise and know-how in the area of processing hydrogen that needs to be covered, mainly due to lack of appropriate framework.

However, there are currently some important initiatives towards the hydrogen industry, such as the HyER, the European Association for Hydrogen and fuel cells and Electro-mobility in European Regions (formally HyRaMP), was established in collaboration with the EU sion in 2008. HyER supports the deployment and uptake of hydrogen and fuel cell technologies and electro-mobility in Europe.

Violation of Legal/Regulatory Framework in the EU

Lack of appropriate legal framework concerning the use of hydrogen cars.

Necessary Standardization Compliant to EU Standardization Policy

Standardization issues will probably need to be resolved.

Available Funding Models

Government or other EU funding; PPP schemes.

Public Acceptance due to Cultural Aspects

There are no perceived obstacles regarding public acceptance due to cultural aspects.

Availability of Resources/Raw Materials

Hydrogen can be produced from a wide range of renewable energy sources, providing low or zero emission energy to all energy consuming sectors. Efficiently producing hydrogen from renewable sources is a key enabler for these developments. Traditionally, hydrogen has been produced from fossil sources by steam methane reforming of natural gas.

However, there are also alternative hydrogen generation technologies that could be further investigated and developed in order to promote and develop the hydrogen industry.

Additional Aspects

Some additional aspects that need to be taken under consideration are the following:

- Limitation of the use and production of hydrogen cars;
- Security issues concerning the use of hydrogen cars;

- Lack of financial resources.

4.5.2 USA: California's Zero Emission Vehicle (ZEV) Program

4.5.2.1 Characterisation

Mobile sources account for well over half of the emissions which contribute to ozone and particulate matter and nearly 40% of the greenhouse gas emissions in California. The Air Resources Board of the California Environmental Protection Agency (ARB) has been a leader in developing programs designed to reduce emissions from such sources. In order to meet California's air quality standards and greenhouse gas emission reduction goals, the transformation away from petroleum, regarding the use of cars, has been defined as a critical point

In this context, ARB has adopted a new approach to passenger vehicles (namely cars and light trucks) by combining the control of smog-causing pollutants and greenhouse gas emissions into a coherent coordinated package of standards. This approach also includes the support and acceleration efforts concerning the numbers of plug-in hybrids and zero-emission vehicles in California. [739]

Method of Implementation

The main implementation method of the ZEV program is the regulation setting. The ZEV regulation has historically been based on reducing criteria pollutant emissions. Based on emissions modeling results for the light duty vehicle sector in 2050, and the 2009 ZEV Technology Review, the staff is currently working now on adjustments to the regulation to focus on plug-in hybrids and pure ZEVs in order to enhance the development of such technologies for large scale market penetration.[740]

OEMs are required to have a certain amount of ZEV in their fleet, otherwise they are not allowed to sell any cars in California.

The ARB has also adopted, in coordination with the United States (U.S.) Environmental Protection Agency (EPA) and National Highway Traffic Safety Administration (NHTSA), the Advanced Clean Cars (ACC) program in 2012. This program, is combing the control of smog-causing pollutants and greenhouse gas (GHG) emissions into a single coordinated set of requirements for model years 2015 through 2025. The goal of ACC is to assure the development of environmentally superior passenger cars - and other vehicles as well - that will continue to offer their owners the expected performance**,** utility, and safety, while also saving them money and fuel.

Target User Group

Citizens of California and USA in general

Financing

The programme is publicly financed by the Federal State of California.

Technologies Employed

The success of the ZEV program, and of the ACC program in particular, requires regular assessment of the state of technology related to the clean vehicles aforementioned, industry parameters, and the consumer market, so as to ensure the maximum benefits possible. That's the reason why, ARB has (co) sponsored research projects to support this kind of development.

Enabling Framework

The really heavy traffic system of California (i.e. over 23 million registered vehicles, over 797 million

[739] California Environmental Protection Agency – Air Resources Board (2016). 2010-2012 Zero Emission Vehicle (ZEV) Regulatory Activities. Retrieved from: https://www.arb.ca.gov/msprog/zevprog/zevprog.htm

[740] California Environmental Protection Agency – Air Resources Board (2016). Zero Emission Vehicle (ZEV) Program. Retrieved from: https://www.arb.ca.gov/msprog/zevprog/zevprog.htm

miles driven every day and over 37 million gallons of gasoline consumed each day, according to 2000 data), as well as the effect this had to the breathing air of Californians, is what urged the ARB and other relevant bodies to commit to this program.

4.5.2.2 Feasibility Analysis

Availability of Technologies and Know-how within the Necessary Timeframe

Under this program no technologies are being developed but their research and development is supported, mainly through sponsoring.

Violation of Legal/Regulatory Framework in the EU

No violation of the EU Legal/Regulatory Framework

Necessary Standardization Compliant to EU Standardization Policy

There is probably no standardization necessary.

Available Funding Models

Public financing or application of PPP schemes.

Public Acceptance due to Cultural Aspects

There are no perceived obstacles regarding public acceptance due to cultural aspects.

Availability of Resources/Raw Materials

The European Union already puts a big part of the overall R&D expenditure into the research concerning the clean vehicles and the reduction of emissions. Therefore, the resources are already available.

4.5.3 USA: Clean Cities

4.5.3.1 Characterisation

The U.S. Department of Energy's (DoE's) Clean Cities program is supporting actions for the elimination of petroleum use in transportation. With almost 100 local coalitions involved in the Clean Cities program, consisted of businesses, fuel providers, vehicle fleets, state and local government agencies, community organizations etc. nearly 15,000 stakeholders participate the program and through their collective efforts are contributing to Clean Cities' goals and accomplishments.

Method of Implementation

These stakeholders share information and resources, inform public policy, educate the public, and collaborate on transportation projects[741].

Target User Group

US citizens. Clean Cities works with large corporate fleets (Coca Cola, Best Buy, etc.) to cut petroleum use. The initiative provides fleets with resources, expertise, and support to incorporate alternative fuels and fuel-saving measures into their operations.

Financing

The program has awarded nearly USD 400 million in matching funds through U.S. Department of Energy funding opportunities and leveraged resources to help communities lay the foundation for more than 500 alternative fuels and vehicle projects.

Technologies Employed

Fuel Economy Technologies

[741] Department of Energy (2016). Clean Cities. Retrieved from https://cleancities.energy.gov/

In 2012 alone, Clean Cities activities -- which include idle-reduction measures and fuel economy improvements -- helped prevent nearly 7 million tons of greenhouse gas emissions. That's equivalent to taking nearly 2 million cars off the road for an entire year.

Alternative Fuel and Advanced Vehicle Aggregating Initiatives

In 2016, the U.S. Department of Energy announced awards for two projects totaling USD 2.9 million to support aggregate purchasing models for plug-in electric and other alternative fuel and advanced technology vehicles, subsystems, alternative fuels, and refueling/charging infrastructure. Through these two awards, the Aggregated Alternative Technology Alliance and CALSTART coordinated, aggregated purchasing among national and regional partners will maximize collective buying power. These projects will address two major barriers to the growth in production and sales of alternative fuel and advanced vehicle technologies: manufacturers' uncertainty around demand and buyers' high upfront costs. Awardees will work with fleets and other buyers to consolidate orders and develop best practices for procurement aggregating initiatives.

Enabling Framework

Clean Cities dates back to the Alternative Motor Fuels Act of 1988 and the Clean Air Act Amendments of 1990. These laws, which encouraged the production and use of alternative fuel vehicles (AFVs) and the reduction of vehicle emissions, led to the creation of the Alternative Fuels Data Center (AFDC) in 1991. The AFDC's mission was to collect, analyze, and distribute data used to evaluate alternative fuels and vehicles.

In 1992, the enactment of the Energy Policy Act of 1992 (EPAct) required certain vehicle fleets to acquire AFVs. Subsequently, DOE created Clean Cities in 1993 to provide informational, technical, and financial resources to EPAct-regulated fleets and adopters of alternative fuels and vehicles.

In 2014, greenhouse gas emissions from transportation were considered the second largest factor of U.S. greenhouse gas emissions, beyond the electricity sector. Greenhouse gas emissions from transportation have increased nearly 17% since 1990, mainly due to increased demand for travel, making the need for programs like Clean Cities more urgent.

Other Aspects

As mentioned above, Clean Cities has awarded nearly USD 400 million through its funding opportunities for hundreds of projects across the country to reduce petroleum use in transportation. These projects have included among other initiatives the following ones:

- Introducing all-electric and hybrid electric vehicles into public and private fleet
- The conversion of conventional vehicles to run on natural gas and propane
- Installing refuelling infrastructure
- The installation of idle-reduction equipment in school buses and tractor trailers
- Developing E85 (85% ethanol, 15% gasoline) fuelling stations along busy transportation corridors.

Furthermore, the Alternative Fuels Data Center (AFDC), which provides information, data, and tools to help fleets and other transportation decision makers find ways to reduce petroleum consumption through the use of alternative and renewable fuels, advanced vehicles, and other fuel-saving measures, is an outcome of the Clean Cities program. The site also provides tips for drivers on maximizing fuel efficiency. FuelEconomy.gov was created in response to DoE's requirement under the 1975 Energy Policy and Conservation Act to publish and distribute an annual fuel economy guide for consumers[742].

4.5.3.2 Feasibility Analysis

Availability of Technologies and Know-how within the Necessary Timeframe

[742] Department of Energy (2016). Clean Cities. Retrieved from https://cleancities.energy.gov/

There is no issue regarding lack of expertise and/ or technologies.

Violation of Legal/Regulatory Framework in the EU

No violation of the EU Legal/Regulatory Framework

Necessary Standardization Compliant to EU Standardization Policy

There is no standardization necessary.

Available Funding Models

Public-Private-Partnerships

Public Acceptance due to Cultural Aspects

There are no perceived obstacles regarding public acceptance due to cultural aspects.

Availability of Resources/Raw Materials

Despite the fact that the European Commission and European countries have invested in the limitation of petroleum use and the reduction of the respective pollutants in recent years, such an initiative could still flourish in Europe considering the remaining lack of alternative fuels production (i.e. biofuels).

Additional Aspects

In addition, another obstacle can be considered the great emphasis given in Europe on the development of electrification rendering alternative fuels and their development and use of secondary importance.

4.6 Additional Best Practices from Countries outside of the Study's Scope

4.6.1 Singapore: Electrified Automated Shared Mobility (Focus Area 1, 2, 3, 5)

The start-up company Nutonomy, a MIT-spinoff, started to offer its service with six vehicles in the 2.5-km^2 university district One-North in 2016. Until the end of the year the company plans to deploy 12 vehicles with a whole fleet until 2018. The company's goal is to reduce vehicles from 900,000 to 300,000. The service is ordered via a Smartphone app, similar to other car and ride sharing services. In September 2016 Nutonomy partnered with Grab (see Transport Network Companies in Manila, Philippines). Around 40,000 drivers are registered in Singapore.[743] So far the vehicles only manoeuvre their passenger between fixed pick-up and drop-off spots and there is always a human driver in case of system failures and a technician for data analyses. As compensation the ride is for free though. For their service Nutonomy uses the Renault Zoe and Mitsubishi i-MiEV, both fully electric vehicles.[744]

Singapore's steady climate without any hazardous weather conditions, its advanced infrastructure and the acceptance of its population to follow traffic rules is very beneficial for testing self-driving vehicles. Also from a market perspective car and ride sharing business models promise to be very fruitful because only around 15% of Singapore residents own a car, owing to the high taxes and fees.[745]

This serves as a best practice since it is the first and only example that brings together the three biggest trends in mobility: automation, electrification and Mobility as a Service.

[743] Yuniar, R. W. (2016). Grab Joins nuTonomy to Offer Self-Driving Taxis in Singapore. Retrieved from http://www.wsj.com/articles/grab-joins-nutonomy-to-offer-self-driving-taxis-in-singapore-1474598345

[744] Hein, C. (2016). In Singapur fahren die Taxis nun selbst. Retrieved from http://www.faz.net/aktuell/wirtschaft/neue-mobilitaet/selbstfahrende-taxis-in-singapur-14405490.html

[745] Kirk, M. (2016). Why Singapore Will Get Self-Driving Cars First. Retrieved from http://www.citylab.com/commute/2016/08/why-singapore-leads-in-self-driving-cars/494222/

4.6.2 Canada: Mobility Ecosystem in Toronto City Planning (Focus Area 2)

In view of the fast growing shared mobility systems in urban regions in the last decade, Toronto City introduced a new innovative mobility master planning process. The process incorporates a quantitative mobility analysis and infrastructure assessment process, and addresses people-oriented needs while redesigning scarce public spaces and the mobility delivery system. Considering the impact of shared mobility options on city policies and planning practices, the model reinforces the low-carbon option while addressing environmental and health benefits as well as social equity in mobility planning for all users. Urban designers involved in the process argue that "smart mobility planning only emerges if inhabitants participate through a transparent process that includes, for example, networking capabilities that link inhabitants to government policy making, smart open-crowdsource data, and an appropriate mobility assessment and implementation process".

The eco-system equally focuses on the following six aspects of urban mobility:

1. Sociability: Reinventing Multimodal Mobility with Social Innovation
2. Smart Growth: Integration of Land-use and Mobility
3. Smart and Easy Access for All Mobility Users
4. Safety First Approach
5. Recommended World Class Infrastructure
6. Smart Use of Energy, Environment and Healthy Planning

This example is exceptional because this newly created planning model takes into account two questions that have been neglected in traditional urban mobility planning processes so far: "(1) What quantitative process in mobility planning can take into account the optimum size of infrastructure or services while maximizing social, environmental and economic well-being of inhabitants?; and (2) what policies can create a mobility ecosystem that keeps "sustainable mobility as core" service and provides incentives to integrate innovative mobility options through the rethinking of land-use strategies and the reallocation of public space or assets toward space and time efficient modes?"[746]

4.6.3 Philippines: Transport Network Companies (TNC) in Manila (Focus Area 3)

The country looks back on a long history on shared transport, so the underlying concept of newly arising shared mobility concepts are culturally deeply ingrained. Car ownership accounts for only 20% of overall urban transport. Traditional forms of shared mobility include Jeepneys for up to 20 passengers and Asian Utility Vehicles (AUVs) with capacities for 8-10 passengers. Whereas AUVs are operated on main urban roads between pick-up and drop-off locations, Jeepneys are hailed by riders at the road side. Most Jeepneys are rented by individual drivers from large fleet owners. Taxis make up 35% of all vehicles in Manila which since 2013 can be hailed via the GrabTaxi app in addition to conventional roadside hailing. Shortly after, in February 2014, Uber accessed the Filipino mobility market and became a competitor of Grab which until then extended its services by GrabCar (ride sharing) and GrabBike (motorcycle sharing).

The TNC market is one of the fastest growing smartphone markets and, similar to uprisings in Europe, face regulatory and legal problems. However, users are increasingly willing to use the service because of its organization and cost transparency (taxi drivers often turn off the taximeter and negotiate prices with customers). However, this is limited to mid and high-income users because, first, these new services are about 10 times as high as Jeepneys and AUVs and, second, not only require users and drivers to have smartphones to be able to access the service but also bank accounts and credit cards because of their integrate payment service. The problem is that only 31% of Filipinos have bank accounts, 4% access to credit cards, and 21% smartphones. Therefore, these services have added to

[746] Karim, D. M. (2017). Creating an Innovative Mobility Ecosystem for Urban Planning Areas. In Meyer, G., Shaheen, S (Eds.). Disrupting Mobility. Springer.

mobility inequality (inequality of access) excluding the majority of the Philippine's population. Similar phenomena can be found in Jakarta and Bangkok. In addition, the growing market triggers more car sales and thus, increases congestion.[747] On a positive note, Grab, the World Bank, and the Philippine Department of Transportation and Communication (DOTC) launched the OpenTraffic initiative in Manila and Cebu City to use data about speeds, flows, intersection delays etc. and make them available to transport planners.

4.6.4 Australia: Freight Labelling & EDI Standard (Focus Area 4)

Considering the highly fragmented nature of Australia's transport and logistics industry, the Australian Logistics Council (ALC) and Global Standards One Australia (GS1 Australia) have officially launched the new "Australian Transport Standards for Freight Labelling and Electronic Data Exchange (EDI)" based on GS1 Open Global supply chain standards. Its goal is to improve interoperability and visibility across multiple transport carriers by providing a common tracking identifier to all parties, to improve productivity and reduce costs in the supply chain by automating manual processes and to reduce waste caused by relabeling freight as it travels across a multi-leg supply chain.

Developed by the ALC Supply Chain Standards Work Group for the Australian Transport & Logistics Industry, it provides guidance to industry on how to physically identify and label logistic and transport units to support efficient transport management processes from origin to destination. Each label has a "license plate" known as a Serial Shipping Container Code (SSCC) for common identification of the logistic or transport unit across different buyers and providers.[748]

[747] Schechtner, K., Hanson, M. (2017). Shared Mobility in Asian Mega-Cities – The Rise of Apps. In Meyer, G., Shaheen, S (Eds.). Disrupting Mobility. Springer.

[748] GS1 Australia (2016). Australian Freight Labelling Standards Launched. Retrieved from https://www.gs1au.org/for-your-industry/trade-and-transport/australian-freight-labelling-standards-launched/

4.7 Best Practices Summarised

Best practices and lessons learned were identified in all countries under study, even where the maturity degree was rather small. Nonetheless, as can be seen in Figure 42, there is a strong correlation between the maturity degree in a certain Focus Area of a country and the number of best practices identified in that very country.

As can be seen, many best practices were identified in Focus Area 1, especially in the USA. This is in line with the previous findings of a very high maturity degree in connected transport and automated driving. In Focus Area 2 a multitude of different positive examples were found in Asia. Due to social drivers such as the huge urbanization rate as well as demographic change a transformation of infrastructure is strongly pushed by different stakeholders. Also in Focus Area 3 a number of smart mobility services are being developed. Here the analysis shows that cultural peculiarities and differences play an important role for the success of such systems. This has to be taken into account for a potential transfer of smart mobility solutions to Europe. Regarding Focus Area 4 there were three completely different best practices of which two identify successfully implemented standardization measures to increase the interoperability between different modes. In Focus Area 5 three best practices were identified of which two are governmental programmes in the US that deal with fostering the uptake of green vehicles (including electrification) and one on hydrogen in South Korea that shows how to successfully manage energy resources across different industries.

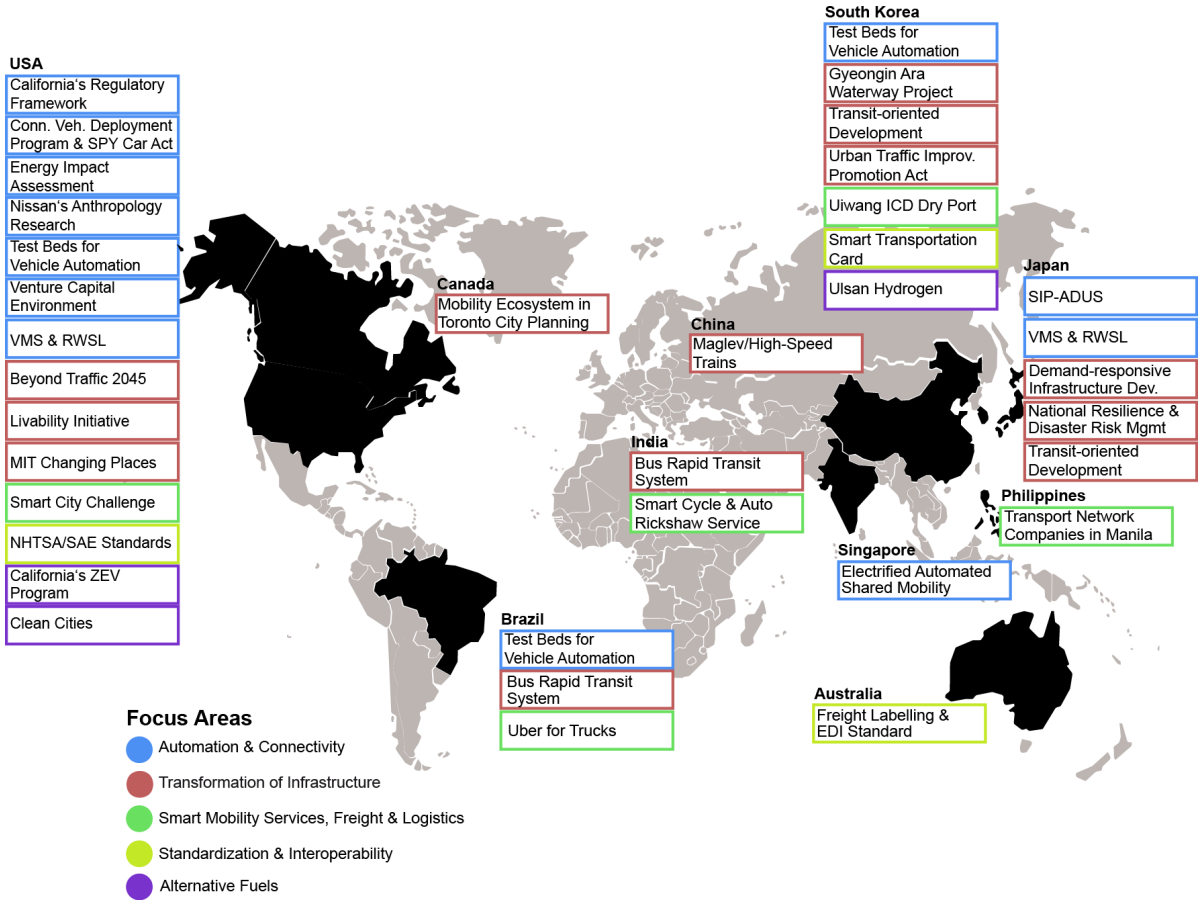


Figure 42: Best practices and lessons learned of integrated transport system along the focus areas in selected countries

5 Action Plans

Whereas lot 1's goal is to identify barriers within the European Union that hamper the development towards a single and innovative European transport system, lot 2 of the study deals with the international assessment by finding best practices with which these barriers can be overcome. Based on lot 1's analysis not only the status quo of different activity fields was defined but also overarching goals for these activity fields were set. The worldwide best practices found through lot 2's international assessment were translated into actions on how to overcome barriers by transferring those best practices to the European context that have proven to be feasible for Europe (see Feasibility Analysis). These proposed actions shall help attain the goal by providing solutions on how to overcome the hurdles.[749]

Once action plan per focus area was established as given in the following. All action plans are illustrated in a twofold manner. First, detailed action plans are given in tables that consist of all the relevant information. Second, the information has been visualised as roadmaps that shall help communicate the plans more efficiently. Within the visualised roadmaps all best practices are directly transferred from the world map continuing with the colour code followed throughout this study. The actions derived out of each best practice are given in the black boxes above the corresponding best practice.

In line with the preceding parts of the study the entire value chain was taken into account for both passenger and freight transportation as well as across all transport modes. Because best practices could be found across the entire value chain also actions for each of the following categories were derived:

- R&D&I
- Demonstration
- Manufacturing
- Skills and Education
- Business Models
- Legislation & Regulation
- Standardization & Interoperability
- Policies & Incentives
- Public & User Awareness
- Infrastructure

As can be seen in the following tables for all actions a time frame it was determined on whether it shall be taken by 2020, 2030 or 2050. Additionally, responsibilities are assigned to each action and Key Performance Indicators (KPIs) defined to continuously keep track of each action's prospective success or failure.

The derived action plans raise no claim to completeness as actions were only defined based on identified best practices or lessons learned in Brazil, China, India, Japan, South Korea or the USA. Additional actions, for which there is no corresponding best practice (e.g. proposed by experts during the Validation Workshops), are defined as potentials for international collaboration within chapter 6.

[749] The action plans contain only the abbreviation for each hurdle; for the explanation please see the annex.

5.1 Focus Area 1 – Connected Driving and Automation of Transport

The overall goal of this focus area is to increase energy efficiency, reduce CO2 emissions and increase road safety. An overview of more detailed goals, the status-quo as well as on actions to be taken can be found in the following table.

Activity Field	Goal	Status Quo	Action	Category	Time Frame	Responsibility	Measurement	Best Practice	Hurdle addressed
Technology development for high level automated and connected driving in complex situations	Fully integrated system with autonomous (highest automation level) and connected (V2V, V2I, V2X) vehicles implemented including complex situations such as urban contexts	Whereas highway situations are already mastered pretty well, more complex urban situations still challenge self-driving systems. R&D and demonstration projects are being undertaken; however they are not publicly deployed yet	Build test beds and demonstration fields that allow for comprehensive research and testing of high-level (SAE levels 4 & 5) automation allowing for an easy transfer to real-life situations	R&D&I, Demonstration	2020	member states, communities, cities	• Number of demonstration projects • Number and budget of demonstration programmes • Implementation in real-life situations	Brazil/South Korea/USA: Test Beds for Vehicle Automation & Connectivity in Urban Environments	FA1-02, FA1-12
Infrastructural Development	Infrastructure for an automated and connected traffic system that allows for maximum accessibility, efficiency and road safety	Lack of information on type and scale of changes required and uneven deployment across member states. Stakeholder groups are hesitant to invest because of unclear lending criteria and uncertainties of investment returns	Wide-scale installation of VMS and RWSL that are independent of air traffic control instructions	R&D&I, Infrastructure	2030	industry	• Number of airports with installed VMS/RWSL	Japan/USA: VMS and RWSL at airports	

Activity Field	Goal	Status Quo	Action	Category	Time Frame	Responsibility	Measurement	Best Practice	Hurdle addressed
Human Factors	Questions regarding Human-Machine-Interaction and human factors are fully resolved	Unclear user acceptance, willingness to pay and business case	Build networks for demand-oriented development of automation and connectivity technology with a special focus on the human factor in order to meet societal needs	R&D&I	2020, 2030	research, industry	• Accessibility • Usability	Japan/USA: Nissan's Anthropology Research	FA1-04
Regulatory Framework	Regulatory framework for high degree automated and connected driving is in place when vehicles are mature for market launch	Because of reactive legislation processes fast-developing technological progress is not sufficiently covered by jurisdiction	Establish necessary regulatory framework for testing and use that is responsive to novel technology development	Legislation & Regulation	2020, 2030	EC	• Speed of regulatory coverage of technological progress	USA: California's Regulatory Framework	FA1-02, FA1-10, FA1-11
			Resolve privacy issues concerning the storage of driving data and set cybersecurity standards	Legislation & Regulation	2020	EC	• Performance of jurisdiction regarding cybersecurity • number of cyberattacks • all cases covered?	USA: Connected Vehicle Deployment Program & SPY Car Act	
			Assess energy impact of connected and automated transport	R&D&I	2030		• Reduction of GHG emissions by transport due to automation/connectivity	USA: DOE Funding of Energy Impact of Connected Automated Vehicles	
Multi-Stakeholder Co-operation	Stakeholders from demand and supply sides coordinate their investments and actions such that innovation	Roles of operational stakeholders is unclear and investment is very low due to weak business cases, a lack of best practices that serve as	Integrate research, testing and implementation in one comprehensive programme to bring together different stakeholders	R&D&I, Demonstration, Legislation & Regulation, Policies & Incentives	2030	EC, member states	• Assessment of intensity of collaboration between governance, research and industry	Japan: SIP-ADUS	FA1-01, FA1-02, FA1-06, FA1-08, FA1-11

Activity Field	Goal	Status Quo	Action	Category	Time Frame	Responsibility	Measurement	Best Practice	Hurdle addressed
	is accelerated	guides as well as due to low user acceptance and willingness to pay	Create environment to encourage high-risk investments	R&D&I, Business Models, Legislation & Regulation, Policies & Incentives	2030	EC, member states, industry	• Money invested (e.g. venture capital) • sectoral turnover • number of high-risk projects implemented	USA: Venture Capital Environment	FA1-01, FA1-09, FA1-10
			Integrate the three current revolutions in mobility (automation, electrification, MaaS) in a single business model	Manufacturing,Business Models, Infrastructure	2020	Industry	• Failure rate • Traffic Fatalities • Changing Behaviour • Environmental balance	Singapore: Electrified, Automated, Shared Mobility	

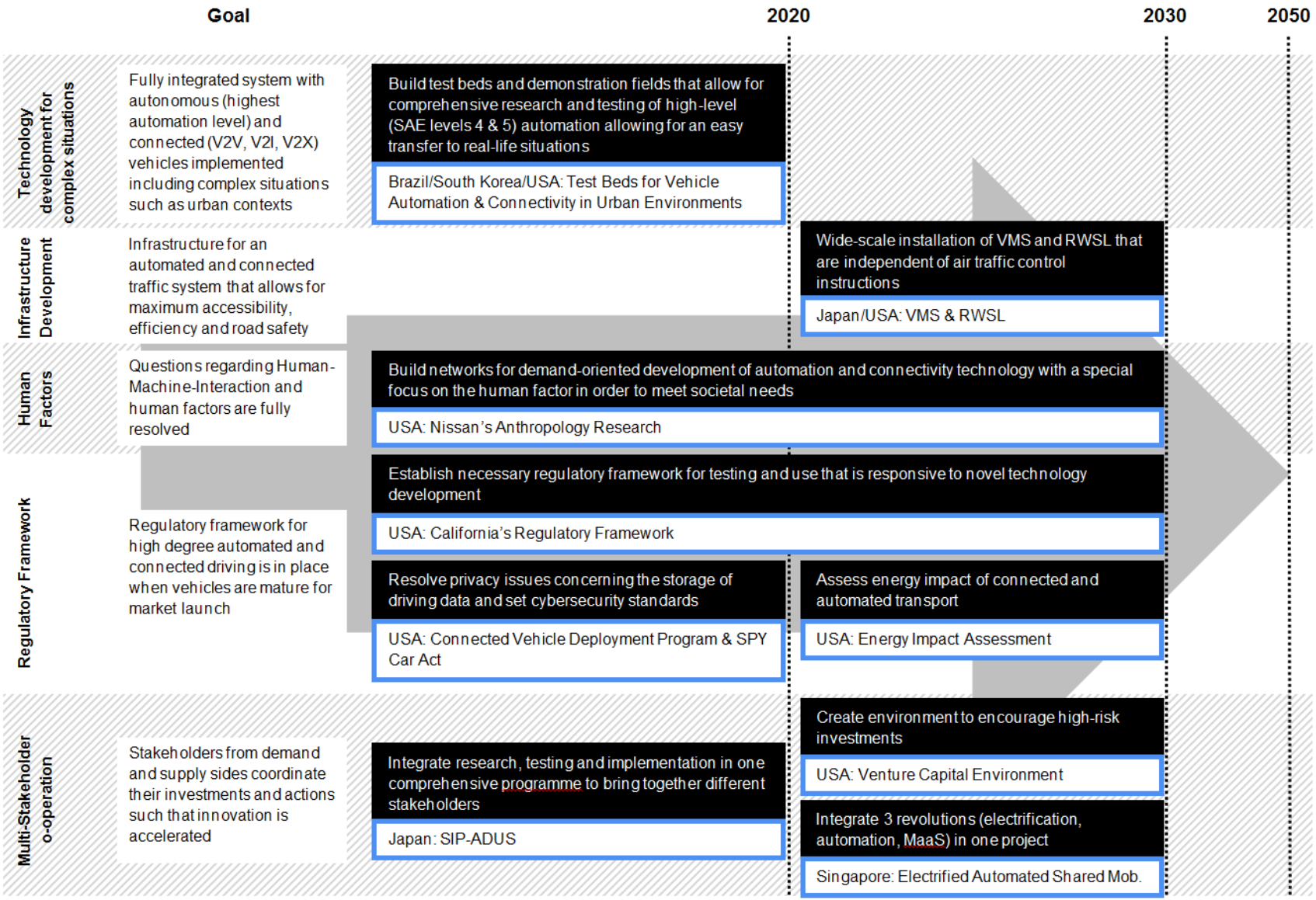


Figure 43: Action Plan on Connected Driving and Automation of Transport

5.2 Focus Area 2 – Transformation of Infrastructure

The overall goal of this focus area is to enable a modal shift rather than the optimization of all transport modes. An overview of more detailed goals, the status-quo as well as on actions to be taken can be found in the following table.

Activity Field	Goal	Status Quo	Action	Category	Time Frame	Responsibility	Measurement	Best Practice	Hurdle adressed
Funding	Availability of funding even where risk is high	Shortage of funding due to high capital costs and uncertainty towards long-term performance	Strengthen business model-driven development and implementation of new transportation infrastructure	Business Models	2020	EC, Member states	• Price performance statistics; • Willingness to payoff suggested Public Transport cost by average traveler.	China: High-speed trains/ Maglev	FA2-01
			Provide effective funding for infrastructure and urban planning programmes	Policies & Initiatives	2030	EC, member states	• successful establishment of such programme; number of funded projects, sum of funding programme, solutions/result being put out	USA: Livability Initiative	FA2-01
Transformation of Infrastructure	New innovations are integrated into existing infrastructure that have successfully lead to a modal shift	Infrastructural development develops along path-dependent trajectories; long investment periods reduce willingness to invest in	Establish European analysis tools that foresee traffic development and anticipate implications of infrastructure development	Business Models	2020	EC, Member states	• Usage of tools by relevant stakeholders; • Usability rating of the tools by stakeholder representatives.	South Korea: Urban Traffic Improvement Promotion Act	FA2-02
			Create a policy framework for integrated	Legislatioin & Regulation, Policies &	2020	EC, member states, cities	• Topics raised • solutions found • problems re-	USA: Beyond 2045	FA2-06

Activity Field	Goal	Status Quo	Action	Category	Time Frame	Responsibility	Measurement	Best Practice	Hurdle adressed
		revolutionary, high-risk projects	development of infrastructures for multimodal transport options	Initiatives			solve		
			Further develop BRT systems	Infrastructure	2020	EC, member states, urban planning, communities, cities	• Number of BRT systems; • Sustainability of these systems; • Number of passengers' occupancy.	Japan/South Korea: Transit-oriented Development	FA2-01 FA2-03 FA2-07
			Establish an emergency and disaster risk management plan to increase resilience	Infrastructure	2030	EC, member states, urban planning, communities, cities	• ability to cope with crisis situations, successful establishment of such plan	Japan: National Resilience & Disaster Risk Management	FA2-02 FA2-08
			Evoke modal shift towards waterborne transportation	Infrastructure	2030	member states, regional authorities, communities, cities,	• livability/life quality • usage of recreational and entertainment facilities • involvement of citizen in planning/designing process	South Korea: Gyeongin Ara Waterway Project	
			Create a holistic infrastructure planning process that takes in ac-	Infrastructure, Policies & Initiatives	2020	Municipalities	• sufficient coverage of all areas	Canada: Mobility Ecosystem in the Toronto City	

Activity Field	Goal	Status Quo	Action	Category	Time Frame	Responsibility	Measurement	Best Practice	Hurdle adressed
			count all spheres of life in an integrated way				• equal funding of all areas • successful implementation of planned projects	Planning Process	
			Develop new strategies regarding urban planning for cities to meet the major challenges of the future	R&D	2020	academia	• sufficient coverage of all areas • topics brought from R&D to market • integration of different areas achieved or not	USA: Changing Places at MIT	
Involvement of citizens into infrastructure development	New infrastructure meets the needs of citizens	Citizens not sufficiently involved in infrastructural development; mostly a supply-sided approach neglecting the user perspective	Directly include citizens in infrastructure planning and transformation process	R&D&I, Demonstration, Infrastructure	2020, 2030	EC, member states, communities, cities, urban planning	• VEC groups covered; • Quality of service per group;	Japan: Demand-responsive Infrastructure Development	

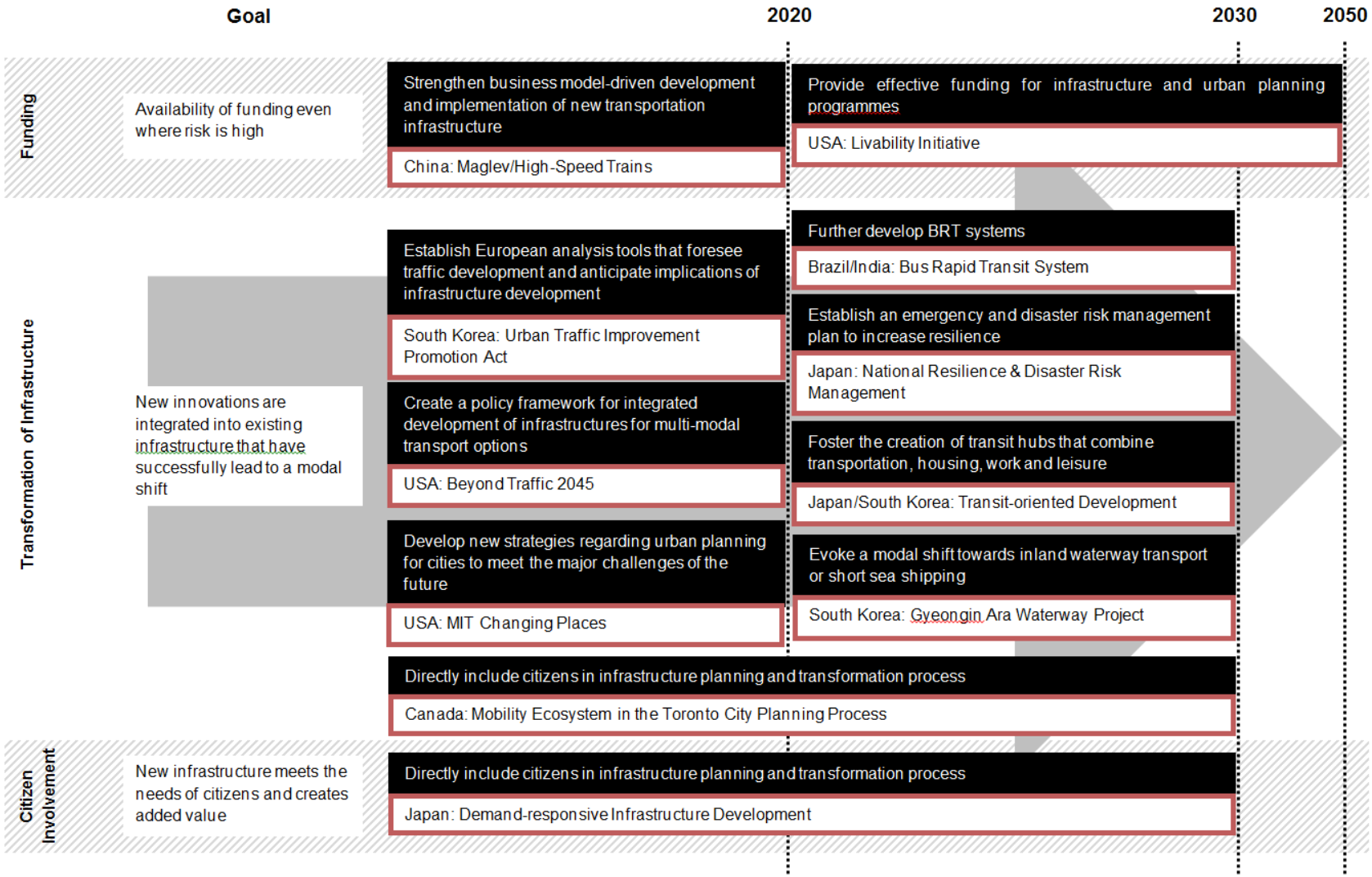


Figure 44: Action Plan on Transformation of Infrastructure

5.3 Focus Area 3 – Smart Mobility Services, Freight, and Logistics

The overall goal of this focus area is to improve air, land and waterborne transport management systems. An overview of more detailed goals, the status-quo as well as on actions to be taken can be found in the following table.

Activity Field	Goal	Status Quo	Action	Category	Time Frame	Responsibility	Measurement	Best Practice	Hurdle addressed
Develop business case	Efficient business cases and programs in place	Business cases lack initiative	Create competition for funding of smart and sustainable urban traffic development that triggers multiple planning and that leads to mutual learning and exchange of experiences	R&D&I, Business models and Policies & Initiatives	2020	EC	• Leverage effect • successful deployment/implementation • number of participants in challenge • timely implementation	USA: Smart City Challenge	FA3-A1, FA3-A4
			Sufficiently include cultural particularities in business models	Business Models	2020	Industry	• services meeting the need of citizens • number of users • uptake of new services	Philippines: Transport Network Companies (TNC) in Manila	
Integration of new services	Wide-scale integration of new mobility services including public passenger transportation as well as end-to-end freight services	Operators are unwilling to share data due to mistrust and unclear liability	Push integration of multi-modal freight services (e-freight) to increase efficiency and eco-performance	Standardisation and interoperability	2020	Cities, communities, regions	• Efficiency rate • emission reduction rate • modal share in logistics (also year-on-year change to see progress)	South Korea: Uiwang ICD Dry Ports	FA3-A5, FA3-C2, FA3-C3

Activity Field	Goal	Status Quo	Action	Category	Time Frame	Respon-sibility	Measurement	Best Practice	Hurdle addressed
			Foster R&D programmes on transfer of transport sharing between passenger and freight transportation	Business models	2020 2030	Re-search, industry	• New mobility services available • efficiency rate • accuracy of real-time da-ta • degree of open data	Brazil: Brazil: Uber for Trucks	FA3-C1
			Support local mobility innova-tion hubs and initiatives on smart mobility services that answer culture-specific mobili-ty demand	Business models	2020 2030	Industry	• Number of services available • services meeting specific de-mand	India: Smart Cycle and Auto Rickshaw Services	FA3-B1

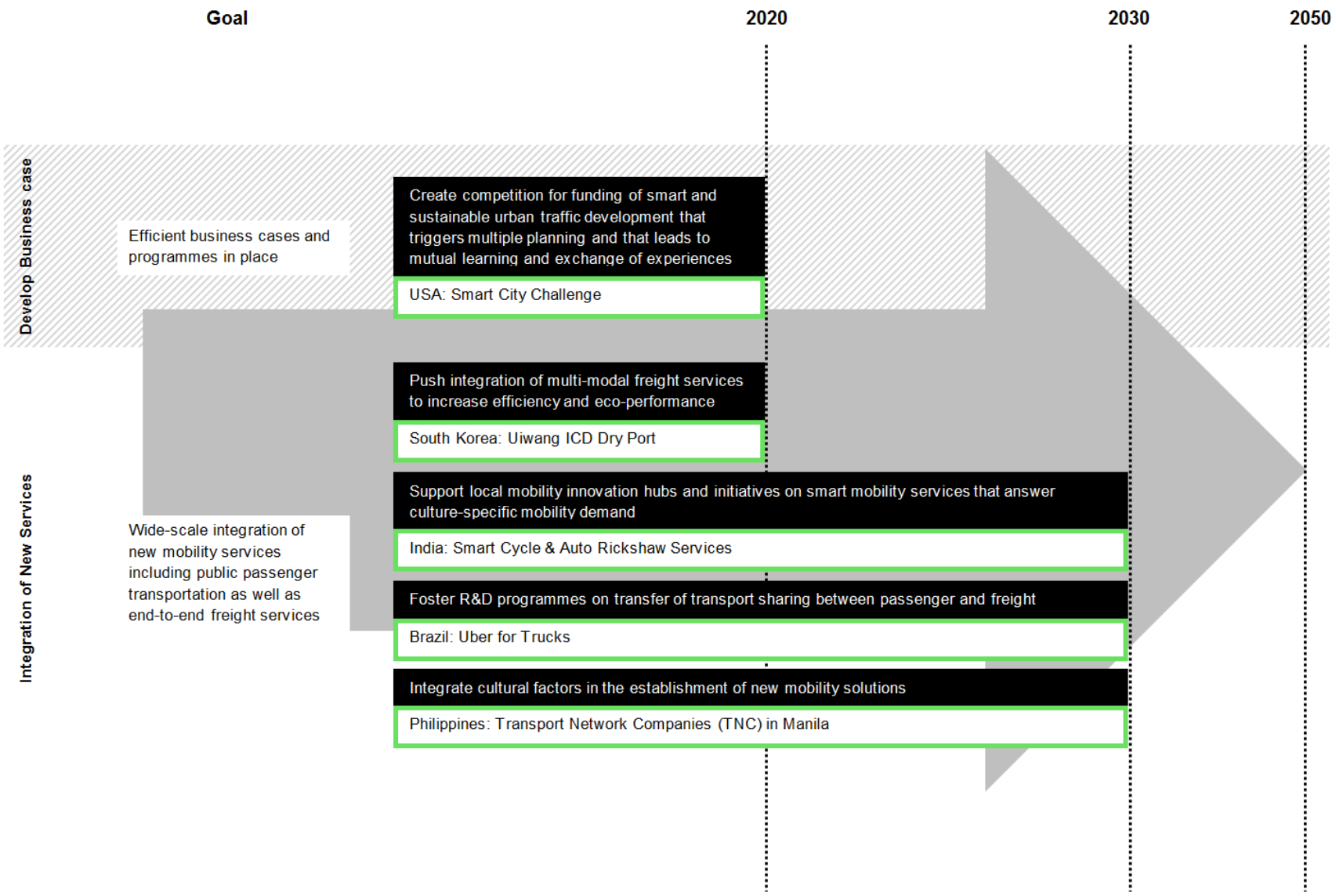


Figure 45: Action Plan on Smart Mobility Services, Freight, and Logistics

5.4 Focus Area 4 – Standardisation and Interoperability

The overall goal of this focus area is to identify appropriate regulatory framework conditions. An overview of more detailed goals, the status-quo as well as on actions to be taken can be found in the following table.

Activity Field	Goal	Status Quo	Action	Category	Time Frame	Responsibility	Measurement	Best Practice	Hurdle addressed
Collaboration between stakeholders and modes	Effective collaboration and sharing of information among stakeholders and across transportation modes	Poor collaboration between stakeholders because of ineffective communication, commercial rivalry, incompatible mode-specific objectives as well as lack of trust and cost sharing models	Further pan-European co-operation between engineers and technology developers in order to accelerate European standardisation	Legislation & Regulation	2030	EC, member states	• visibility of European standardisation • European standards replicated in global standardisation • intensity of co-operation between member states	USA: NHTSA/ SAE standards	FA4-08
Interoperability & Compatibility	National standards are harmonized to increase interoperability and compatibility	Protectionist behavior of member states and ineffective harmonization at EU level	Guarantee direct compliance for open data standards across all member states	Standardisation	2020	EC	• number of member states participating • number of member states where standard is implemented • number of interoperable application	South Korea: Smart Transportation Card	

			Increase efficiency of freight transportation through digitalization and end-to-end services	Standardisation	2020		• efficiency rate • customer satisfaction • freight labels used across different modalities	Australia: Freight Labelling & EDI standard	

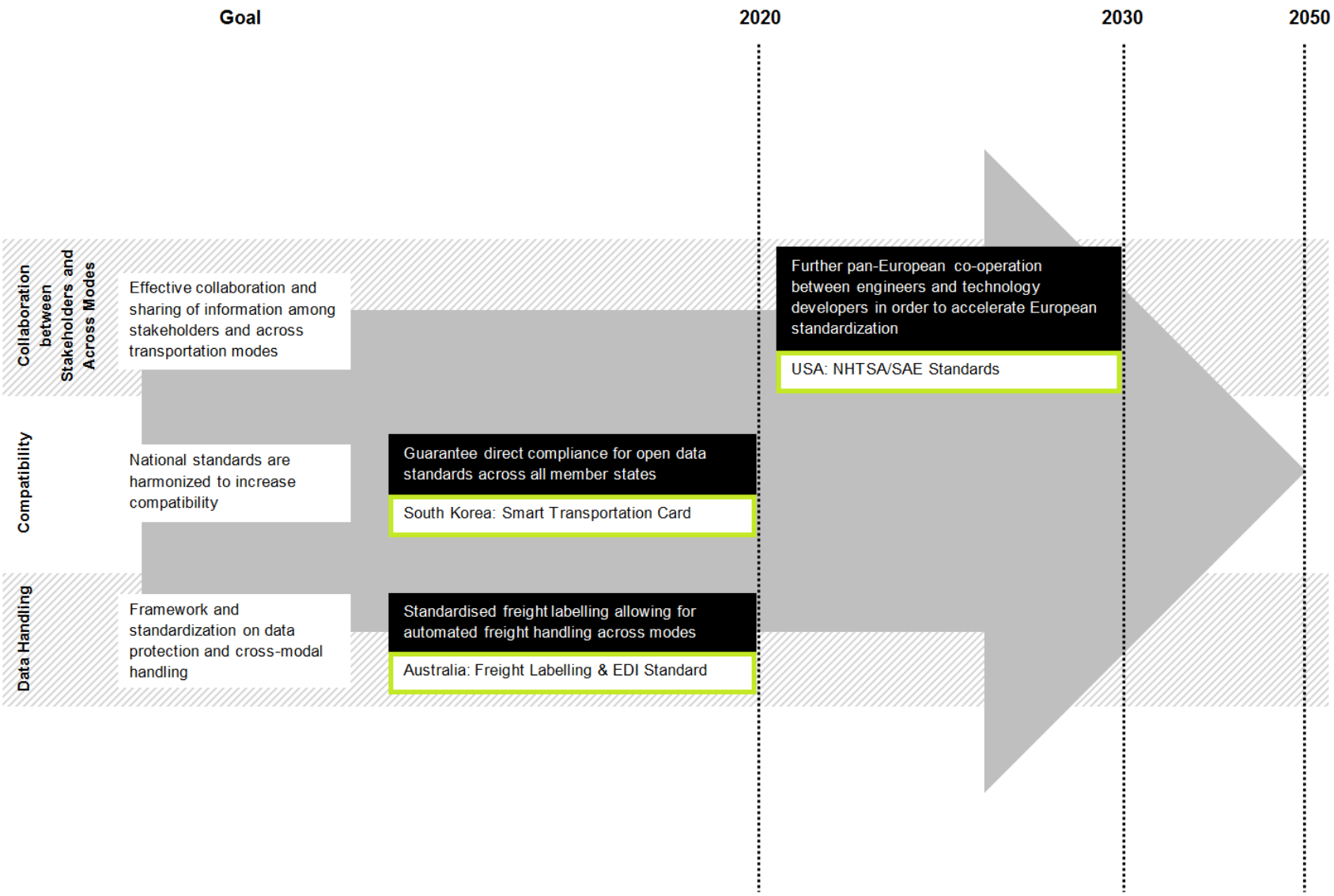


Figure 46: Action Plan on Standardisation & Interoperability

5.5 Focus Area 5 – Alternative Fuels Other than Electrification

The overall goal of this focus area is to become independent from oil imports and reduce of greenhouse gas emissions in all transport modes. An overview of more detailed goals, the status-quo as well as on actions to be taken can be found in the following table.

Activity Field	Goal	Status Quo	Action	Category	Time Frame	Responsibility	Measurement	Best Practice	Hurdle addressed
Supply	Shift towards sustainable alternative fuels is reached because they are more competitive than conventional fuels	High production costs of infrastructure for alternative fuels and retail prices keep conventional fuels more competitive	Motivate local stakeholder (businesses, authorities, mobility providers, etc.) to shift from fossil fuels to green energy by fostering collaboration with other stakeholders (e.g. by setting up a regional PPP)	Policies & Initiatives	2030	EC, member states, communities, cities,	• establishment of a PPP, amount of money invested in PPP • participants • successful collaboration • number of alternatively fueled vehicles deployed	USA: Clean Cities	FA5-05 FA5-03
			Manage energy resources across different industries	Manufacturing	2030	member states, industry	• decrease of energy prices for alternative fuels • amount of energy produced • competitiveness with traditional forms of energy	South Korea: Hydrogen Industry in Ulsan	

Activity Field	Goal	Status Quo	Action	Category	Time Frame	Responsibility	Measurement	Best Practice	Hurdle addressed
Policies & Initiatives	Effective policies and initiatives resulted in a high share of alternative fuels in overall energy market	Minimal uptake of alternative fuels because of ineffective policy measures	Design forward-looking and effective climate policies to reduce emissions	Policies & Initiatives	2020	EC	• Number of policies & Initiatives • Efffectiveness of programs • Successful of implementation of initiatives • Number of vehicles due to initiative	USA: California's California's Zero Emission Vehicles (ZEV) Program	

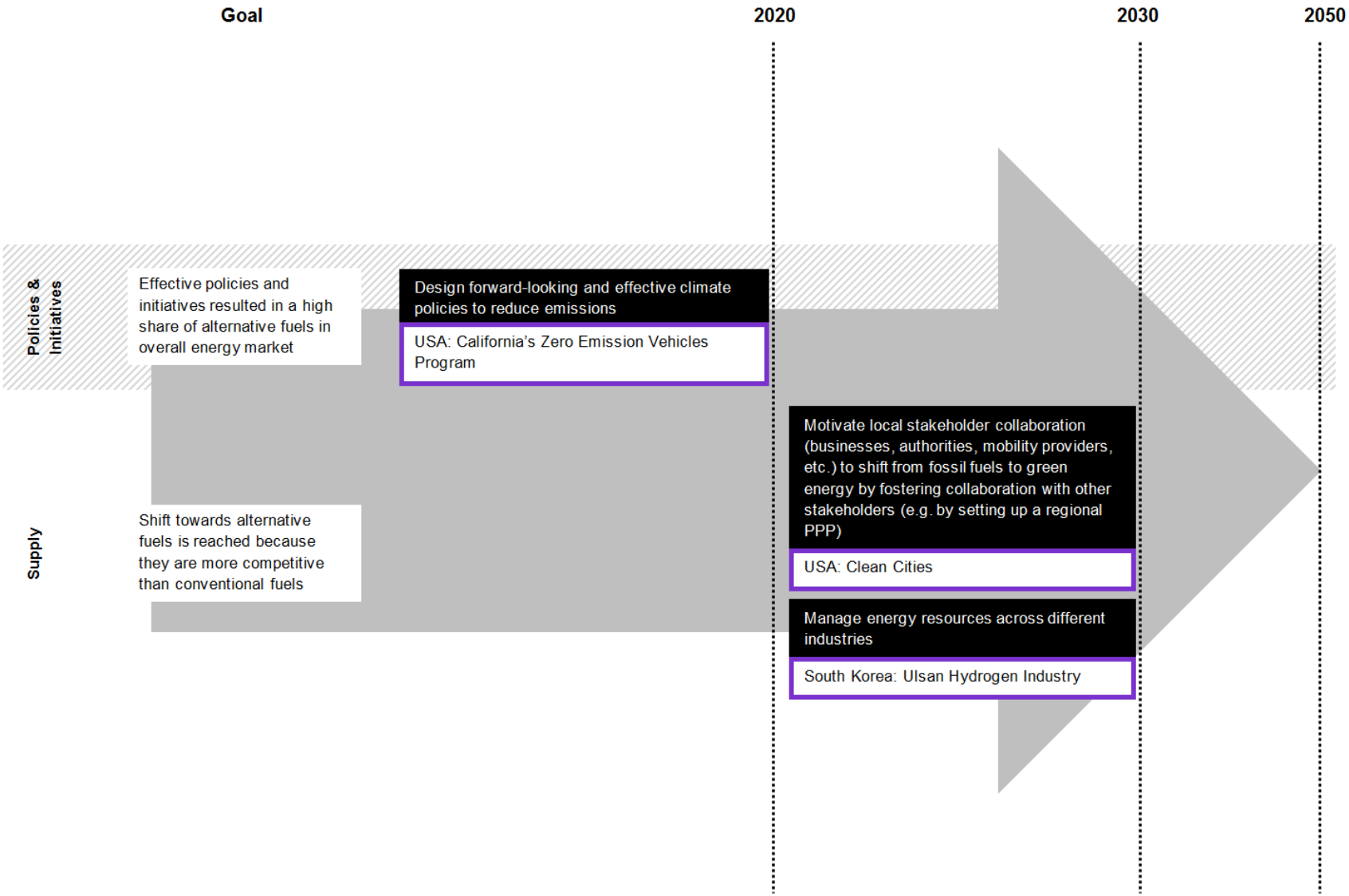


Figure 47: Action Plan on Alternative Fuels (Other than Electrification)

6 Potentials for International Co-operation

Based on best practices potentials for international co-operation have been suggested during the 1st Validation Workshop. General aspects as well as best practices were brought up by participating experts and then categorized if raised topic should be transferred to Europe or vice versa. Additionally, fields where international collaboration would be beneficial for furthering the level of integration in transport systems have been proposed. The following table gives an overview of the findings.

World ⇨ EU	**World ⇔ EU**	**World ⇦ EU**
• Create a comprehensive urban mobility European challenge based on knowledge gained from the Smart City Challenge as a motivation to smart mobility development • Further analyse why Columbus won the Smart City Challenge and keep track on how citizens are continuously engaged • Transfer the Clean Cities coalitions paradigm with the cooperation between different member states and create a common standardization system for successful implementation • Avoid the concentration on one single propulsion system to mitigate risks by following a multi-fuel approach (such as in Brazil or US) starting with investments on relevant intercity corridors • Transfer knowledge about liability issues which impede adoptions of automated driving, multimodal ticketing etc. • Create an enabling framework for MaaS applications by SME's (e.g. car sharing, carpooling, last mile delivery by private's, etc.) with a focus on the citizen as the entrepreneur such as in the US	• Establish international co-operation on high-speed rail technologies and systems • Foster international co-operation on standardized and interoperable smart solutions with joint projects • Support peer-learning between cities, national governments, business operators, etc. • Twin international with EU programs (e.g. Smart Cities, CiViTAS, …) to increase effectiveness • Take further action on including connectivity into standards for automation levels as e.g. brought forward by the EU-JPN-US Trilateral Working Group • Take further account of the greening aspect of transportation • Push the inclusion of user acceptance both for passenger and freight transportation across the value chain • Further strengthen development towards intermodal transport solutions, especially in the urban context to create smart cities	• Export knowledge of integrated traffic and transport management to other parts of the world • Take on lead in international standard setting by building on knowledge gained within the EU • Export successful business models to other parts of the world

Along with these results new suggestions brought forward by experts who participated in the 2nd Validation Workshops to enhance the potential of international co-operation. This could be achieved by grouping these suggestions within four high-level clusters:

1) Strengthening of the EU competitiveness: Measures strengthening the excellence and attractiveness of research and innovation in the European Union will ultimately support its economic and industrial competitiveness. Within the context of international cooperation this will be enabled by global networks and cooperation facilitating the access to external sources of knowledge. Thus, novel approaches and ideas for measures supporting the development and implementation of innovations that advance the integration of the European transport system can be derived and transferred to Europe. Further, agreements on common practices and policies on technological and industrial objectives, common R&D policy objectives and regulatory conditions will optimize the conduction of research and the exploitation of results.

2) Addressing market access issues: Measures to facilitate the access to existing, new or emerging markets including specific trade or development issues will be derived.

3) Contribution to addressing global challenges: Global societal challenges can be tackled more rapidly by developing and deploying effective solutions within international collaborations and by optimizing the use of international and European research infrastructures.

4) Identification of global players and programmes: The identification of key actors and main R&D&I programmes including financing models within the focus areas in each country will enable initiating effective global networks and collaborations and offer the opportunitiy for joint initiatives or harmonization in R&D&I activities.

In the following table the outcomes are consolidated to deliver an overview of all additional recommendations for international co-operation.

	FA 1: Connected Driving & Automation of Transport	FA 2: Transformation of Infrastructure	FA 3: Smart Mobility Services, Freight & Logistics	FA 4: Standardisation & Interoperability	FA 5: Alternative Fuels	General
High-Level Cluster 1: Strengthening the EU competitiveness	• Continuously penetrate the world market with new product and service innovations	• Create an enabling framework for MaaS applications by SME's (e.g. car sharing, carpooling, last mile delivery by private's, etc.) with a focus on the citizen as the entrepreneur such as in the US • Create alternative ways of funding, with the direct involvement of citizens or by using crowdfunding-like methods	• Create an enabling framework for MaaS applications by SME's (e.g. car sharing, carpooling, last mile delivery by private's, etc.) with a focus on the citizen as the entrepreneur such as in the US • Further knowledge and deployment of the physical internet • Export successful business models to other parts of the world	• Take on lead in international standard setting by building on knowledge gained within the EU • Reduce historically grown standards and implement single standards and to increase standardisation efficiency • Strengthen EU role in defining standards in the international scene • Create a roadmap on standardization • Decrease national standardization motivated by protectionism and increase European standardization • Include citizens' needs into standards, define re-	• Further assess alternative fuel solutions in other countries (e.g. South Korea's (hydrogen industry • Conduct a Make-or-Buy analysis on different alternative fuels for the European Union	• Export knowledge of integrated traffic and transport management to other parts of the world Competitive corporations and fast-flexible uptake of new ideas • Create PPP in R&I

				sponsibilities and create a framework for flexible performance standardization (e.g. responding to changing needs)		
High-Level Cluster 2: Addressing market access issues	• Understand responsibility of automated systems by also including cultural factors • Study the acceptance of self-driving capabilities by users (across all modes) in view of cultural particularities • Harmonize freight ship automation based on traffic automation starting from EU harmonization	• Support the uptake of innovation results from R&D to market	• Develop regulation on shared mobility by pricing shared vehicles (e.g. similar initiative in Sao Paulo)	• Promote standardisation issues in order to create an "open" market • Increase transfer of solutions between passenger and freight as well as across modes		
High-level Cluster 3: Contribution to addressing global challenges	• Increase expertise in artificial intelligence • Create a framework for sharing and protection of personal data	• Create a comprehensive urban mobility European challenge based on knowledge gained from the Smart City Chal-	• Create a comprehensive urban mobility European challenge based on knowledge gained from the Smart City Chal-	• Develop mobility standards to combat climate change • Push global standard setting for alternative	• Avoid the concentration on one single propulsion system to mitigate risks by following a multi-fuel approach (such as	• Establish international co-operation on high-speed rail technologies and systems • Foster interna-

	• Compare roles of automated vehicles in public transport • Transfer knowledge about liability issues which impede adoptions of automated driving, multimodal ticketing etc.	lenge to Europe as a motivation to smart mobility development • Further analyse why Columbus won the Smart City Challenge and keep track on how citizens are continuously engaged • Transfer the Clean Cities program with the cooperation between different member states and create a common standardization system for successful implementation • Increase infrastructure security (e.g. for terrorism issues), including also cyber security	lenge as a motivation to smart mobility development • Further analyse why Columbus won the Smart City Challenge and keep track on how citizens are continuously engaged • Push technological progress of smart mobiles to increase the inclusion of the disadvantaged and to reduce emissions	fuels • Set up standards for a plan B (e.g. in case of system break-down) • Develop standards for transshipment and automation across modes (standards, infrastructure, ownership)	in Brazil or US) starting with investments on relevant intercity corridors • Foster R&D in byproducts/waste useable as alternative fuels • Support development of sustainable, safe solutions based on Hydrogen • Transfer the Clean Cities coalitions paradigm with the cooperation between different member states and create a common standardization system for successful implementation • Avoid the concentration on one single propulsion system to mitigate risks by following a multi-fuel ap-	tional cooperation on standardized and interoperable smart solutions with joint projects • Support peer-learning between cities, national governments, business operators, etc. • Twin international with EU programs (e.g. Smart Cities, CiViTAS, …) to increase effectiveness • Take further action on including connectivity into standards for automation levels as e.g. brought forward by the EU-JPN-US Trilateral Working Group • Take further account of the greening aspect of transportation • Push the inclu-

					proach (such as in Brazil or US) starting with investments on relevant intercity corridors	sion of user acceptance for passenger and freight transportation across the value chain • Strengthen development towards intermodal transport solutions, esp. in the urban context to create smart cities
High-level Cluster 4: Identification of global players and programmes	• Create a bilateral programme between EU and Japan based on SIP-ADUS			• Further the collaboration with the International Civil Aviation Organization (ICAO) and International Maritime Organization (IMO) to foster standards on alt. fuels	• Further the collaboration with the International Civil Aviation Organization (ICAO) and International Maritime Organization (IMO), especially to foster standards on alternate fuels	• Take further action on including connectivity into standards for automation levels as e.g. brought forward by the EU-JPN-US Trilateral Working Group • Increase the cooperation with the Int. Transport Forum

7 Conclusions

This Final Report summarizes the findings of the international assessment within the study “Towards a Single and Innovative European Transport System” that develops action plans on how to create an integrated European transport system. The overall goal of the study is to identify barriers within Europe (lot 1) and to find best practices in the international arena (lot 2) that can be potentially translated to the European context to overcome these barriers. Subject of this report is the international assessment conducted as part of the contract concerning “International assessment and action plans of the focus areas”, i.e. Lot 2 of the original call for tenders.

The Focus Areas on which this report is built mirror five thematic transport research areas in accordance with the Strategic Transport Research and Innovation Agenda (STRIA): (1) connected driving and automation of transport, use of automated optimization of traffic flows, (2) transformation of infrastructure to address connectivity, resilience, new fuels and energy efficiency, (3) smart mobility services (including provision and use of data, and urban mobility), freight and logistics, (4) standardization and interoperability, and (5) alternative fuels other than electrification.

In light of the growing globalization with increasing co-operation between nation states and the elimination of cultural and political differences, learning from each other not only creates opportunities for international collaboration and transfer of knowledge but also reduces redundancies and the likelihood of taking faulty measures. Therefore, analysing other countries’ best practices and lessons learned of successful transportation initiatives and activities comes in beneficial. The countries in focus – Brazil, China, India, Japan, South Korea and United States of America – represent both highly industrialized as well as industrializing nations with different challenges.

This study’s first step was the examination of the state of play in selected countries that serves as the fundament for the identification of best practices. To be able to draw a complete picture the analysis was conducted in a systematic way along the transportation value chain from research to industry and market across all transport modes. The results were mainly gained through desktop research and by drawing on the expertise of so-called “ambassadors” for all Focus Areas in the countries under study. Despite of the wide variety of sources with quite diverse levels of details, it has been achieved to generate an overall picture allowing for a comparison of selected countries and for a transfer of findings into SWOT analyses illustrating each country’s transportation system’s strengths, weaknesses, opportunities and threats. Based on these the degree of maturity of their integrated transport system has been assessed and rated on a five-point scale processed in a world map to guarantee a fast and easy understanding as well as world-wide comparison. Additionally, the outcomes have been juxtaposed to the European situation.

It is no surprise that the transport systems of the countries in focus represent a broad spectrum of maturity levels. They not only have different industrialization levels – from developing to industrializing to newly industrialized and highly industrialized countries – but also very diverse histories with different path-dependent developments. Also from a cultural point of view, the willingness and acceptance of integrated transport solutions by citizens and users differ from country to country.

That is why each country has their specific challenges to cope with. However, due to the increasing globalization there is more and more collaboration between nation states. This holds true where international market access is concerned (e.g. in the automotive industry) as well as in standardization measures. Also, political, economic, ecological and societal drivers of innovative transportation are often similar. Here, only little differentiation along the industrialization level can be undertaken. Especially due to the ratification of international policies many countries follow the same goals, for example when it comes to the reduction of greenhouse gas emissions. Not only through active goal setting but also in view of the user perspective many countries face the same problems asking for technological solutions and infrastructural shifts. These similarities span across many different aspects, foremost demographic change and aging society. Especially for energy-related issues, the establishment of resilient systems that help reduce the dependence on energy imports further boosts developments towards a more sustainable traffic system including the energy grid, the reduction of congestion and traffic fatalities as well

as the reduction of air pollution and dependence on imports. Interestingly, the prospective hosting of major world sporting events, such as the Olympic Games, act as a driver since countries are eager to show off their technologies.

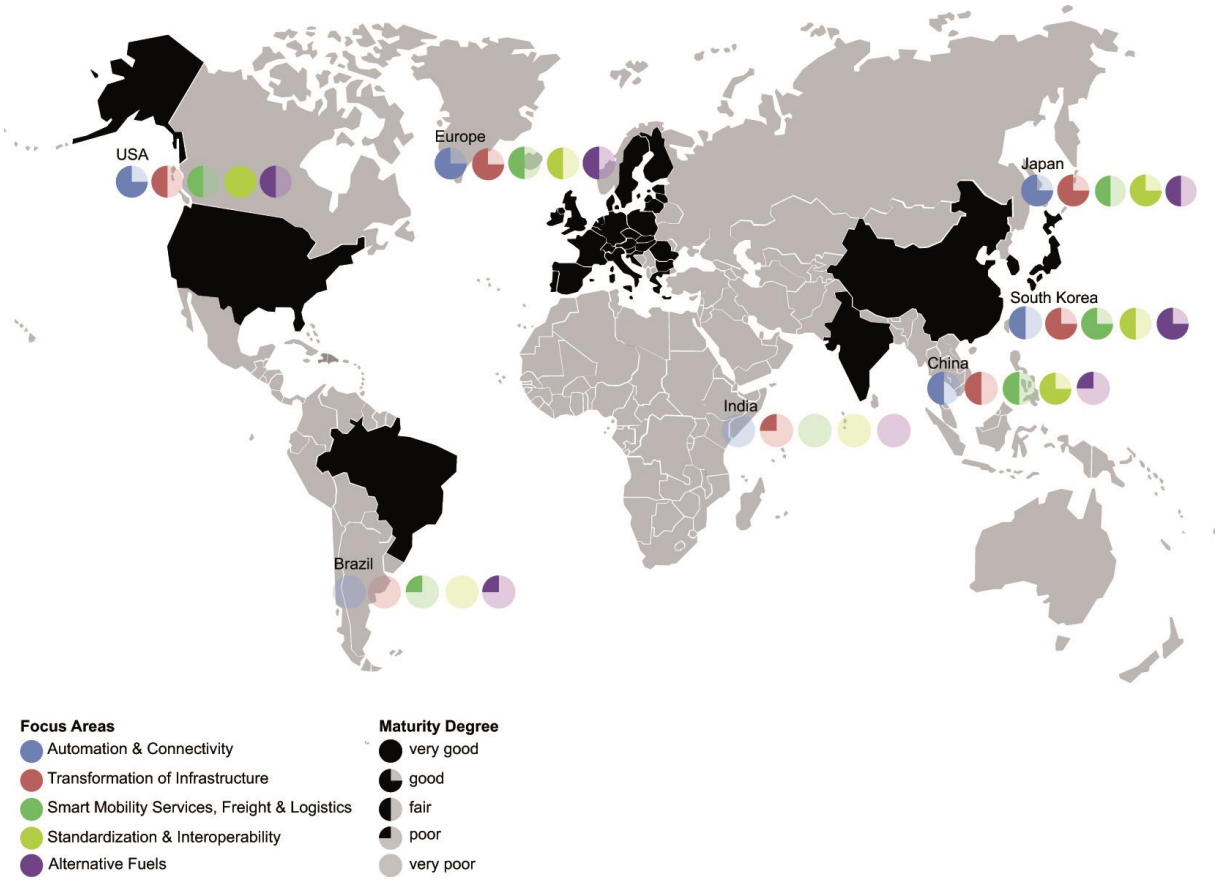


Figure 48: Degree of maturity of the integrated transport system along the focus areas in six countries and in Europe

The main findings and results are depicted in a graphic to give an overall image of the global situation regarding tendencies and progress towards an integrated transportation system (Figure 48). It can be seen that the USA and Japan are leading in almost all of the analysed focus areas, not just for road transport, but for several of the modes. This is mainly because of early technological advancements and the interplay of different beneficial legal, economic and societal factors. Especially in Focus Area 1 Japan has a lot of expertise that stems from the fact that technological advances have a very fertile ground, e.g. in robotics. Additionally, since the Great East Japan Earthquake the government expressed an urgent need for building up resilient infrastructures. There is not only very strong governmental support but also strong academic and industrial research, especially regarding ITS activities, and advanced involvement in international standard setting. Japan successfully manages to turn its opportunities into strengths. The major setbacks in Japan are its seemingly miss-out on exporting opportunities partially due to its manifold island solutions in transportation that are not applicable widely.

The favourable situation in the USA is mainly due to its integrated way of thinking enabling cross-industrial collaborations and the early inclusion of legal questions. Also, the availability of many test beds comes in beneficial for the uptake of technologies in automation, connectivity, interoperability, and smart mobility services. The competitive situation results in an innovation environment that continuously pushes technological progress, particularly in the information and communication technologies such as big data analytics that are at the heart of smart and integrated transportation systems of the future – almost all major players in this field are located in the U.S. This is also supported by a trial-and-error culture that does not attribute mistakes to personal failures. Furthermore, there are many funding oppor-

tunities both from the government as well as the private sector due to a multitude of venture capitalists ready to invest in high-risk companies. The main hurdles the US has to deal with are the increasing sell-out of knowhow to China, a lack of infrastructure especially for telecommunication networks because of the government opting for improving the satellite system instead, a focus on roads that neglects other transport modes and the uptake of multi-modal transportation solutions. For the topic of automated and connected road transport, both Japan and the US have entered a trilateral cooperation with the European Union to foster international cooperation and participation.

China and Korea benefit from their relatively favourable traffic environments. However, in both countries opportunities have yet to be exploited. The biggest drivers in China are the enormous air pollution in urban regions. Clearly its production capabilities, market size and export-oriented economy are all beneficial for further progress, too. Its abundance of resources is very favourable for the development of propulsion systems running on alternative fuels. Recently, China has enjoyed many advances in IT-related industries as well as in the provision of innovative services and smart mobility solutions. The country mainly suffers from the cooling down of its economy and the slow uptake of new technologies. Furthermore, the federal system and the different technological levels between provinces lead to huge differences between urban centres and rural areas as well as between the developed coastal area and the inner land.

In Korea the geographical situation and societal drivers for innovative transport solutions are very similar to the Japanese situation. However, in opposition opportunities are not turned into strengths as successfully. Nonetheless, the SWOT analysis shows that the country leads in smart mobility services because of its widespread and nation-wide integration of services that span across multiple transport modes as well as across passenger transit and logistics solutions. The biggest obstacle towards an integrated transport system is its rigid economic system based on business conglomerates that prevent the creation of innovative start-ups. Additionally, the country suffers from a lack of resources and its ongoing dispute with North Korea.

Compared to these four countries Brazil and India are lagging behind in almost all infrastructural and traffic-related questions due to poor framework conditions. Both countries suffer from a very disadvantageous environment based on exploding traffic volumes in highly chaotic traffic systems, and a lack of infrastructure. From an economic point of view both countries have very high poverty rates that decrease the economic viability of new technologies, weak automotive industries, and a non-existent ground for innovative start-ups. The missing government support and the in part low education rate add to this situation.

However, the two countries also excel in specific aspects. Brazil's competitive advantage is definitely its long experience with bioethanol production and its abundance of resources. Due to the government's desire to increase public security there have been a number of developments pushing tracking technologies, both of individual vehicles and freight. India benefits mainly from its strong IT industry that has already brought forward a multitude of different smart mobility services responding to the country's transport particularities. The huge acceptance of these new technologies can be attributed to the widespread diffusion of smartphones that in many cases enable anybody independent of social status to access online services.

To bring these results in the context of the study's overall goal the EU's situation has been assessed, too. We came to the conclusion that despite enormous differences among European countries, the EU's overall situation is perceived to be either as advanced as other countries (Focus Area 1 and 2) and or in the middle range of analysed countries (FA 3, 4, 5) but never lagging behind.

In the context of step 1 of this study also a Porter 5-Forces has been undertaken. For one industry per country that stood out in the state of play analysis, a Porter's 5-Forces analysis was undertaken showing the respective industry's market dynamics. Chosen industries cover all focus areas except standardisation and interoperability.

Brazil's bioethanol industry is extremely dynamic mainly because of the tough competition between a handful of incumbents who are the major force behind new technologies developed. There are only a

few new entrants who cannot yet compete with the established players. As for substitutes gasoline poses the biggest threats. Other propulsion systems such as battery electric or fuel cell vehicles do not play a role since there is hardly any market for them in Brazil. The bargaining power of both suppliers and buyers is very low. The only influencing force seems to be the government regulating the ethanol market. However, the industry is also extremely vulnerable to a variety of external influences such as the recent economic crisis and the climate change that have had huge impact on the industry.

In China smart logistics services are quite a new market which have, however, already been widely diffused and adopted across the country. The rivalry among smart logistics service providers is still quite low if not taking the manual labour into consideration. However, there is increasing threat of new entrants from abroad against which the government tries to establish protection. Since it is quite a new market itself, there is no threat of substitution to this point. As for suppliers, their bargaining power is increasing since they recognized the market potential and enter into co-operations with main players. Whereas a few big players (logistics companies) on the buyer-side have huge bargaining power, smaller companies do not have much.

India's rickshaws are the most important means of transportation in domestic cities. Therefore, it is no surprise that competition is quite fierce on the market. What was a highly chaotic system seems to change along with innovations such as mobile rickshaw hailing services. Even though the market is oligopolistic, the main providers are in a fierce battle with each other. This has influences on both the bargaining power of suppliers (rickshaw drivers) who benefit from many services offered by the providers to bind them. On the other hand customers benefit from reduced prices and increased service, thus their bargaining power is high as well. Also the threat of new entrants is of relevant size since the Indian market is quite attractive in consideration of their increasing middle class and rising wealth. Only the threat of substitute is comparably low. This can be ascribed to the fact that the market is quite new itself.

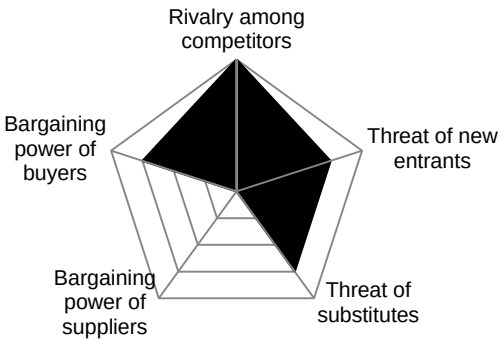
Opposed to these dynamic industries, Japan's high-speed rail market is quite rigid. It is dominated by seven enterprises that originated out of the formerly state-owned JR group through privatisation. Even though they were privatized they are not perceived as competitors. Apart from the JR Group there are 16 train companies. However, the JR Group is the only one operating Shinkansen trains. So, there is an oligopolistic high-speed train market and a monopolistic Shinkansen market. Since it is extremely expensive to both build the necessary infrastructure as well as the trains themselves, the only possibility for new entrants would be to operate services on existing tracks owned by the JR group. Hence, there is no real threat from new entrants. As for substitutes, there is only a threat in long distances due to air fares becoming cheaper. For medium distances Shinkansen are still the most competitive means of transportation. Whereas the suppliers' bargaining power is quite low because of the JR groups standing, the buyers' bargaining power is comparably high due to them being very price sensitive and open to switching to existing and prospective substitutes.

Despite the fact that South Korea's smart mobility service market is quite young a market, it is similarly rigid. This is mainly due to its citizens preferring local brands. Kakao Corporation, a company that became quite popular based on their mobile communication applications successfully turned this into a business opportunity and outlawed international competitors, e.g. Uber. Even though Uber is still on the market, Kakao Corporation benefits from its all-in-one platform covering car and ride sharing services as well as payment services. Out of all these reasons it is quite hard for both domestic and international companies to enter the market. Since the smart mobility service market is relatively young, there are no substitutes so far. As for bargaining power of suppliers and buyers Kakao Corporation is in a similar position as car and ride sharing service providers in other countries. They have a dictating role towards their suppliers but are very sensitive to their users' behaviour. Thus, an almost inexistent bargaining power of suppliers opposes a huge bargaining power of buyers.

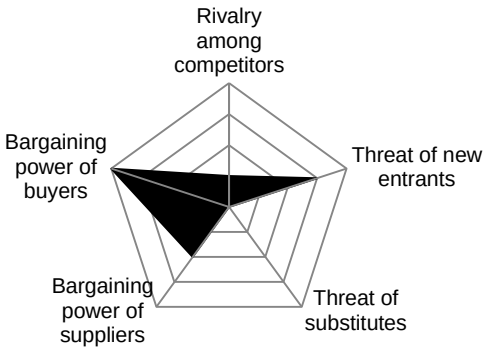
In the US the digitalisation led to substantial disruptions in the path-dependent automotive industry. Especially, advances in connected and automated driving technologies are changing these developments since they have impacts on various levels. The incumbents (OEMs) do not only have to compete against their rivals but also to keep off new entrants and substitute products which are increas-

ingly entering the automotive market because of their expectations of high industry profitability. Whereas the bargaining power of suppliers seems to remain unchanged, the bargaining power of buyers is quite high since they will eventually be the ones to decide if the technology will gain market coverage and who will be the leading force.

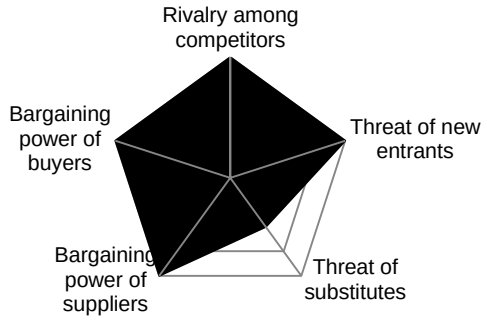
Biofuels in Brazil



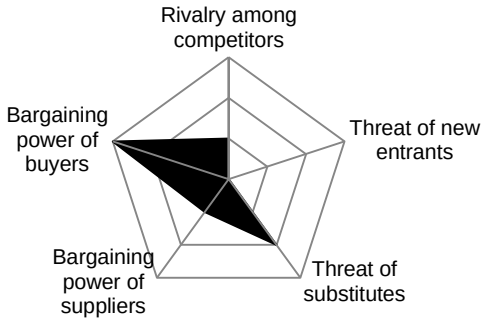
Smart Logistics Services in China



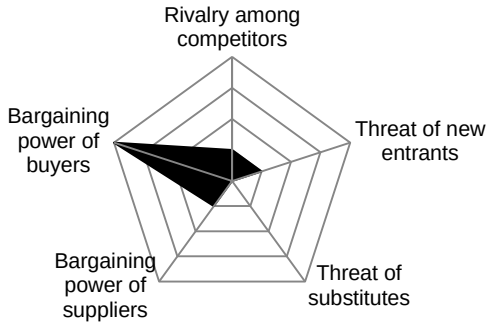
Smart Cycle & Auto Rickshaw Services in India



High-Speed Trains in Japan



Smart Mobility Mobile Platforms in Korea



Automated Driving in USA

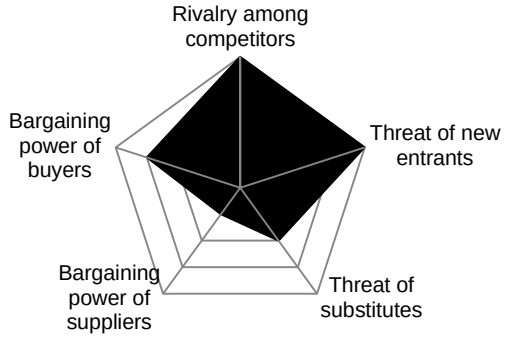


Figure 49: Results from Porter's 5-Forces analyses for one value chain per country under study

Based on the state-of-play, SWOT and Porter's 5-Forces analyses best practices and lessons learned on integrated transportation were identified in step 2 of the study, as summarized in Figure 50. A total of 32 best practices and lessons learned were identified across all focus areas. However, most best practices could be identified in Focus Area 1 and 2. Due to the study's approach to take into consideration the whole value chain, best practices were identified in all areas including legislation, policies, funding programmes, R&D efforts, business models, application of technologies and demand-oriented examples. Once identified, they were characterized and analysed in terms of their feasibility for the European situation. Best practices could be found in all countries except from China where only one lesson learned was identified. The lesson learned in China is that business cases shall not be avoided in the advancements of technologies towards new forms of transportation. Even when new means of transportation turn out very successful, their operation can only be operated continuously if they yield positive monetary returns, e.g. through profitable business solution or alternatively through continuous public funding.

In addition, four best practices outside of the six countries under study where added to provide additional input for proposed actions. These were found in Singapore, Canada, the Philippines and Australia.

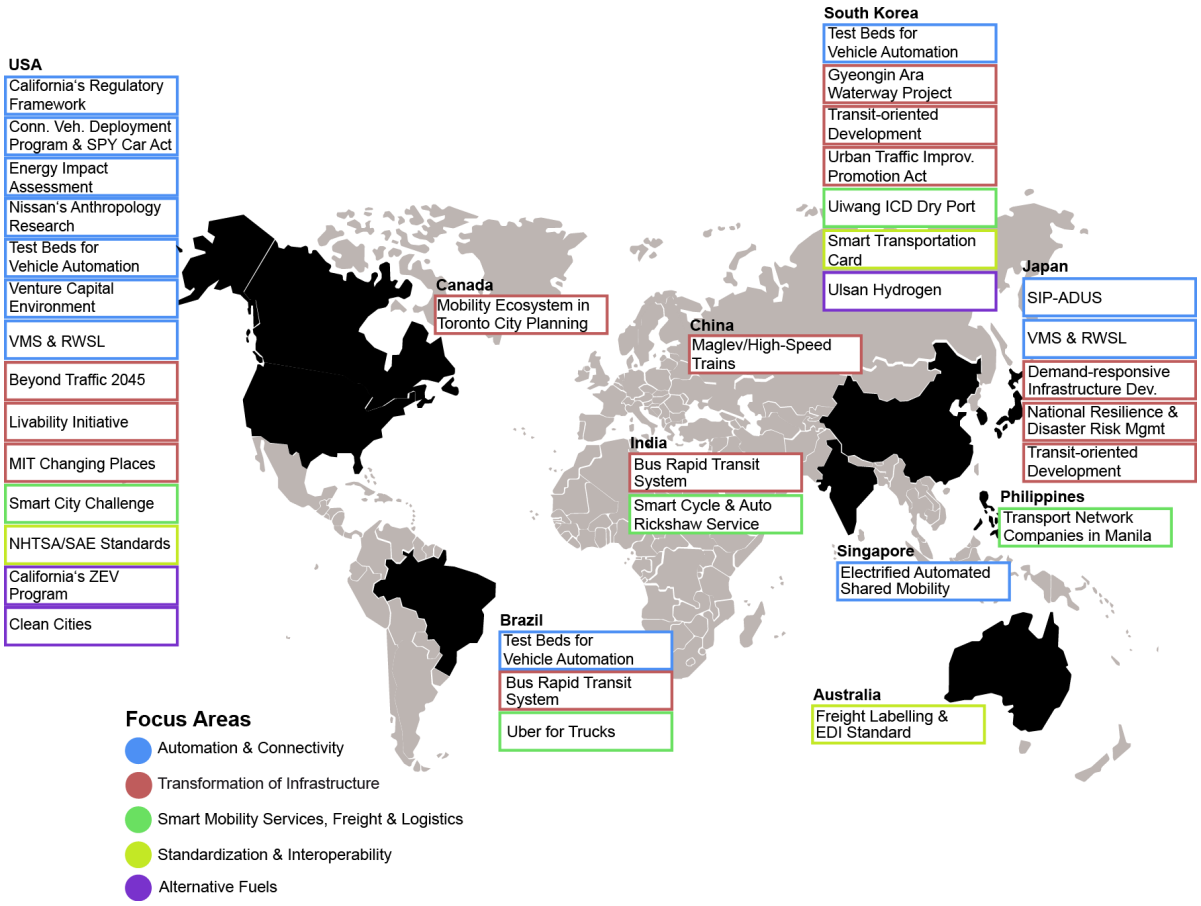


Figure 50: Best practices and lessons learned of integrated transport system along the focus areas in selected countries

In case overlaps where found, single best practices were not analysed separately but consolidated in order to provide insights into differences of the implementation approach across countries. The most striking examples for this case are the transit-oriented development in Japan and South Korea; the deployment of test beds for automated and connected driving in Brazil, South Korea, and the US; as well as the implementation of Variable Message Signs and Runway Status Lights at Japanese and US airports.

The analysis shows strong coherence with the preceding assessment of each country's maturity degree. The number of best practices identified within a certain focus area strongly correlate with the ma-

turity degree assigned to the same focus area across analysed countries. The higher the maturity degree the more likely it was to find best practices in the specific country and focus area.

Despite the fact that electrification is particularly exempted from the analysis it has become clear in step 1 and 2 of the study that it is an aspect that shall not be neglected since most countries under analysis as well as Europe have decided to opt for the development of this technology rather than other propulsion systems. In fact, it is not only perceived as one of the three big automotive revolutions (together with automation/connectivity and sharing) but also of growing relevance for other transport modes. Even though the topic has not been specifically addressed in Focus Area 5, it was included in other Focus Areas where its impact was perceived to be rather big (e.g. Focus Area 2) or where it made up an important part of a best practice (e.g. Singapore: Electrified Automated Shared Mobility).

As a final step the study provided input to the development of action plans for the establishment of an integrated transport system in Europe. Here, lot 2 drew on lot 1's identified barriers within Europe. Where the feasibility analysis of best practices returned positive results, one action plan per focus area was defined on how to overcome existing barriers through the transfer of experiences in selected countries to Europe. For each best practice an action was identified. Different actions to be taken were bundled into activity fields for each of which the status quo was identified based on lot 1's results. Besides the description of the current situation goals were derived that are attained if all actions were taken. Decision-makers can draw on these established action plans with regards to what part of the value chain the specific action tackles, who is responsible for the action to be taken, what action to prioritise, and to disclose timely interdependencies between the actions themselves. Thus, roadmaps can be built on how to reach a single and innovative European transport system with milestones in 2020, 2030 and 2050. In line with preceding results, the actions span across the entire value chain.

It can be seen that the lack of stakeholder collaboration, especially cross-border collaboration within Europe as well as insufficient cross-country interoperability seems to be the biggest hurdle. In the analysis of the six selected countries this was a minor problem, mainly due to the fact that in comparison to the European Union all countries under study do not comprise different nation states within their respective legislation. Similarly important for Europe is a stronger interplay of politics, research, industry and the user such that systemic change is shaped by all relevant spheres of society without one lagging behind, e.g. not having sufficient regulation on innovated technologies. A further action to be taken foresees the fostering of user-oriented technology design and citizen-oriented infrastructure design. It can be shown that the early inclusion of the user or citizen in the development process – may it be products, services or constructions – is pivotal for the success of the specific project. New, more effective funding, e.g. funding models with leverage effects that motivate investment beyond the funded project, are necessary to support the development towards a single and innovative transport system. Even though this lies for most parts within the responsibility of public sponsors such as the European Commission or member states, it would also be advantageous if private grant providers invested where risk is very high. This, however, would ask for a cultural shift since European investors tend to be comparably conservative about their investments. Recognizing that this is a rather long-term goal, it is advisable to establish tools to anticipate the impact of projects to be undertaken, especially where perceived implications are rather big. The assessment shows that most actions can be taken either until 2020 or 2030 as they are built on current best practices. As for responsibilities, the majority of actions are to be taken by the European Commission, member states and municipalities.

Furthermore, the study also pointed out potentials for international co-operation between Europe and countries under study. In a first approach recommendations were given on which best practices or lessons learned shall be transferred to Europe, where Europe shall export its expertise to other countries or where measures are to be taken in a joint effort. In a second stage these results along with findings from the action plans were further processed into high-level clusters. These high-level clusters are (1) the strengthening of the EU competitiveness, (2) market access issues, (3) the contribution to dealing with global challenges and (4) the identification of global players and programmes for enabling collaboration, cooperation and joint initiatives.

All results were validated by international and European experts in two Validation Workshops in different stages of the study. Through this approach outcomes were not only verified or falsified but also enhanced by additional input, especially for the identification of potentials and recommendations for international co-operation.

Through the involvement of European stakeholders in the Validation Workshops it became clear, too, that there is a growing need to overcome the lack of stakeholder collaboration and cross-country interoperability in Europe. This is illustrated by the amount of additional recommendations on standardisation spanning over all clusters. To guarantee worldwide interoperability, which is inevitable in today's globalised world, there is no alternative as to undertake standardisation on an international level. As mentioned above, Europe suffers from the unique situation of having to deal with a multitude of different legislations. However, it could turn this obstacle into an opportunity by pushing international standard setting based on experiences from efforts taken regarding inner-European harmonisation. Once this has been achieved, a shift of focus from harmonisation and interoperability between different nations to harmonisation and interoperability between different transport modes would add to the advancement of all high-level clusters in Europe.

8 Annex

The following table contains all barriers identified by lot 1 including the identification code as well as the full title of the barrier as given in the State of Play and Analysis of Barriers – Final Report.

Barrier Code	Title
FA1-01	Difficult acceptance and hesitance to invest from driver stakeholder groups
FA1-02	Little knowledge among public authorities about the type and scale of changes required to the physical road infrastructure
FA1-03	Unclear business case and “sensibility case” for C-ITS deployment in urban areas
FA1-04	Unclear user acceptance, willingness to pay and business case for C-ITS services
FA1-05	Long waiting period and high penetration rates are required until benefits such as optimisation of traffic flow materialises
FA1-06	Unclear role for operational stakeholders for enhanced traffic management
FA1-07	Road Safety concerns from C-ITS and Automation
FA1-08	Uneven deployment of C-ITS across EU-28
FA1-09	Unclear lending criteria to finance C-ITS measures
FA1-10	The “Hybrid” Issue: Uncertainties about investment into C-ITS communication infrastructure?
FA1-11	Liability, legislation and insurance related aspects
FA1-12	Unclear risks between interaction with non-equipped and equipped vehicles
FA2-01	Funding gap in the development or improvement of transport infrastructure

Barrier Code	Title
FA2-02	Risk-averse policies
FA2-03	Challenges to incorporate new technologies and innovation into already existing infrastructure networks
FA2-04	Timing of the standardisation process
FA2-05	Large number of agents implied with different priorities and visions (Fragmentation)
FA2-06	Incompatible and inflexible policies and regulatory frameworks
FA2-07	Unequal and limited ERTMS deployment across Europe
FA2-08	Information gap and uncertainties on climate behaviour
FA2-09	Limited demand of new fuels and lack of innovative business models
FA3-A1	Stakeholders do not collaborate well with each other
FA3-A2	Insufficient availability of open data
FA3-A3	Underutilisation of (real-time) data in spatial/urban planning
FA3-A4	Fragmented responsibility and/ or lack of coordination with respect to transport-related data management and digital services
FA3-A5	Systems, services and data lack interoperability (lack of standards)
FA3-B1	New mobility services so far are little integrated in MMITS
FA3-B2	The quality of data is insufficient making MMITS very inconvenient

Barrier Code	Title
FA3-B3	On-demand mobility services require new legislation and funding schemes
FA3-C1	Logistics sharing: the bundling of freight does not materialize due to a lack of cooperation and trust among the logistics stakeholders
FA3-C2	Little work towards a freight system based on synchromodality, including a lack of use of ICT and data governance
FA3-C3	Unsystematic urban freight data collection and management and lack of internalization of environmental impacts of logistics operations (eco-performance)
FA4-01	Poor collaboration between stakeholders
FA4-02	Low levels of information sharing
FA4-03	Few recognized business and operational models for horizontal collaboration
FA4-04	Poor collaboration between modes
FA4-05	Incompatible standards and regulations
FA4-06	Inadequate flexible ICT
FA4-07	Insufficient recognition of the role of modular units in facilitating inland and air transport
FA4-08	Inadequate transshipment technology
FA4-09	Weak market dynamics
FA5-01	Insufficient supply
FA5-02	Low demand

Barrier Code	Title
FA5-03	Innovation chain discontinuities and lack of investment
FA5-04	Insufficient policy support
FA5-05	High retail cost
FA5-06	Weak user acceptance
FA5-07	Dominance of the existing system
FA5-08	Fragmented market across Europe
FA5-09	Short-term policies


European
Commission