

11.

RESEARCH AND HUMAN RESOURCE DEVELOPMENT





TABLE OF CONTENTS

VISION	534	KNOWLEDGE GENERATION IN OPERATING COMPANIES/ORGANISATIONS/MUNICIPALITIES	557
INSTITUTIONAL SET-UP	535	JOB OPPORTUNITIES FOR HIGHLY-TRAINED PROFESSIONALS IN THE TRANSPORT SECTOR	557
National Transport institutions	536	Production of the Workforce	557
Sectoral institutions	539	Sponsored Master's and Bachelor's Degree Programmes	558
Knowledge Generation and Government Ministries	541	In-Service Training	558
Statistics and Analysis	542	Lateral Hiring	558
Funding Research and Training in Academic institutions	543	SUMMARY	558
University Research Centres	543	Investment in institutions	560
Overall Systemic Lessons	545	Standalone National institutions	560
INDIAN CONTEXT	546	Science and Technology Capability in Transport Ministries	560
Existing institutions and Organisations	546	State-and City-Level institutions	561
FUTURE REQUIREMENTS	550	Academic Centres of Excellence	561
Skills Gap	550	Knowledge Generation in Operating Companies/Organisations/Municipalities	561
Data Requirements	551	Job Opportunities For Highly-Trained Professionals in the Transport Sector	561
Converting information into Knowledge	552	Production of the Workforce	561
New institutions For Capacity Building	552	Sponsored Master's and Bachelor's Degree Programmes	562
Expertise For Public-Private Partnerships	552	In-Service Training	562
RECOMMENDATIONS FOR INSTITUTION BUILDING	553	Lateral Hiring	562
Standalone National institutions	554	CONCLUSIONS	562
SCIENCE AND TECHNOLOGY CAPABILITY IN TRANSPORT MINISTRIES	555	ANNEX	563
Research institutions	555	REFERENCES	573
Department of Technology Development and Policy Analysis	555		
State-and City-Level institutions	555		
Academic Centres of Excellence	555		

11. RESEARCH AND HUMAN RESOURCE DEVELOPMENT

In order to ensure more efficient, safer and cleaner transportation systems in India, there is an urgent need to set in place institutions and mechanisms for knowledge creation and training of professionals in all aspects of transportation planning and operations. Well-informed planning methods and use of modern scientific and technical tools for analysis and monitoring of existing systems can play an important role in transforming the transportation infrastructure in India.

The competencies of professionals working in the transportation field have to be strengthened considerably. India must also put in a place a system to continuously renew these capacities, both by updating existing workers' skills as well as inducting new expertise into public service as needed. Technology changes as well as evolving means of implementing transport projects through public-private partnerships (PPPs) require a variety of new skills from engineering, social and management sciences.

For the past many decades, transportation policies focussed mainly on increasing transport capacity and operational speeds. Over the next few decades issues concerning safety, climate change, harmful emissions, equity and energy efficiency, intermodal connectivity will also have to be an integral part of all transportation policies and embedded in all levels of decision making. This cannot be done without improving skills and increasing the knowledge of the transportation workforce and decision makers. We will also have to focus on supporting local transportation professionals through training, technology transfer and information exchange activities.

At present knowledge gaps exist in all areas of activity:

- (a) Design, construction, operation, management, maintenance

- (b) Safety
- (c) Demand management
- (d) Project management
- (e) Use of Intelligent Transport System (ITS)
- (f) Finance

Expertise in such areas needs a great deal of interdisciplinary work and collaboration between knowledge producers and practitioners at all levels.

Future transportation planning and policy making will also require a much more sophisticated approach to set in place systems that ensure the consideration of climate change and safety issues as integral components of infrastructure and technology options. In particular, all agencies will have to incorporate climate change and energy efficiency issues into their transportation planning processes. In the coming years all new transportation plans will have to include explicit reference to the effects of transportation on climate change and the role of transportation in mitigating these effects. There is a need for greater involvement of both central and state governments in climate change issues. Organisations at the local level in particular will need data and expertise input on how and where to incorporate climate change. The quantification of climate-forcing and health-damaging emissions as costs to be weighed in the transportation planning process is a

new challenge for transportation agencies. All this will have to be implemented across all transport sectors and national, state and city levels for:

- Multimodal transportation planning
- Selection, integration and management of technologies
- Building, construction and maintenance of infrastructure
- Management of transportation systems
- Monitoring of systems: financial, energy, emissions, lifecycle costs, safety, efficiency, etc.

Decision-makers, transportation officials, and staff face increasingly complex issues when addressing transportation needs in their communities. Examples of expertise requirements would include:

- Air quality assessment and health impacts: natural and physical sciences, medical sciences, mathematical modelling, instrumentation
- Freight and human movement: All engineering sciences, mathematical modelling
- Safety: engineering and medical sciences, epidemiology, statistical modelling, psychology and sociology
- Asset management, cost estimation, financial planning: economics, accounting modelling
- Operations: management, operations research, survey techniques, sociology and psychology
- Public involvement: education, public relations

Expertise needs to be developed specifically in all these areas with special reference to different modes of transport. At present none of the agencies involved—educational institutions, research laboratories, operators, government agencies, non-governmental organisations (NGOs)—have adequate interdisciplinary expertise or the required number of personnel to service these needs.

One way to understand the status of knowledge production in different countries is to examine the number of scholarly articles on different subjects originating from those countries. Five key areas were identified, pertaining to the field of transportation research:

1. Road Safety
2. Civil Engineering projects related to development in transport facilities
3. Emissions, covering air and noise pollution
4. Railways
5. Transportation planning, oriented towards developing the transport facilities

Each of the areas mentioned here, were indexed using unique keywords and a search done on the online search engine Scopus™. The results of the search for the countries India, China and Brazil are shown in Table 11.1 and the output normalised for

population (2011) shown in Table 11.2. These tables reveal that not only does India fare poorly in terms of total output, when normalised for population levels in 2011, India's output appears poor in comparison with both Brazil and China. Even more worrisome is the fact that the gap between India and China has widened considerably in the past decade (Table 11.3) especially on topics dealing with railway technology.

If we assume that research output may have some relationship with per capita income and number of people in each society, even then these results show India is doing much worse than China and not even as well as Brazil.

It is possible that these data do not contain studies published from India which are not included in indexed journals, and that the quality of studies from India may be better than many originating from China. However, the gaps are so large that we need to take corrective measures on an urgent basis. The number of papers from China per person per US\$ per capita income are more than three times greater than that from India in all areas. This means that if we want to catch up with China in 10 years with their present levels of productivity, we will have to grow at more than 10 per cent per year. However, this would not be adequate enough for the kind of growth we need in knowledge generation and innovation to put in place systems in the next 10 years that serve us well for the next 30 years. It would be safe to assume that we need to plan for a dramatic increase in human resource development, research output and creation of jobs for highly trained professionals.

VISION

The research figures are only a symptom of general gaps in capacity available in India. Increase in research output alone is not likely to yield the kind of systemic changes required for ensuring a more evidence and knowledge based policy-making environment necessary to steer us towards a sustainable transportation future. The system we envision must address the unique issues of concern in India. Sustainable growth of transportation requires an integrated interdisciplinary approach that incorporates our special needs. Work for sustainable transport will need an innovative combination of current and future international knowledge adopted to local findings. This knowledge will have to be produced in India within the socially dominant forms prevalent here. We have to set up a system of research which responds dynamically to include a heterogeneous set of practitioners collaborating on problems defined here in localised contexts but integrating international concerns and learning from international experience in a rigorous, internally consistent format.

Table 11.1
**Number of Academic Articles
 Published Originating in India, China
 and Brazil, 2006-10**

	INDIA	CHINA	BRAZIL
Road Safety	120	911	118
Railways	121	2,167	28
Emissions	15	60	51
Civil Engineering	151	1,234	19
Air Transport	33	323	29
Marine Transport	12	97	1
Transport Planning	18	129	13

Source: NTDP Research done through Scopus™.

Table 11.2
**Number of Publications,
 2006-10**
 [Per 100 Million Population]

	INDIA	CHINA	BRAZIL
Road Safety	10	68	62
Railways	10	162	15
Emissions	1	4	27
Civil Engineering	12	92	10
Air Transport	3	24	15
Marine Transport	1	7	1
Transport Planning	1	10	7

Source: NTDP Research done through Scopus™.

Table 11.3
**Ratio of Journal Papers Published by China and India, 1961-2005
 and 2006-10**

TOPIC	1961-2005	2006-10
	CHINA/INDIA	CHINA/INDIA
Road Safety	1.1	5.5
Transportation Planning	1.4	12.9
Emissions	0.6	4.0
Railways	8.1	23.0
Civil Engineering	3.3	8.4

Source: NTDP Research done through Scopus™.

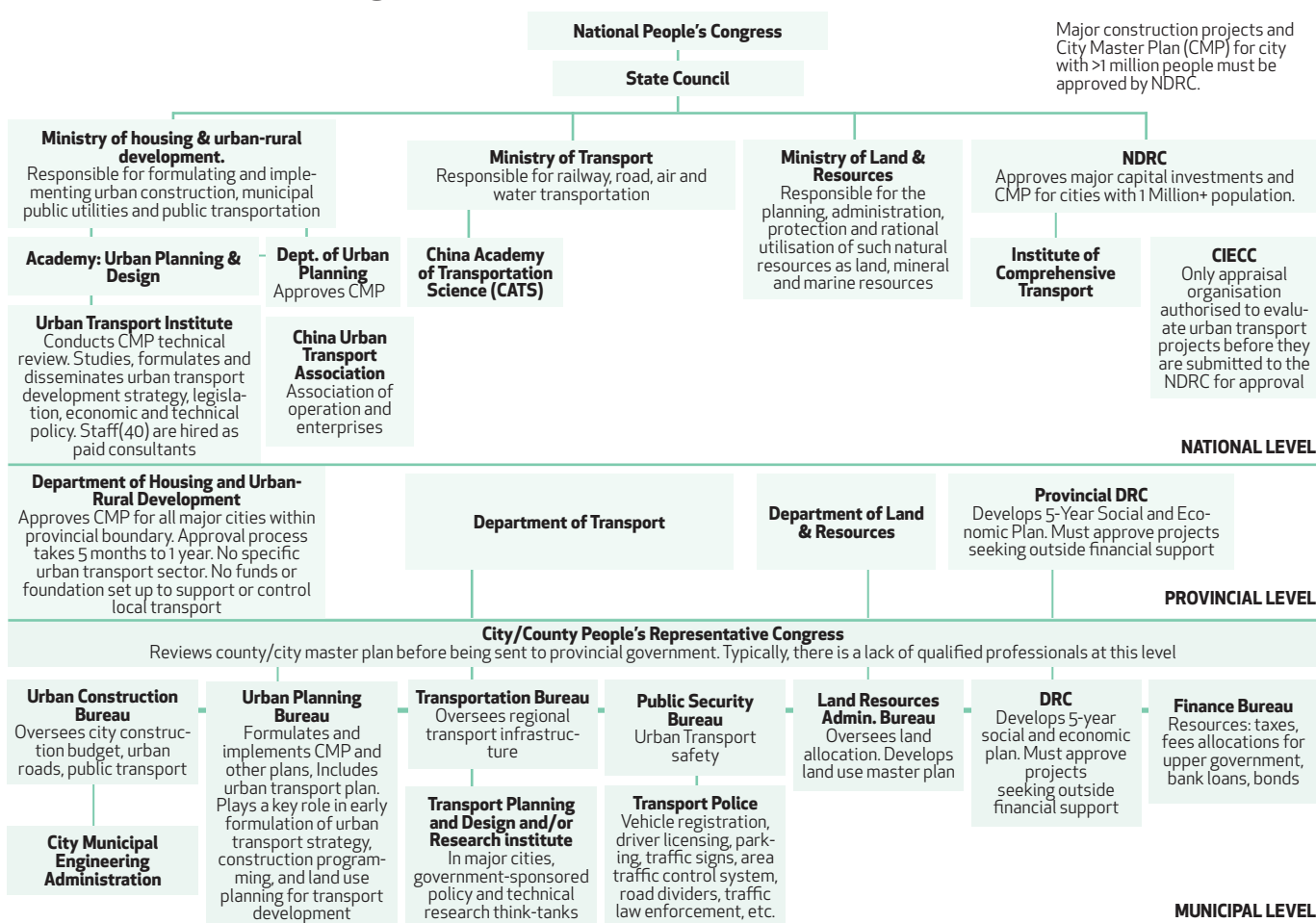
We must plan to set up systems for local knowledge producing mechanisms that aid researchers in responding to demands of society. Such systems are in a very nascent stage of development here, but the good news is that the divides between research and practice that are entrenched in many of the world's top-ranked research programmes also have not been replicated in India. It is possible to build such knowledge systems even as higher education reform moves forward, rather than having to unlearn ways of research production and then re-learn. Researchers will have develop new and appropriate tools of analysis and technological solutions for tackling the complex problems of safety, pollution, access and mobility. We must create quality resources needed for integrating hard and soft sciences research. It is these resources, publications and networking activities that will bring continuity and permanency to activities that also address quality of life issues. The effort would be to experiment with new forms of knowledge generation where there is continuous negotiation between disciplines on one hand and between scientists and society on the other, and where the solutions developed will normally be beyond that of any single contributing discipline. They will necessarily be transdisciplinary.

INSTITUTIONAL SET-UP

Functioning transportation systems in any location involve interactions between individuals, socio-economic imperatives, technologies, geophysical structures, built environment, organisational capacities, political compulsions, knowledge limitations, influence of special interest groups, and historical path dependencies of societies. As with any other complex structure, we tend to deal with transportation systems with little knowledge about these interactions and their myriad feedback loops. We have some knowledge of the input and output variables, but little of the transfer functions and the feedback loops. In such a situation it is very necessary to have organisational systems that keep track of inputs and outputs on a continuing basis so that transfer functions can be developed and modified periodically. This understanding would help us in technology choices, development of appropriate physical and management structures and periodic course corrections.

There are a large number of models available around the world for institutional frameworks that attempt to satisfy the above goals. To address deficiencies in data and data processing limitations, lack of infor-

Figure 11.1
China Transport Planning and Research



Source: World Bank report prepared by Zhu Lin, 2004.

mation on costs, demand, revenues and asset condition, effective regulation procedures, management and accountability, forecasting models, technology choice assessment, different governments have established:

- independent research institutions at national and regional levels that work on all modes of transport and also mode-specific institutions;
- formally structured, information provision units within government or operating as service providers to government, whose responsibilities include defining, collecting, forecasting, structuring and disseminating information on transport problems and trends and the performance of policy instruments. Such units use information from all relevant transport agencies;
- relatively large policy making and technical research departments in ministries and operating agencies;
- centres of excellence at academic and research institutions.

The variety of institutions is important to ensure a flow of knowledge from global to local expertise: faculty and researchers move between independent departments on temporary basis,

while their colleagues may establish longer-run relationships with public servants and policy-makers. The dispersed knowledge creation also creates scope for variety, and particular attention to local issues that researchers experience personally. It also ensures competition between research groups and insulates against mistakes or organisational challenges that one institution faces. For example, as Figure 11.1 shows, China has set up institutions that work on transportation related issues at different levels.

The following subsections give a few examples of knowledge-producing institutions for comparative perspective and summarise lessons from international experience with overall research production systems.

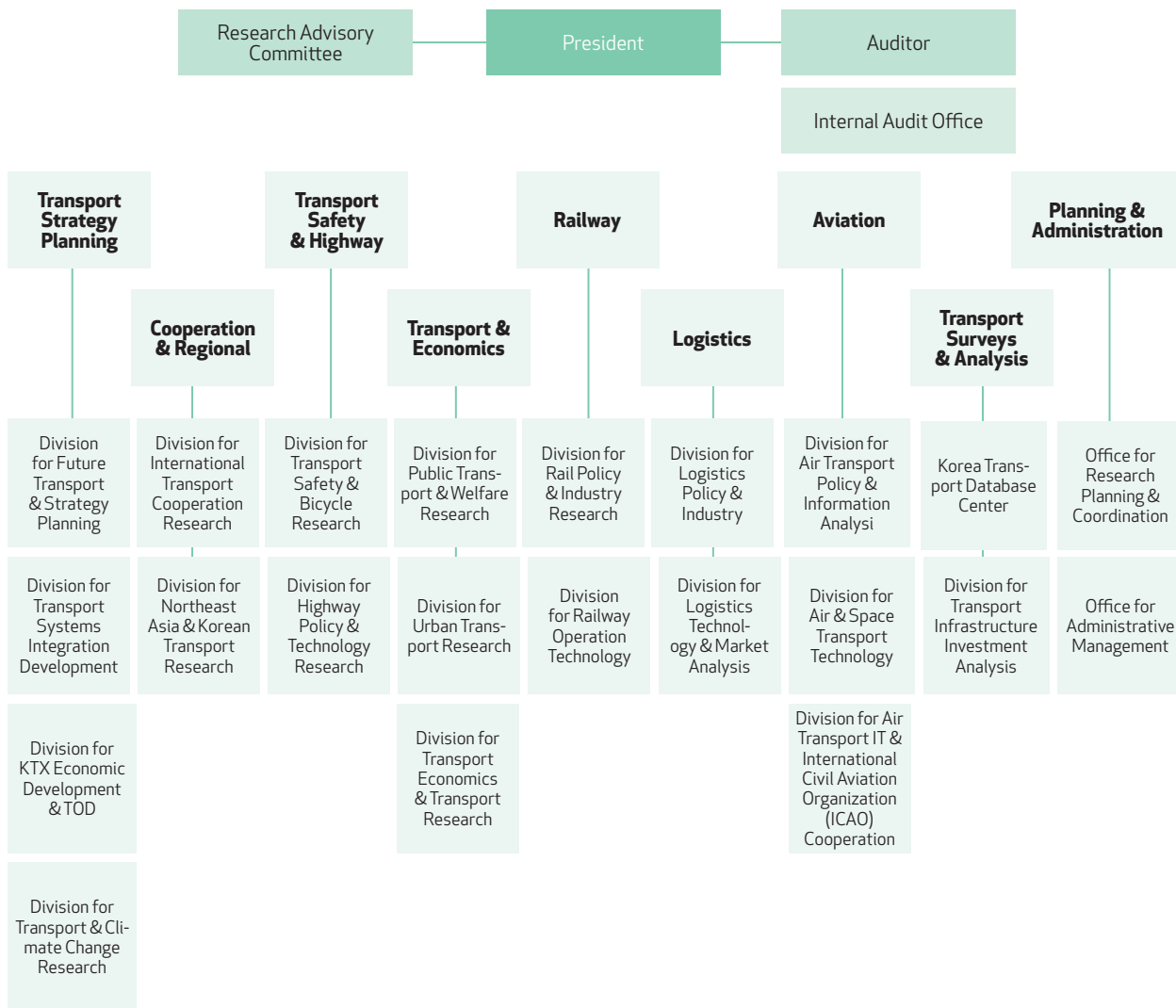
NATIONAL TRANSPORT INSTITUTIONS

THE KOREA TRANSPORT INSTITUTE (KOTI)

KOTI, established in 1985, is the official research agency for the government of the Republic of Korea. In 1987 it began operations as a government-funded institution pursuant to Article 24 of the Urban Transport Promotion Act. It joined the Korean Council of Economics & Social Research Institutes pursuant to the Article of the Government Grant Act

Figure 11.2

Administrative Structure of the Korea Transport Institute (KOTI)



Source: KOTI.

for the Establishment, Operation and Promotion of Research Institutes. Since then it has developed into a very influential institution for developing national policies and social agenda in the transport sector with objective of:

- Providing policy-making assistance to the government (guidelines, public hearings, seminars, etc.).
- Developing future transport technologies to explore new growth engines for the national economy.
- Devising a new strategy to support national transport policies.
- Pursuing a knowledge-sharing programme in the transport sector.
- Developing global agenda and promoting cooperation with international organisations.
- Developing creative and innovative endeavours.
- To serve as a comprehensive research institute on transport and logistics and as a National Think-Tank.

- Serve as hub for global transport cooperation.

The Institute has nine departments and the structure is shown in Figure 11.2. KOTI covers all areas of transport, employs over 200 researchers, and has agreements with a large number of Korean transportation organisations and academic institutions. These include for example: Transportation Command, R.O.K, Korea Institute of Construction and Transportation Technology Evaluation, Korea Transportation Safety Authority (KOTSA), Korea Advanced Institute of Science and Technology (KAIST), Korea Institute for Construction Technology, Graduate School of Environmental Studies at Seoul National University, Daegu University, Institute of Urban Sciences at University of Seoul, Busan Transportation Corporation, The Korea Railway Association, Korea Airports Corporation, Korea Aerospace University.

Since its foundation, KOTI maintains close foreign relationships with foreign institutions and research organisations. These include MOUs and academic exchanges. Examples of these are given below:

- The Establishment of a master plan for the Arterial Road Network in Sumatra Island, Indonesia.
- Integrated International Transport & Logistics System for Northeast Asia (partner UNESCAP).
- MOUs with over 20 organisations including: The Institute for Transport Policy Studies (Japan), TRL (UK), OECD, Asian Development Bank, Land Transport Authority Academy (Singapore), The World Bank, Tsinghua University (Beijing, China), Gesellschaft fuer Internationale Zusammenarbeit (GIZ, Germany), MIT (US) and Electronic Navigation Research Institute (Japan).

STANDING COUNCIL ON TRANSPORT AND INFRASTRUCTURE (SCOTI), AUSTRALIA¹

The Standing Council on Transport and Infrastructure (SCOTI) (formerly known as the Australian Transport Council) was established in September 2011 and brings together Commonwealth, State, Territory and New Zealand Ministers with responsibility for transport and infrastructure issues, as well as the Australian Local Government Association.

SCOTI is advised and assisted by the Transport and Infrastructure Senior Officials' Committee (TISOC) on all non-infrastructure priorities, and the Infrastructure Working Group providing advice and guidance on the coordination of infrastructure planning and investment, across governments and the private sector.

The Council's high-level policy responsibilities include:

- surface transport;
- transport safety and security;
- promotion of more efficient and environmentally conscious transport, including through vehicle emission standards and national cycling promotion;
- infrastructure policy and investment, including road, rail and ports;
- infrastructure and related land use planning; and
- strategic planning for infrastructure and consistency with agreed criteria for capital city strategic planning systems.

The Council works closely with the Standing Council on Regional Australia to ensure integrated action for regional Australia.

The Council's priority issues are:

- (a) Achieving national systems for regulation of heavy vehicles, maritime safety and rail safety;
- (b) Completion of the National Freight Strategy, including the development of a dedicated National Ports Strategy, with additional work undertaken to outline how airports and airport land use planning might be taken into account in the National Freight Strategy;
- (c) Consideration of national heavy vehicle pricing and funding reform through finalisation of the COAG Road Reform Plan process;
- (d) Consideration of the National Urban Policy and integration with agreed criteria for capital city strategic planning systems;
- (e) Developing and implementing reforms to infrastructure investment and financing;
- (f) Developing a National ePlanning Investment Plan by end 2012 through the National ePlanning Steering Committee.

INSTITUTION FOR TRANSPORT POLICY STUDIES (JAPAN) AND THE JAPAN RESEARCH CENTRE FOR TRANSPORT POLICY²

The Institution for Transport Policy Studies is an independent, non-profit foundation established under the auspices of the Japanese Ministry of Land, Infrastructure and Transport. The activities of the Institution involve comprehensive research and survey programs on transport matters. The Institution also evaluates transport policy and offers recommendations to the Japanese government and concerned parties on transport policy issues. The overall aim of the Institution is to contribute towards the development of transport policy in order to promote the welfare and quality of life of people in Japan, its economy, and greater harmony in international relations.

Primary activities are to:

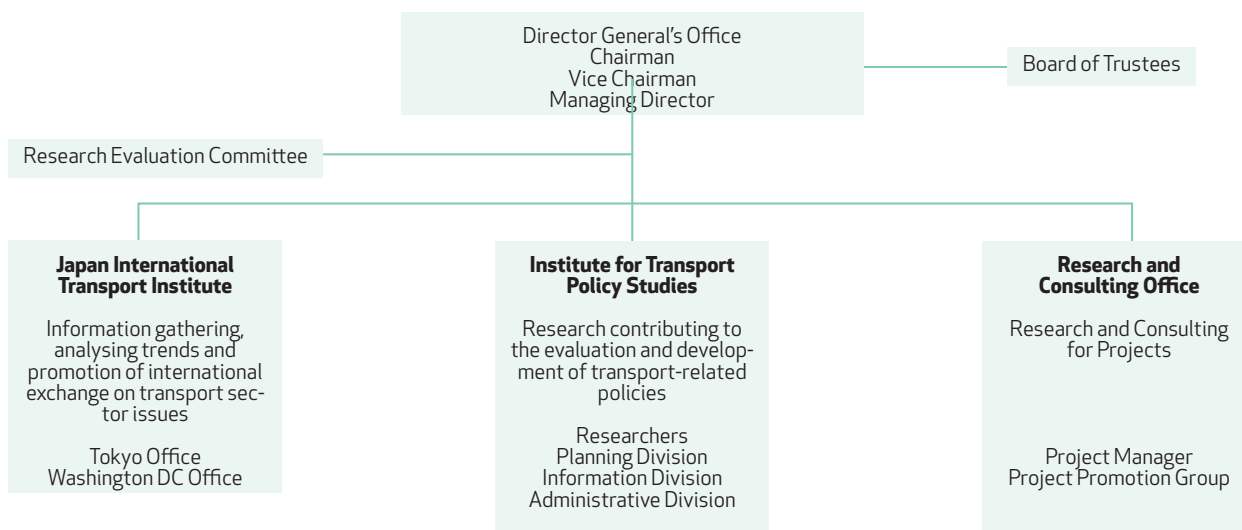
- (a) Conduct research and surveys on transport matters
- (b) Evaluate and advise the national government on transport policy issues
- (c) Collect and analyse transport-related data
- (d) Survey overseas transport trends
- (e) Conduct regional and international cooperative exchange programmes and activities related to transport issues
- (f) Consult on matters related to transport issues
- (g) Host lecture sessions, study meetings and seminars to promote awareness of transport issues.

The Japan Research Centre for Transport Policy was founded in 1971. Since then, the Centre (a private non-profit organisation involving transportation specialists and researchers active in universities, private industry, government and local governments)

1. <http://www.scoti.gov.au> (accessed 12 January 2013).

2. <http://www.jterc.or.jp/english/gaiyo.htm>; <http://www.nikkoken.or.jp/english/index.html> (accessed 15 November 2012).

Figure 11.3
Organisational Chart for Institution for Transport Policy Studies, Japan



Source: NTDP Research.

has been carrying out interdisciplinary academic research focused on transport policies for roads and motor vehicles, and providing educational activities and proposing policies regarding a comprehensive transport system that will contribute to the beneficial development of Japanese society. It has been formally certified as a Public Interest Incorporated Association under the new organisation reform act.

The centre conducts surveys and research pertaining to transportation policy. The primary focus is the movement of people and goods that are a vital part of the socio-economic activities of the nation. Research is conducted primarily through the efforts of the Centre's regular and associate members and by securing the participation of key outside partners. Research projects include topics selected from proposals submitted by members and includes research conducted in collaboration with associate members. Another purpose is to cultivate and mentor aspiring young researchers. Special research focused on themes of particular societal concern is often chosen for study. The outcome of the research is the formation of transportation policies for entities concerned with improving the quality of life. These entities include national and local governments, concerned institutions and various other organisations.

Examples of topics on which work is done include the prevention of global warming, preservation of natural resources and energy, social and economic impacts of a dwindling birth rate, changes in population demographics (aging and shrinking population), development of a safe and comfortable transportation system, streamlining and globalisation of physical distribution, expanding inter-regional gap between outlying regions and urban centres and funding issues concerning road maintenance and improvements.

3. Guofang and Tianyun (2003).

Major activities include: research of transportation policies that improve safety, comfort and mobility; study of transportation policies consistent with environmental, energy, national, regional and urban policy; research regarding transportation policies affecting businesses and the movement of people and goods; research and development of financing policy.

SECTORAL INSTITUTIONS

CHINESE ACADEMY OF RAILWAY SCIENCES (CARS)³

Since its establishment more than 50 years ago, the history of CARS is closely related to the railway construction of the People's Republic of China. In November 1949, only one month after the PRC was founded and everything needed to be rehabilitated, the Ministry of Railways decided to establish a railway scientific research institution. On 1 March 1950, the Railway Technology Institute of the Ministry of Railways was formally founded in and in September the same year, the name was changed into Railway Research Institute of the Ministry of Railways and its leading body was then moved to Beijing. Since the 1950s, it organised personnel and material resources to revitalise the war-torn railway network and construct new lines. After the Railway Research Institute was expanded to the China Academy of Railway Sciences in 1956, their technical personnel participated in the compilation of 1956-1967 Perspective Planning of Railway Science and Technology Development and undertook its execution. In 2002, it was transformed from a state-owned institute to an enterprise under the direct control of Ministry of Railways.

The past 50 years have seen CARS grow into a comprehensive institution with multiple disciplines and specialties and a centre of scientific research, experiment, industrial products and material inspection,

In 1949, only a month after the People's Republic of China was founded, it decided to set up a railway scientific research institute.

scientific and technical information, and standard and metrology. In CARS, there is a staff of 2,359, of which 1,640 are professional technical personnel accounting for 69 per cent of the total. In addition, there are 510 people with senior technical titles and 755 medium-level technical titles.

Since its establishment, CARS has undertaken several thousand scientific research topics centring around subjects such as rock engineering and geo-engineering, track structure, continuous welded rail (cwr) track, bridge and tunnel construction, hydraulic and hydrological engineering, engineering blasting, structural vibration, subgrade in desert or permafrost, prevention and control of landslide and debris flow, automation of marshalling yard, station computer control, despatching control, radio communication, optical fibre communication, data transmission, computer application, metal and non-metallic new material and techniques, non-destructive flaw detection technique, automatic detection, passenger and freight transportation organisation, transport economy, loading and unloading equipment, fundamental standard, scientific and technological information as well as soft science research.

Research Institutes

- Locomotive and Car Research Institute
- Signal and Communication Research Institute
- Railway Engineering Research Institute
- Computer Technology Research Institute
- Metals and Chemistry Research institute
- Transportation and Economics Research institute
- Environmental Control and Labor Hygiene Research Institute
- Scientific and Technological Research Institute
- Standards and Metrology Research Institute

Centres

- Railway Science and Technology Research and Development Centre
- Quality Supervision and Inspection Centre for Railway products, Railway Scientific, Technological and Economics
- Inspection and Measurement Centre for Railway Infrastructure
- State Railway Test Centre
- Railway Technology Training Centre

State Engineering Research Centre

- National Centre of Railway Intelligent Transportation System Engineering and Technology

4. <http://www.nlr.nl/index.php> (accessed 12 October 2012).

Metrological Stations

- State Track Scale Station, State Railway Tank Car Volume Measurement Station

CARS confers master's degrees in 13 specialties and doctoral degrees in five. In addition, there are two post-doctoral research centres in CARS. CARS publishes 12 kinds of academic and technical publications (including two internal publications), and has a library with a collection of over 300,000 copies of books, documents and papers. Backed by the related departments and the Ministry of Railways, CARS actively strengthens the international cooperation and exchanges as well as extends cooperation fields.

NATIONAL AEROSPACE LABORATORY, THE NETHERLANDS (NLR)⁴

The Government Service for Aeronautical Studies (RSL) was founded in 1919 to increase air safety for military aviation. The rapid emergence of civil aviation, however, caused the RSL to focus on that sector too. In 1937, the RSL was turned into a foundation (the NLL and subsequently the NLR), which created a better basis for conducting scientific research for the national aircraft industry (Figure 11.4).

NLR is the aerospace knowledge enterprise in the Netherlands. It answers questions such as: how can aircraft be made more silent, fuel-efficient and safer whilst increasing capacity on the ground and in the air? How can you ensure that satellites remain at a constant temperature so they can continue to function efficiently?

A staff of 650 employees develops new technologies, combining disciplines such as aircraft engineering, electrical engineering, mathematics, physics, information science and psychology. NLR has state-of-the-art facilities such as wind tunnels and interconnected aircraft and air-traffic control radar and tower simulators. NLR targets the entire lifecycle of aircraft: from research, via design, servicing and maintenance to modernisation in both civil and military aviation. NLR publishes about 600 reports, including some 40 technical publications annually.

NLR is the Dutch knowledge enterprise for identifying, developing and applying advanced technological knowledge in the area of aerospace. NLR is also committed to being the most competitive knowledge organisation for the Dutch aerospace sector in Europe (with the best price-quality ratio). NLR has (inter)national collaboration with aerospace enterprises and miscellaneous small and medium-sized companies, with KLM-Air France, Schiphol and LVNL, universities, the Netherlands Aerospace Council, the regions in the Netherlands with aerospace ambitions and with its counterparts DLR.

Figure 11.4
Areas of work: National Aerospace Laboratory, The Netherlands

<p>Air transport safety Airport noise and flight track monitoring Aircraft noise policy Aircraft noise sources Airspace capacity Alternative energy and fuels</p>	<p>ATM and airports Avionics development and qualification Education and training Emission inventory and reduction Flight testing Gas turbines Noise source identification</p>	<p>Operator performance Remotely piloted aircraft regulations Rotorcraft flight procedures Satellite navigation Simulation solutions for aircraft systems Third party risk Unmanned rotorcraft systems</p>
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Source: NTDP Research.

SWEDISH NATIONAL ROAD AND TRANSPORT RESEARCH INSTITUTE (VTI)⁵

VTI, the Swedish National Road and Transport Research Institute, is an independent and internationally prominent research institute in the transport sector. The Institute is a government agency under the Swedish Government. VTI's principal task is to conduct research and development related to infrastructure, traffic and transport. Areas of work include: pavement technology, infrastructure maintenance, vehicle technology, traffic safety, traffic analysis, people in the transport system, environment, planning and decision-making processes, transport economics and transport system. The knowledge that the institute provides gives a basis for decisions for players in the transport sector and in many cases finds direct application in both national and international transport policies. VTI conducts commissioned research in an interdisciplinary organisation. The institute also works with investigations, provides consultancy services, and performs different kinds of measurement and testing services. The institute also has a great deal of technically-advanced equipment and world-class driving simulators. There is also a laboratory for road materials and a crash test laboratory.

VTI's researchers participate in international research projects, principally in Europe, and in international networks and alliances. In Sweden, VTI collaborates with universities and other higher education institutions that conduct related research and education. VTI has about 200 employees and is located in Linköping (head office), Stockholm, Gothenburg and Borlänge.

KNOWLEDGE GENERATION AND GOVERNMENT MINISTRIES

US DEPARTMENT OF TRANSPORTATION

There are many different structures for knowledge generation within government ministries. The objec-

tives and plans of the Department Transportation of USA (USDOT) are given here as an illustration⁶.

USDOT's operating administrations are:

- Federal Aviation Administration (FAA)
- Federal Highway Administration (FHWA)
- Federal Motor Carrier Safety Administration (FMCSA)
- Federal Railroad Administration (FRA)
- Federal Transit Administration (FTA)
- Maritime Administration (MARAD)
- National Highway Traffic Safety Administration (NHTSA)
- Pipeline and Hazardous Materials Safety Administration (PHMSA)
- Research and Innovative Technology Administration (RITA)
- Saint Lawrence Seaway Development Corporation (SLSDC).

All of these agencies have a role to play in capacity development, research and development, and product innovation (RD&T) and many of these agencies employ more than a hundred professionals. Though the US Federal Government owns and operates only limited portions of the nation's transportation system, the USDOT has a responsibility for RD&T investment as one of the most effective ways the Federal government can contribute to the improvement of the transportation system. USDOT role for RD&T includes:

- Developing transportation research policy.
- Creating incentives for collaborative cross-modal research focusing on the interfaces of individual modes.
- Expanding the knowledge base by investing in university transportation centres (UTCs) that advance innovation, research, education, and technology transfer; and prepare the future transportation workforce to face the challenges of the 21st-century transportation network.

5. <http://www.vti.se/en/om-vti/about-vti/> (accessed 21 November 2012).

6. USDOT (2012).

- Encouraging multidisciplinary research.
- Stimulating innovation in transportation services and products through targeted partnerships with key entities, such as States, Metropolitan Planning Organisations (MPOs), transit operators, ports, counties, cities, academic institutions, and private companies or organisations.
- Funding long-term, exploratory research as well as short-term applied research.
- Identifying, facilitating and supporting the deployment of emerging technologies and best practices.
- Developing and disseminating tools and techniques that foster greater, more efficient use of technology and innovation.

In its future plans, USDOT includes crosscutting RD&T priority areas so that it encourages collaboration across operating administrations and government agencies, and promotes consultation and partnership with stakeholders in industry and academia. The development of cross-modal research projects will require discussions with stakeholders, rigorous examination of cross-cutting transportation issues and problems, and the incorporation of ideas from peers and experts within the research, asset owner, and user communities. USDOT collaborates with other agencies, such as the Environmental Protection Agency (EPA), Department of Energy (DOE), Housing and Urban Development (HUD), Department of Homeland Security (DHS), and the Department of Defense (DOD) (including the US Army Corps of Engineers), to provide the most effective transportation systems. In addition to collaborating with its Federal partners, the USDOT collaborates with and performs joint research with stakeholders and partners across the entire transportation sector, including State and local agencies, academia, industry, and not-for-profit institutions, such as the American Association of State Highway and Transportation Officials (AASHTO), the Transportation Research Board (TRB), and the American Public Transportation Association (APTA).

USDOT's Research Clusters include senior research professionals from each operating administration. Cross-modal research working groups and online forums have been established within each Research Cluster. There are Research Clusters in the following areas:

- Infrastructure and Materials
- Human Factors
- Energy Sustainability
- Risk-Based Analysis to Address Safety Issues
- Data-Driven Decision Making
- Multimodal Intelligent Transportation Systems
- Liveability
- Modelling and Simulation
- Positioning, Navigation, and Timing

- Transportation Implications for an Aging Population and Those with Special Needs
- System Resilience and Global Logistics
- Policy Analysis
- Travel Behaviour
- Economics

STATISTICS AND ANALYSIS

In the UK, transportation statistics are collected, analysed and published by the Department for Transport.⁷ The statistics are based on two main sources—data gathered from statistical surveys, and data extracted from administrative or management systems. A number of administrative sources are currently used by the Department for Transport statistical teams to compile official statistics. In all cases where such sources are used, professional statisticians are involved in quality assuring the use of the data for statistical purposes. Examples include data from the Driver Vehicle Licensing Agency (DVLA) to produce Vehicle Registration and Licensing Statistics, and by taking a sample of vehicles from DVLA records to produce statistics for road freight statistics. Estimates of vehicle excise duty evasion are also produced using the administrative data held by the DVLA. The Maritime and Coastguard Agency (MCA) Seafarer Documentation System is used as an input to UK Seafarer Statistics. The Authority's main requirements are set out in the third Protocol attached to their Code of Practice for Official Statistics and the databases include:

- Journey time database, local authority managed roads
- Journey time database, Highways Agency managed roads
- Maritime and Coastguard Agency Training Database
- Maritime and Coastguard Agency Seafarer Documentation System
- National Road Condition Database
- DVLA Vehicle Information Database
- Driving Standards Agency: Testing and Registration System

The Department has also set up a Transport Statistics User Group that aims to:

- identify problems in the provision and understanding of transport statistics and to discuss solutions with the responsible authorities;
- provide a forum for the exchange of views and information between users and providers;
- encourage the use of transport statistics through greater publicity;
- facilitate a network for sharing ideas, information and expertise.

The group holds regular seminars on topical subjects connected with the provision and/or use of transport statistics. In addition, a CLIP Transport Statistics (CLIP-TS) has been established, which is a

7. <https://www.gov.uk/statement-of-administrative-sources-for-official-statistics-published-by-the-department-for-transport> (accessed 15 November 2012).

sub-group of the Central and Local (Government) Information Partnership (CLIP), the main forum for discussion between central and local government on statistical matters. Its formal terms of reference are:

- to act as a conduit for wider dissemination of transport statistics which are of particular interest to local authorities;
- to discuss transport statistics of interest to either side that are not dealt with by other topic-specific groups. In particular;
- monitoring of transport and related plans;
- sub-national statistics (including neighbourhood statistics);
- to identify gaps in coverage and investigate methods of filling these;
- to investigate methods of using local authority data to satisfy local, regional and national needs.

The membership of CLIP-TS includes representatives from the Local Government Association, Association of London Government, Passenger Transport Authorities, Shire Counties, Transport for London and the Department for Transport.

FUNDING RESEARCH AND TRAINING IN ACADEMIC INSTITUTIONS

USDOT UNIVERSITY TRANSPORTATION CENTRES (UTCs)⁸

In the US, The Safe, Accountable, Flexible, Efficient Transportation Equity Act, enacted on 10 August 2005, authorised up to \$76.7 million (Rs 415 crore) per year from central funds for grants to establish and operate up to 60 University Transportation Centres (UTCs) throughout the US. Twenty of these centres were competitively selected during 2006. The University Transportation Centres (UTC) programme, initiated in 1987 under the Surface Transportation and Uniform Relocation Assistance Act, authorised the establishment and operation of transportation centres in each of the 10 standard federal regions. The Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA) reauthorised the UTCs for an additional six years and added four national centres and six University Research institutes (URI). The mission of the 14 UTCs was to advance US expertise and technology transfer. The six URIs each had a specific transportation research and development mandate.

In 1998, the Transportation Equity Act for the 21st Century (TEA-21) reauthorised the UTC Program for an additional six years and increased the total number of Centres to 33. In addition to the 10 regional Centres, which were to be selected competitively, TEA-21 created 23 other Centres at institutions named in the Act. TEA-21 established education as one of the primary objectives of a University Transportation Centre and institutionalised the use of strategic planning in university grant management.

Vision: Internationally recognised centres of excellence, fully integrated within institutions of higher learning, that serve as a vital source of leaders who are prepared to

meet the nation's need for safe, efficient and environmentally sound movement of people and goods.

Mission: To advance US technology and expertise in the many disciplines comprising transportation through the mechanisms of education, research and technology transfer at university-based centres of excellence.

Goals: (a) Education: a multi disciplinary programme of course work and experiential learning that reinforces the transportation theme of the Centre. (b) Human Resources: an increased number of students, faculty and staff who are attracted to and substantively involved in the undergraduate, graduate and professional programmes of the Centre. (c) Diversity: students, faculty and staff who reflect the growing diversity of the US workforce and are substantively involved in the undergraduate, graduate and professional programmes of the Centre. (d) Research Performance: an ongoing programme of basic and applied research, the products of which are judged by peers or other experts in the field to advance the body of knowledge in transportation. (e) Technology Transfer: availability of research results to potential users in a form that can be directly implemented, utilised or otherwise applied.

A UTC must be located in the US or territories. It may be a single university or a consortium of two or more universities. Each Centre is required to obtain matching funds from non-federal sources. National and Regional UTCs must obtain matching funds in an amount at least equal to the USDOT grant amount. The amount of funds to be disbursed are reflected in the 2013-14 call for proposals:

- Five National UTCs, up to \$3.0 million (Rs 160 million) per Centre per fiscal year;
- Ten Regional UTCs, one of which must be dedicated to comprehensive transportation safety, up to \$2.75 million (Rs 150 million) per Centre per fiscal year; and
- Up to 20 Tier-1 UTCs, up to \$1.5 million (Rs 80 million) per Centre per fiscal year.

UNIVERSITY RESEARCH CENTRES

DALIAN MARITIME UNIVERSITY, CHINA (DMU)⁹

DMU was created in 1953 through the amalgamation of three merchant marine institutions: Shanghai Nautical College, the Northeast Navigation College and Fujian Navigation School. In 1960, DMU was designated a national key institution of higher education. Later in 1983, the Asia-Pacific Region Maritime Training Centre was established at DMU by the United Nations Development Program (UNDP), and the IMO and in 1985 a branch of the World Maritime University (WMU) was established.

The University specialises in Maritime research and training with the following departments: (a) Navigation College, (b) Marine Engineering College, (c) Information Science and Technology College, (d) Transportation Management College, (e) Transportation

8. <http://www.rita.dot.gov/utc/about> (accessed 15 November 2012).

9. <http://english.dlmu.edu.cn> (accessed 15 November 2012).

& Logistics Engineering College. Over the past few decades it has broadened its scope and in addition established the following schools and departments: School of Law, Environmental Science and Engineering College, Humanities and Social Sciences College, School of Foreign Languages, Department of Mathematics, Department of Physics, Department of Physical Education, Continuing Education College.

The University includes the following special research centres: Waterway Transportation Regulations Institute, International Maritime Law Research Centre, Ship Automation and Simulation Institute, Environmental Information Institute, Marine Environment Research Centre, Ocean Development and Management Research Centre, Marine Transportation Safety Institute, Waterway Transportation Planning and Design Institute, International Shipping Human Resource Institute, Transportation Economy Institute, Ship Electromechanical Equipment Institute, High Performance Ceramics Institute, Ship Power Engineering Institute, China Navigation History Documentation Research Centre.

MONASH UNIVERSITY ACCIDENT RESEARCH CENTRE, AUSTRALIA

The Monash University Accident Research Centre (MUARC) was established in 1987 and is Australia's largest transport safety research centre. Research, consultancy and training include safety across all modes of transport. Since its founding it has developed research-based solutions that have led directly to making Australians safer and made it an acknowledged leader in the field. The Centre works with a number of key stakeholders including VicRoads, the Transport Accident Commission, the Department of Justice, and Victoria Police. The work is conducted across six priority areas:

- Behavioural safety science
- Human factors
- Injury analysis and data
- Global engagement
- Regulation and in-depth crash investigations
- Safe system strategies and road infrastructure

MUARC is a part of the Monash Injury Research Institute where around 100 researchers and post-graduate students work across a range of specialised areas, including: biostatistics, computer science, engineering, epidemiology, human factors Medicine, psychology, public health, statistical analysis.

INSTITUTE OF TRANSPORTATION STUDIES AT THE UNIVERSITY OF CALIFORNIA, BERKELEY (US)¹⁰

The Institute was created as an Organised Research Unit in 1948 by the California state legislature in response to the deferred maintenance of transportation facilities during World War II. Its mission was to conduct research and provide instruction to a new generation of transportation professionals.

More than 100 graduate students pursuing master's degrees and PhDs currently study there. The Institute's programs receive an average of \$20 million in extramural funds each year, one of the largest such totals at the University for a research facility or academic department, and leverages its core state funding by a ratio of about 20:1.

ITS Berkeley is home to seven transportation research centres:

- California Partners for Advanced Transit and Highways (PATH) is the one of the world's largest programmes for intelligent transportation research. It has recently merged with California Centre for Innovative Transportation (CCIT)
- National Centre of Excellence for Aviation Operations Research (NEXTOR) is the nation's leading centre for aviation research
- University of California Pavement Research Centre (UCPRC) is an international authority on pavement materials and management
- Safe Transportation Research and Education Centre (SafeTREC)—formerly Traffic Safety Centre—is devoted to the reduction of transportation system-related fatalities and injuries through education and research
- Transportation Sustainability Research Centre (TSRC) focuses on six major research areas that include advanced vehicles and fuels, energy and infrastructure, and goods movement
- UC Berkeley Centre for Future Urban Transport (Volvo Centre) concentrates on the interplay of technology and policy for urban transportation

University of California Transportation Centre (UCTC), a multi-campus research unit, is currently headquartered at ITS Berkeley.

THE INSTITUTE FOR TRANSPORT STUDIES, UNIVERSITY OF LEEDS (UK)¹¹

The Institute's primary purpose is to advance the understanding of transport activity, operations and use, and to develop skills and best practice among transport professionals and decision makers. The history of ITS goes back more than 40 years and the University of Leeds first offered a transport Masters programme in 1965. The Institute was formally established in 1972, and is the UK's largest single academic group providing transport courses and training. In a typical year there are around 500 students taking undergraduate modules, 80 students on Master's programmes, up to 40 registered PhD students, and dozens of delegates participating in short courses.

The research at ITS is sponsored by a variety of organisations, including the UK Department for Transport, the European Commission, and the Engi-

10. <http://www.its.berkeley> (accessed 15 November 2012).

11. <http://www.its.leeds.ac.uk/about/> (accessed 15 November 2012).

neering and Physical Sciences Research Council. ITS has approximately 50 academic/research staff and about a dozen support staff. The staff come from a wide variety of background disciplines, including economics, engineering, geography, mathematics, computing, psychology and social science. ITS staff have provided expert advice to international organisations such as the World Bank, the European Commission and the International Transport Forum, to national governments around the world and to UK entities such as the House of Commons Transport Select Committee.

OVERALL SYSTEMIC LESSONS

International experience offers several relevant lessons for building expertise and a professional community. First, it is important to establish transport planning as a high-status occupation and applied science makes it easier to attract ongoing political and financial support as well as some of the most competent professionals. In Europe, the Commissioner of Transport is often selected by the President to be one of the Vice-Presidents of the European Commission, a designation that conveys little real power but signals an important appointment and comes with a higher salary.

Boarnet argues that the ability of the National Advisory Board of Highway Research (1920) and its successors, the Highway Research Board (1925) and Transportation Research Board (1974) to create a strong culture of cutting edge research and attracting top engineers was in part due to its position as part of the National Research Council (NRC).¹² The NRC is the top science, engineering, and medicine advisory body in the US, so the membership signalled that transportation research was a high priority rather than a low-status applied version of civil engineering. The Transportation Research Board continues to be one of just five divisions of the NRC as well as one of the most specifically defined. Similarly, merging the HRB transport research and data module within the premier data collection effort, the US Census, in 1956 reiterated the importance of transport research in US policy.

The Indian structure of having CRRI as part of the CSIR, with the Prime Minister as President and the Minister of Science and Technology as Vice President, could be seen as superficially similar to the positioning of transportation research within the NRC. However, CSIR is associated with one of several 'science policy' Departments within the Ministry of Science and Technology (the Department of Scientific and Industrial Research, distinct from the Department of Science and Technology, the Department of Biotechnology, etc) in contrast to the NRC's

position as a science policy advisory body for all science- and engineering-related questions. The CRRI also operates more like a government department than a node in larger professional ecosystem of university departments, think-tanks, and other employers of independent researchers.

Second, it is important to decentralise the institutional system and build networks. The Transportation Research and Innovation Portal¹³ is one example of a platform for bringing together research and datasets across a federation (the 'European Research Area') as well as providing information on events that help foster exchanges between the community of experts. Other countries visited as part of the 2008 FHWA study tour used universities and non-government research institutions as a way to encourage work with a broad perspective land, infrastructure, energy, and social outcomes that might not otherwise be undertaken by a particular Ministry. The report of the study tour also noted, 'host countries' research programmes incorporated academic and industry participation earlier in the research process than those of the US. In the host countries there is a continuous flow that incorporates collaboration throughout the research process—from problem definition (which may include participation in establishing the research framework) through the conduct of the research and the delivery of research products'¹⁴.

In the US, the fact that National Association for Biomedical Research (NABR), HRB and Transportation Research Board (TRB) NABR/HRB/TRB funded studies by other agencies, states and universities rather than doing the work in-house had significant long-run benefits for policy. It meant that the program build up a regionally-dispersed, diverse group of experts who shared a common professional network. Boarnet argues that this was one of the factors that allowed the US to quickly create functional national and state agencies as new transportation needs became apparent¹⁵. The tradition continues today with the Research and Innovative Technology Administration's funding of University Transport Centres and regional Transport Knowledge Networks. The distribution of funds for UTC is designed to be balanced across regions, but otherwise merit-based, fostering competition among researchers to establish strong incentives for excellence.

The funding also enabled the NABR/HRB/TRB to actively manage the portfolio of research to support state-level experiments and disseminate successful results across states, as well as to set standards for data collection that improved quality and comparability of locally-generated statistics. The Bureau of Public Roads, for example, cooperated with Chicago

12. Boarnet (2011).

13. <http://www.transport-research.info> (accessed 10 February 2014).

14. FHWA (2008).

15. Boarnet (2011).

and Cleveland in their landmark local and regional traffic counting studies in the 1920s, and then encouraged other states to follow. Eleven other states had traffic counting efforts underway by 1930.¹⁶

Third, it is important to encourage transport stakeholders to learn by doing. FHWA found that several of the countries studied encourage ‘collaborative innovation’—research partnerships between academia and parts of government to design programmes eligible for funding.¹⁷ Similarly, the United States’ Bureau of Public Roads developed national programmes based on reviewing states’ suggestions using transparent analytical criteria. The states that were more successful in proposing technically strong projects were thus better able to shepherd their priorities through the system to obtain concrete rewards for building capacity to site and justify roads. Boarnet (2011)

argues that the collaborative approach paid off in quick implementation of the plan: ‘Possibly more importantly, the decades-long effort by the BPR to develop and disseminate knowledge-based approaches to highway planning and construction had built a professional community that was ready to quickly build the national network, per accepted methods of analysis and federal standard-setting, once political questions had been settled’.¹⁸

The United States’ Bureau of Public Roads used transparent criteria to review states’ suggestions. States that were more successful in proposing concrete projects were able to shepherd their priorities through the system.

INDIAN CONTEXT

EXISTING INSTITUTIONS AND ORGANISATIONS

RAIL TRANSPORT

A. Institutions under the Ministry of Railways

a. *Indian Railways Institute of Civil Engineering (IRICEN), Pune*

IRICEN was established in 1959 when a ‘Permanent Way Training School’ was set up at Pune to provide in-house training to freshly recruited civil engineers of Indian Railways. Over the years, advancement in track and bridge technology led to the upgrading of the institute to cover track, bridges and other modules that a railway civil engineer encounters.

Professional staff: 16 (mostly BE and ME level)

b. *The Indian Railways Institute of Mechanical & Electrical Engineering (IRIMEE), Jamalpur*

IRIMEE is the centralised training institute of Indian Railways, for the training of officers and supervi-

sors of the Mechanical Engineering department. It conducts (a) Professional courses for serving officers and supervisors of Mechanical Department, (b) Training of IRSME probationers, (c) Theoretical and practical training of Special Class Apprentices (d) Technical Training of Apprentice Supervisors of all Indian Railways, (e) Special courses as per requirement for Non-Railway Organisations and Foreign Railways.

Professional staff: 27 (mostly BE and ME level)

c. *Indian Railways Institute of Electrical Engineering (IRIEEN), Nasik Road*

The Institute was set up in the year 1988 at Nasik Road, Maharashtra, for imparting training to Electrical Engineers of Indian Railways and other departments involved in train-operation. The Institute imparts training as a statutory measure to: (a) IRSEE Probationers, (b) Integrated orientation course for Group-B, (c) Senior Professional Development Course for Junior Administrative Grade, (d) Short-term special courses conducted throughout the year on specialised subjects.

Professional staff: 9 (mostly BE and ME level)

d. *Indian Railways Institute of Signal Engineering and Telecommunications (IRISET), Secunderabad*

IRISET provides initial as well as advanced training, theory as well as hands on, in Railway Signalling and Telecommunications. It caters to the total training requirement of the officers and supervisors of the Signal and Telecommunication department of Indian Railways. IRISET is in the approved list of ESCAP and UNDP. It provides training in railway signalling and telecommunications to private and public sector enterprises as well.

Professional staff: 21 (mostly BE and ME level).

e. *National Academy of Indian Railways (NAIR), Vadodara*

NAIR functions as the apex training institute for the officers of all departments of Indian Railways in general and Accounts, Personnel, Stores and Medical departments in particular. The Academy runs training programmes for officers of all disciplines and all grades right from Probationers to General Managers. Around 2,500 officers participate in various training programmes each year. The duration of programmes varies from one to 10 weeks. Managers of a few public sector undertakings, other ministries of the government and a few managers from railway systems abroad also attend training programmes in this college.

Professional staff: 25 (mostly BE and ME level).

f. *Indian Railway Institute of Transportation Management (IRITM), Lucknow*

The institute is a training centre for probationary officers of the Indian Railway Traffic Service (IRTS).

16. Seely (1987), summarised in Boarnet (2011).

17. FHWA (2008).

18. Boarnet (2011).

The training module includes, planning, financing and management of transport infrastructure, transportation and logistics management, operational practices, commercial principles, transport economics, information technology, etc. The institute also imparts advanced training to in service railway officers in these areas. Besides, it also functions as a research centre in PPP and as an accident investigation cell.

Professional staff: 7

g. Indian Railway Institute of Financial Management (IRIFM), Secunderabad

It is being set up to impart structured and professional training to finance and accounts officers of Indian Railways in contemporary areas and equip them with necessary skills on a regular basis to enable them to face emerging challenges and tap opportunities for strengthening the finances of the organisation.

B. Academic Institutions

a. The Centre for Railway Research (CRR)

CRR was set up at Indian Institute of Technology Kharagpur based on the MoU signed between the Ministry of Railways, Government of India and Indian Institute of Technology Kharagpur on 13 February 2010, to develop a long-term framework for research collaboration. This is the first such research centre set up in an academic institute with direct and full funding by the Indian Railways. The following have been identified as core areas of research focus:

- Advanced Materials and Manufacturing
- Heavy Haul Technology
- High Speed Rail
- Advanced Maintenance and Operation

b. Railway Technology Cell at Indian Institute of Technology Kanpur

This cell has been established in collaboration with RDSO to handle projects related to development of a detector for wheel flats, finite element method (FEM) analysis of wheels and geo-technical problems such as field validation of design methodologies for rehabilitation of unstable structures and strengthening of existing structures for heavier axle loads.

AIR TRANSPORT

A. Directorate General of Civil Aviation

DGCA is the regulatory body governing the safety aspects of civil aviation in India. Its functions include:

1. Registration of civil aircraft
2. Formulation of standards of airworthiness for civil aircraft registered in India and grant of certificates of airworthiness to such aircraft
3. Licensing of pilots, aircraft maintenance engineers and flight engineers, and conducting examinations and checks for that purpose

The Centre for Railway Research at IIT Kharagpur, funded by Indian Railways, focuses on advanced materials and manufacturing, heavy-haul technology, high-speed rail and advanced maintenance and operation.

4. Licensing of air traffic controllers
5. Certification of aerodromes and CNS/ATM facilities
6. Maintaining a check on the proficiency of flight crew, and also of other operational personnel such as flight dispatchers and cabin crew
7. Granting of Air Operator's Certificates to Indian carriers and regulation of air transport services operating to/from/within/over India by Indian and foreign operators, including clearance of scheduled and non-scheduled flights of such operators
8. Conducting investigation into incidents and serious incidents involving aircraft upto 2250 kg and and taking accident prevention measures including formulation of implementation of Safety Aviation Management Programmes
9. Carrying out amendments to the Aircraft Act, the Aircraft Rules and the Civil Aviation Requirements for complying with the amendments to ICAO Annexes, and initiating proposals for amendment to any other Act or for passing a new Act in order to give effect to an international Convention or amendment to an existing Convention
10. Coordination of ICAO matters with all agencies and sending replies to State Letters, and taking all necessary action arising out of the Universal Safety Oversight Audit Programme (USOAP) of ICAO
11. Supervision of the institutes/clubs/schools engaged in flying training including simulator training, AME training or any other training related with aviation, with a view to ensuring a high quality of training
12. Granting approval to aircraft maintenance, repair and manufacturing organisations and their continued oversight
13. To act as a nodal agency for implementing Annex 9 provisions in India and for coordinating matters relating to facilitation at Indian airports including holding meetings of the National Facilitation Committee
14. Rendering advice to the Government on matters relating to air transport including bilateral air services agreements, on ICAO matters and generally on all technical matters relating to civil aviation, and to act as an overall regulatory and developmental body for civil aviation in the country
15. Coordination at national level for flexi-use of air space by civil and military air traffic agencies

and interaction with ICAO for provision of more air routes for civil use through Indian air space

16. Keeping a check on aircraft noise and engine emissions in accordance with ICAO Annex 16 and collaborating with the environmental authorities in this matter, if required
17. Promoting indigenous design and manufacture of aircraft and aircraft components by acting as a catalytic agent
18. Approving training programmes of operators for carriage of dangerous goods, issuing authorisations for carriage of dangerous goods, etc.
19. Safety Oversight of all entities approved/ certified/licensed under the Aircraft Rules 1937.

B. CSIR National Aerospace Laboratory

National Aerospace Laboratories (NAL), a constituent of the Council of Scientific and Industrial Research (CSIR), India, is the only civilian aerospace R&D laboratory in India. CSIR-NAL is a high-tech oriented institution focusing on advanced topics in aerospace and related disciplines and has a mandate to develop aerospace technologies with strong science content, design and build small and medium-size civil aircraft and support all national aerospace programmes.

CSIR-NAL has many advanced test facilities (many of them recognised as National Facilities) and has a strength of 1,100 with 400 scientists, 460 technical staff and 160 administrative staff. CSIR-NAL has also provided value-added inputs to all national aerospace programmes. CSIR-NAL mandate is to develop aerospace technologies with strong science content, design and build small and medium-sized civil aircraft, and support all national aerospace programmes.

CSIR-NAL activities involve the design, development, manufacturing and certification of small civil aircraft, the only such centre in the country. Major projects completed/in progress include certification of a two-seat ab-initio all-composite aircraft HANSA-3 (15 aircrafts built so far); a 14-seat light transport aircraft SARAS, that is presently under development (two prototypes built and test flown; a production standard aircraft with CFC wing under assembly for flight testing and final certification); and the development of a new five seat general aviation aircraft C-NM5 in association with Mahindra Aerospace Pvt Ltd, Bangalore, of the Mahindra corporate group. Marking the milestone event for India's first public-private partnership in aircraft development, the C-NM5 successfully completed its maiden flight at Australia on 1 September 2011. CSIR-NAL is the lead agency identified by the Government of India for carrying out feasibility study for the devel-

opment of a National Civil Aircraft (70 and 90) seater for re-regional connectivity.

Academic Departments

Institutions with special departments for aerospace engineering include:

- Indian Institute of Science Bangalore
- Indian Institute of Technology Kanpur
- Indian Institute of Technology Kharagpur
- Indian Institute of Technology Chennai
- Indian Institute of Technology Mumbai

These departments offer courses from bachelor's to PhD level, but are largely confined to engineering aspects of aviation.

WATER TRANSPORT

A. Indian Maritime University

The Indian Maritime University, came into being through an Act of Parliament (Act 22) on 14 November 2008 as a Central university. The objectives of the University are to facilitate and promote maritime studies, training, research and extension work with focus on emerging areas of studies like oceanography, maritime history, maritime laws, maritime security, search and rescue, transportation of dangerous cargo, environmental studies and other related fields. The IMU has its regional campuses at Chennai, Mumbai, Kolkata, Visakhapatnam, Kochi and Kandla. IMU presently offers port and marine short-term courses and degree courses in Nautical Science, Marine Engineering, Naval Architecture and Ocean Engineering, Ship Building and Repair. The Indian Maritime University encompasses under its fold the following seven premier government institutions

- a. National Maritime Academy, Chennai
- b. TS Chanakya, Mumbai
- c. Lal Bahadur Shastri College of Advanced Maritime Studies and Research, Mumbai
- d. Marine Engineering Research Institute, Mumbai
- e. Marine Engineering Research Institute, Kolkata
- f. Indian Institute of Port Management, Kolkata
- g. National Ship Design and Research Centre, Visakhapatnam
- h. IMU Kochi Campus
- i. IMU Kandla Campus

ROAD TRANSPORT

The Central Road Research Institute (CRRI), Delhi

CRRI is a national research organisation for highways traffic and transport planning and all other allied aspects. It carries out R&D in the areas of road and road transportation. CRRI was established in 1952 as a constituent laboratory of the Council of Scientific and Industrial Research (CSIR). The major

R&D programmes of CRRRI related to the entire spectrum of pavement design and performance, road condition monitoring, pavement deterioration modeling, maintenance planning and management, pavement management system, landslide management and hazard mitigation, geotechnical investigations and ground improvement techniques, traffic engineering and management and improved transportation planning technology for emerging urban needs. Besides these, applied research in the area of planning and engineering aspects of rural roads, material characterisation, pavement evaluation, highway instrumentation, conditioning monitoring and rehabilitation of bridges, design of high embankments and reinforced earth walls, subways and underpass construction, transportation planning, traffic engineering, road safety and environmental problems, form an integral part of the programme of the institute. The Institute employs about 60 scientists in eight departments.

B. Indian Academy of Highway Engineers (IAHE), NOIDA (UP)

IAHE is the apex training institute set up to address the training needs of Highway and Bridge Engineers in the country. It was set up as an institute in the year 1983 with the primary objective to fulfill the need for training of highway engineers at the entry level and during the service. Its objectives include:

- To impart training to engineers and professionals of Highway Sector at entry level and during service at different levels of central and state governments, public and private sectors
- To help highway sector engineers build up character and develop an all-round personality as a part of Human Resource Development
- To assist various organisations in developing their training institutes and training of their faculty
- To promote cooperation and foster exchange of knowledge, ideas and experience in all the sphere of highway engineering among engineers in India and abroad
- To impart training to Highway sector professionals from India and abroad (SAARC countries, Afro-Asian countries under schemes pertaining to IAFS, ITEC, Colombo Plan, etc.)

IAHE has officers on deputation from the government and uses experts available in the area for delivering lectures in the raining programmes. There is no research activity at the IAHE.

C. Central Institute of Road Transport (CIRT), Pune

CIRT is funded by the Government of India and offers management development programmes covering general management, transport operations and maintenance engineering. The programmes are meant for practicing managers in state trans-

port undertakings, other organisations operating transport services besides road transport officials. All programmes are residential and their duration ranges from one week to four weeks. In addition, the Institute undertakes consultancy and research assignments on transport policy, transportation planning, traffic management, maintenance management, materials management, human resource management and management information systems. CIRT employs about 15 professionals mostly at bachelor's and master's level.

D. Academic Institutions

Most Indian Institutes of Technology (IITs), National Institutes of Technology (NITs), and many state universities and private institutes offer courses in Transportation Engineering based in the civil engineering department. Most IITs, Indian Institute of Science Bangalore, and some NITs also offer masters degrees in transportation engineering, again in the civil engineering department. Institutions offering Masters programmes in Transportation Planning include Birla Institute of Technology Ranchi, CEPT University Ahmedabad, and School of Planning and Architecture Delhi.

Over the past few years, five centres of excellence for urban transport have been recognised and funded by the Ministry of Urban Development (MoUD), and one by the Government of Karnataka (GoK):

- Transportation Research and Injury Prevention Programme (TRIPP), Indian Institute of Technology Delhi (MoUD)
- Centre of Excellence in Urban Transport, Indian Institute of Technology Madras (MoUD)
- Centre for Urban Transportation Studies, NIT Warangal (MoUD)
- Centre for Excellence in Urban Transport, CEPT University Ahmedabad (MoUD)
- Centre for Infrastructure, Sustainable Transportation and Urban Planning (CiSTUP), Indian Institute of Science Bangalore (GoK)

These centres have been awarded grants that provide research support of the order of Rs 20-30 million per year, but no support has been provided for hiring extra faculty members or building significant infrastructure or laboratories.

INDEPENDENT TRANSPORT RESEARCH INSTITUTIONS

Asian Institute of Transport Development (AITD)

The National Transport Policy Committee (1980) in its Report had observed that transport studies had been comparatively neglected in the country and there was no institution that could undertake studies on transport problems from a common outlook and approach. It had also emphasised the need for aug-

Capacity building comprises three challenges: training individuals, building systems for R&D to update capacity, and ensuring that these individuals have the ability and incentives to be productive within teams and organisations. India must not only increase supply of capacity, it must also ensure a strong demand side.

menting training facilities for building capacity to cater to the growing requirements of evolving, implementing and monitoring the transport projects, plans and policies. As a result, the Asian Institute of Transport Development (AITD) came into being in 1989 as an independent, not-for-profit, inter-disciplinary centre devoted to research, human resource development and regional cooperation in infrastructure sector with special focus on transport and logistics.

The Institute has since grown professionally and gained credentials both at national and regional levels. It has been granted special consultative status by the United Nations. It has also acquired a pan-Asian footprint through its activities aimed at capacity building, environmental concerns and development of regional transport corridors.

The Institute has collaborated with centres of excellence dealing with critical areas in transport sector, for example Transport Research and Injury Prevention Programme (TRIPP) at IIT Delhi. It also provides substantial support to regional country groupings—SAARC, BIMSTEC, Mekong Ganga Cooperation etc.—in human resource development.

The Institute has carried out inter-disciplinary studies dealing with intermodal choices, environmental and social sustainability, poverty alleviation, regulatory structures, funding of infrastructure, etc. The Planning Commission has drawn on its expertise and knowledge while formulating the Five Year Plans and long-term policy perspectives.

FUTURE REQUIREMENTS

‘Capacity building’ comprises three challenges: training individuals, building systems for research and development to update capacity, and ensuring that these individuals have the ability and incentives to be productive within teams and organisations. India must not only increase the supply of capacity by expanding the number and quality of opportunities to study transport planning and allied fields, but it must also ensure a strong demand side. The effective ‘demand’ for capacity will depend on employment policies that attract these transport planners to public sector work as well as public

expenditure and programmatic policies that encourage Ministries, state agencies and metropolitan bodies to spend discerningly on capacity building. It will also need to invest in transport research so that training, decision support, and policy action improve over time and adapt to changing opportunities and challenges. Capacity building should also be designed to also support India’s efforts integrate its many transport-related organisations with a common culture focused on transport systems across national, state and metropolitan scales. This section discusses future requirements across these three dimensions.

SKILLS GAP

Little seems to be known about the extent and nature of the ‘skills gap’ in transport planning. Although all of the sector Working Groups of NTD-PC were asked to ‘assess the availability of human resources’ and ‘suggest measures for skill development and institutional capacity building for various stakeholders’, there is very little information in the Working Group reports on the scale or nature of training required.

The civil aviation and ports Working Groups provided some figures on the numbers and general skills required for the sector over the coming decade, but these are not broken down by level of government, region, or compared in detail to existing available personnel. However, the civil aviation Working Group report does highlight the magnitude of the problem faced: ‘Closely related to safety in civil aviation is skill augmentation in its entire dimension. The task ahead would be of identifying the different categories of personnel required whether technical, managerial, pilots and cabin crew, trainers etc to meet the needs of airport development and operations...According to the Report of Working Group on Civil Aviation for formulation of 12th Five Year Plan (2012-17), the total manpower requirement of Indian carriers is estimated to rise from 62,000 in FY-2011 to 117,000 by FY-2017’.¹⁹

The Working Group on urban transport gives some estimates of staff strength, but not broken down by skill. Railways and roads reports called for a ‘training needs assessment’ and a consultant to prepare a capacity-building plan. There appears to be no information about the numbers and distribution of transport planning professionals familiar with GIS, impact assessment, traffic modelling, and other skills required to anticipate network needs.

What is needed is an organised approach to interdisciplinary policy-relevant research. For example, an integrated approach is needed to address transport related health impacts, from emission-related respiratory illness to injuries from traffic accidents. This

19. NTDPC (2012).

can be done only if faculty members from various departments at the best institutions like IITs collaborate with government departments, industry bodies, international organisations, and other experts on research, teaching, applied projects, and on policy advice on developing urban transport systems, inter-city connections, vehicles, and transport infrastructure plans. Researchers also need to collate and analyse available data to assess and report on the impact of transport infrastructure development and policies on freight patterns, mobility, congestion, and other performance indicators.

It would be worthwhile to strengthen and replicate such structures at high-quality research institutions in India to encourage and support research on other socio-economic impacts that the transport system could have. With sufficient core funding, these programs could also play an important role as data repositories for aggregating and managing information from various government and private sources. Active researchers, as users of data, are likely to have a stronger incentive to collect and maintain up to date databases than are individuals who are simply charged with building a database.

Current institutions that conduct interdisciplinary research on some of these areas include:

- The Transport Research and Injury Prevention Programme (TRIPP) at IIT Delhi, which draws on faculty across academic departments, while developing a core expert team
- The Energy and Resources Institute (TERI), which, in its transport related research, focuses on issues related to energy and environment and draws on experts from its different departments
- The Asian Institute of Transport Development, which calls on experts from different fields to collaborate on research related to planning and policy issues with a focus on transport and logistics, often with an international perspective.

DATA REQUIREMENTS

There is very little reliable data available for inter-city or urban passenger or freight travel patterns. In this situation infrastructure investment has to be done on a fire-fighting basis with little knowledge of long-term consequences on efficiency, or financial and environmental stability. Technology choices have to be based on hunches and influenced by powerful supplier lobbies. This situation is likely to get worse in the face of accelerated economic growth and urbanisation, as political and public pressure for provision of transportation services will demand quick fixes.

Analysis for transport governance rests on the following types of data, among others:

Much of the Indian data needed for transport governance are scattered across agencies and departments, with no common georeferencing and metadata standards.

- (a) Transportation Planning and Management characteristics in cities and regions (encompassing institutions, policies, projects planned and under implementation, funding mechanism, taxation regime, etc.)
- (b) Traffic Management characteristics in cities (including agencies, signal time details for signalised intersections, one-ways, etc.)
- (c) Spatially referenced transportation network database for all modes: roadways, railways, airways and waterways (spatial)
- (d) Mobility/Accessibility/Congestion index measurements for cities
- (e) Commuter travel characteristics by all modes (modal split) across (time series):
 - (i) Cities-intercity commuting
 - (ii) Within cities
- (f) Freight transport characteristics by all modes (time series)
- (g) Public transport characteristics (modes and supply details)
- (h) Public terminal commuter characteristics (spatial and time series)
 - (i) Automobile registration database (time series)
 - (j) Emissions and air quality characteristics (time series)
- (k) Fuel consumption characteristics (time series)
 - (l) Accident characteristics across modes—no of accidents, fatalities, injuries (time series)
- (m) Demographic, economic, employment and density patterns of the region and/or cities
- (n) Land-use characteristics for key cities in question and their densities (spatial)

Many of these data exist, but are scattered across agencies and departments, without common georeferencing and metadata standards that allow them to be collated for system-wide analysis. The first step in building transport research capacity, or encouraging more research attention to transport issues, might be to lower the transactions costs of empirical research by collating and making public these kinds of data.

India must also invest in decision support systems so that available capacity can actually be exercised for maximum effect. Geospatial Information System (GIS) expertise, for example, is wasted when available datasets on infrastructure or traffic are neither comprehensive nor spatially referenced. Decision support tools can also substitute for expertise in some cases by embedding rules of thumb in analytical

algorithms. The IT backbone for decision support can also be an infrastructure for de facto integration of decision-making, by making data more easily shareable across departments, automating sharing, and automating some processes for common application across agencies, geographies, or levels of government.

CONVERTING INFORMATION INTO KNOWLEDGE

Second, the institutional framework must also be capable of converting information into transport knowledge. A review of international practices in transportation research, training and development clearly shows that a large number of countries have established well-funded and professionally-staffed institutions at all levels and across disciplines. These institutions exist within government departments, as standalone institutions, within transport management organisations, and in universities and academic institutions (Annex). Many countries do not depend mainly on knowledge and technology transfer from other countries, even when there are peers at similar levels of income and styles of living. For example, though Australia is not very different from the US in per capita income or lifestyles, the Australian central and state governments have set up a large system with significant funding for knowledge generation and training. This is because most societies have realised that while basic theories, issues and technologies may be somewhat similar across nations, how they get applied and administered very often can be substantially different. In addition, priorities and strategies to be followed can vary dramatically depending on political structures

and administrative models from place to place.

The shift from public to private delivery with public facilitation actually places a greater burden on the public sector's project planning skills, especially ex-ante characterisation of risks in order to allocate them between partners.

It is quite clear that there is already a great shortage of trained manpower and absence of institutional support for policy making and technology development in India. We do not have any institutions within government departments and operating agencies, universities centres or stand-alone institutions in any area of transportation that compare favourably with

institutions reviewed in previous sections except for an institution or two like the National Aerospace Laboratory. The research centres at academic institutions are sub-critical in number of faculty members involved, and resources available. Except in a few centres, most of the academic activity is not interdisciplinary in nature, and there is almost a complete absence of involvement of professionals from the social sciences—economics, law, etc.

Most of these groups appear to have limited exchange with global transport researchers. Researchers are thus not placed in the kind of active, evolving research environment that many would view as important for innovation. The overall number of recognised experts seems small relative to the magnitude of the policy challenges. Non-governmental organisations such as EMBARQ (Mumbai and Bangalore), MapUnity (Bangalore), City Connect (Chennai, Bangalore, and Hyderabad) are also sources of policy expertise and networks of global experts, but are sometimes seen as advocacy groups rather than neutral parties.

NEW INSTITUTIONS FOR CAPACITY BUILDING

Management of transportation systems in the face of increasing energy costs and environmental pollution and threats of global warming requires that we set up new institutions and organisations at an accelerated and urgent basis for all transportation sectors. These are needed for skill development and knowledge generation for:

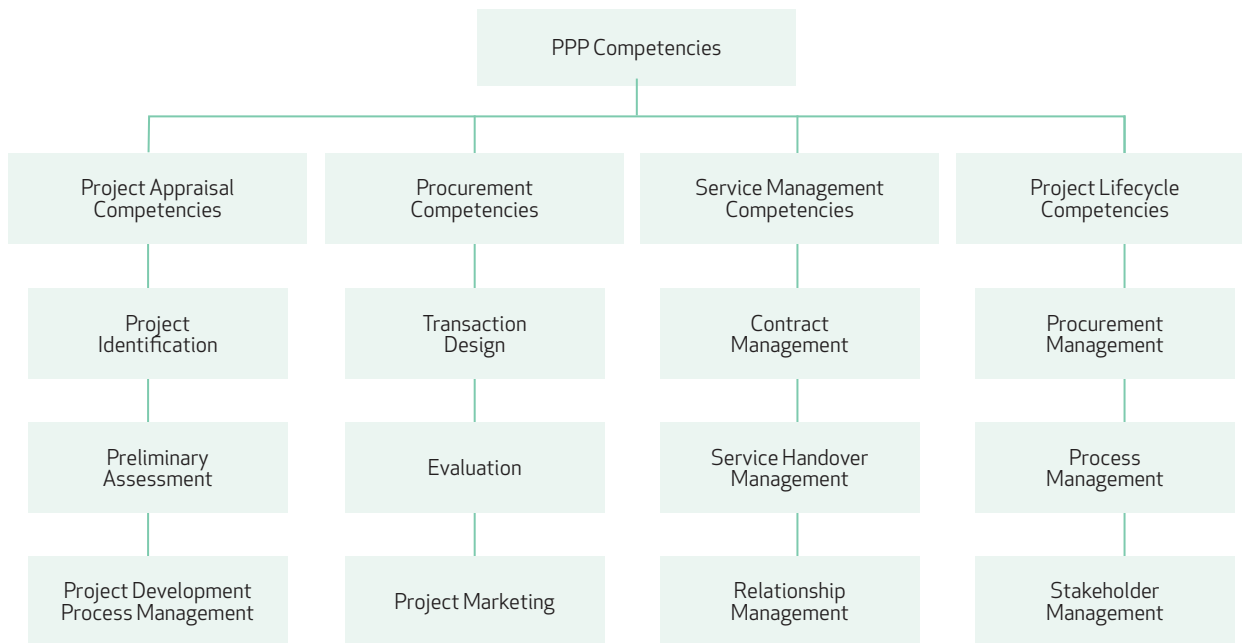
- a. Planning
- b. Management
- c. Designing standards
- d. Design of transport systems
- e. Integration of policy options across transportation sectors
- f. Dealing with environmental degradation and global warming issues

EXPERTISE FOR PUBLIC-PRIVATE PARTNERSHIPS

The move toward relying more extensively on PPPs and private provision of infrastructure is not unique to transport, but it is particularly common in roads, ports, airports and other transport infrastructure. This shift from public delivery to private delivery with public facilitation is often seen as a remedy for public sector weakness, but it actually places a greater burden on the public sector's project planning skills including especially ex-ante characterisation of risks in order to allocate these between partners. It also magnifies the consequences of poor project planning: mistakes in sequencing or delays in critical steps such as land acquisition can affect the allocation of costs between partners and lead to additional delays during dispute resolution. Figure 11.5 shows some of the individual capacities required for PPPs.

Many of the existing efforts to build capacities for PPPs have focused on building capacity for project appraisal and transaction design, both through training, lending of expert consultants, and creation of templates to allow relatively less-trained people to manage PPPs. However, the service management and project lifecycle competencies should not be overlooked.

Figure 11.5
Capacities Required for Implementation of PPP Projects



Source: Devkar (2013).

RECOMMENDATIONS FOR INSTITUTION BUILDING

The following sections describe the effort necessary for setting up institutions and structures needed for planning, decision-making and implementation for the next two decades. This will require that funds be earmarked for these institutions as 1-2 per cent of investment for each transport sector. This is a very small amount to invest considering the challenges facing us. We have to start planning for these institutions now to catch up with other nations in a decade or so.

The number, size and type of institutions being recommended is based on international comparisons, in particular with countries with similar levels of development at present. As indicated earlier, India is significantly behind countries like China and Korea in knowledge production, skills, innovation and technology development at all levels and areas of transport operations. It has to be emphasised that scientific findings and innovation cannot be ordered. We must build capacity with a number of professionals in all fields so that a few of them may come up with path breaking ideas in the future. The enormity of this task can be illustrated by the fact that in the US the Federal Government alone employs a few hundred professionals to work on road safety, where as in India the combined strength of such professionals in the central and state governments would be less than a handful.

International experience suggests that it takes more than a decade to build viable quality institutions. A demand has to be created for persons with expertise in these areas with availability of jobs in institutions. This sends a signal to academic institutions to start relevant academic programmes and for potential students to apply for the same. In the absence of a large number of such institutions good quality students do not apply for transportation related programmes even when they exist in some academic institutions. Even worse, the Indians being trained in foreign institutions on different aspects of modern transportation planning and implementation have no incentive to return to India as there is a dearth of employment opportunities that provide a meaningful work environment.

We present these institutions as distinct public and private entities, but collaboration is also important to ensure that transportation research is seen as neutral and credible, particularly if/as recommended action on route planning for road and rail, subsidies for passenger transport, air quality regulation, reinvigorating different forms of mass transport and investing in non-motorised transport takes place.

The Health Effects Institute is one example of an institutional design meant to produce credible research in a contentious setting. It was established to help overcome arguments between the US Environmental Protection Agency and the automobile industry over the impacts of automobile-related

air pollution: both groups were separately funding studies, neither trusted each-others' selection of studies or examples, and the argument was playing out in public politics. The HEI was set up with equal funding from the EPA and the auto industry, and staffed with an independent board of directors pulled from eminent academic institutions (including the Presidents of Stanford University and Bell Labs). It performed wide-ranging reviews of existing literature on health impacts (to overcome each side's accusations of selection bias among studies) and funded independent research, which was then peer reviewed by external experts (to avoid claims of insider approvals).

STANDALONE NATIONAL INSTITUTIONS

Indian Institute for Transport Research (IITR)

The proposed Indian Institute for Transport Research will be responsible for research on all aspects of transport and logistics by all modes, and play a leading role in transport policy and technology development.

The Institute would be responsible for research on all aspects of transport and logistics by all modes. It will be expected to play a leading role in national transport policy and technology development. The Institute may be set up under the Ministry of Science and Technology and would work closely with the Office of Transport Strategy (OTS)²⁰ recommended by the Committee. It would cover all modes and type of transportation

by setting up departments covering aviation, national highways, urban transport, railways, maritime transport, inland water transport, environmental impact assessment, policy planning, extramural research, and statistical analysis.

IITR could develop four or five regional centres to focus on regional issues and coordination with regional authorities. At maturity, IITR should expect to employ about 300-500 professionals at the post-graduate level by the end of the 13th Five Year Plan period.

IITR would be responsible for:

- (a) Providing policy options and analysis to transport ministries (central and state), operating agencies and city governments.
- (b) Conducting cost effectiveness studies across different modes of transport and available technologies.
- (c) Conducting exploratory and future technology studies.
- (d) Providing a framework and modalities for interdisciplinary and inter-sectoral studies.
- (e) Identifying, facilitating, and supporting the

deployment of emerging technologies and best practices.

- (f) International technology assessment.
- (g) International collaboration.
- (h) Funding research and establishing centres of excellence at academic institutions.
- (i) Taking up studies for different transport ministries at central and state level.
- (j) Identifying data needs and coordination with Indian Institute for Transportation Statistics.

A similar recommendation was made by the National Transport Policy Committee, 1980 as mentioned earlier, and AITD was set up as an independent non-government institution. The Planning Commission has extended its support to AITD, keeping in view the long-term role of the Institute in building human capital as also for providing research support on all aspects of transport and logistics. In future, the IITR could play the role for supporting and extending financial support for research to such institutions.

Indian Institute for Transportation Statistics (IITS)

IITS will be responsible for acquiring, preserving, managing, disseminating transportation data, statistical analysis and associated information for use by central, state and city transportation departments, researchers and any other concerned agencies. Its various roles would include:

- Coordinate with all national and state statistical organisations associated with collecting transport related data, especially the Office of the Registrar General & Census Commissioner and the National Sample Survey Organisation.
- Serve as a central depository for data, statistics, research results and technical publications of all agencies dealing with various sectors of transport services.
- Publicise, facilitate and promote access to the information products and services.
- Publish an annual transport statistics database.
- Conduct a national personal passenger and goods transportation survey every five years. This will include flows of people, goods and vehicles, social, economic, and environmental data, conditions that affect or are affected by the transportation networks for all modes of transport.
- Coordinate with all agencies associated with transportation issues and IITR.
- Fund studies and research in academic organisations.

It would be responsible for synchronising other demographic and socio-economic data for the country. At the end of the 13th Five Year Plan IITS would have a staff of about 150-200 postgraduate professionals.

20. Please see Chapter 5 on Institutions for Transport System Governance.

SCIENCE AND TECHNOLOGY CAPABILITY IN TRANSPORT MINISTRIES

RESEARCH INSTITUTIONS

Each department associated with transport (air, water, road and railways) should establish a multidisciplinary research organisation for applied research on current concerns and future technology development:

- Indian Institute for Aviation Research
- Indian Maritime and Water Transport Research Institute
- Indian Institute for Intercity Road Transport
- Indian Institute for Urban Transport
- Railway Research and Development Institute

By the end of the 13th Five Year Plan, each of these research institutes would have:

- 100-300 research professionals (60-70 per cent permanent employees of the institute and 30-40 per cent on deputation)
- Regional centres for coordination with state and city governments
- Advanced laboratories for technology development and testing
- Statutory responsibility for setting standards and regulations

The service conditions at these institutions should be similar to those at CSIR and the Director General of each Institution with rank and facilities similar to those of at CSIR laboratories/Secretary to the Government of India. The Director Generals will report directly to the Minister of the appropriate Ministry. Terms of reference would be similar to those at the IITR, but with greater emphasis for applied work as per needs and requirements of each Department. We have recommended elsewhere (Chapter 5, Volume II) the need to set up a unified Ministry of Transport. Once that happens, all these institutions would come under the umbrella of this Ministry and it would then be easier for these institutions to collaborate with each other more.

DEPARTMENT OF TECHNOLOGY DEVELOPMENT AND POLICY ANALYSIS

Each Transport Department must set up an internal Division of Technology Development and Policy Analysis. The Division must be staffed by 20-50 professionals headed by an officer of the rank of Additional Secretary to the Government of India. However, two-thirds of the professionals working in the Division would be permanent employees with service conditions same as those of scientists working in the CSIR, and one-third would be on deputation. The role of the Division Department would include:

- Liaison with IITR, IITS and with the respective ministerial research institution

At the state level, each ministry dealing with transport issues should establish a transport research department focusing on the special needs of the state.

- Technology evaluation and assessment
- Data collection and analysis
- Responding to needs of operating agencies
- Funding research in academic institutions
- Outreach
- Organising scientific workshops and conferences
- Policy assessment and strategic planning
- Align areas of research with ministry goals.
- Investment policy regarding ministry R&D
- Track redundancy and duplication of effort

We have recommended elsewhere the establishment of an Office for Transport Strategy (OTS). Once such an office is established, these entities could work intensively with the OTS.

STATE- AND CITY-LEVEL INSTITUTIONS

- a. All states should consider establishing State Institute for Transport Research (SITR) with objectives similar to the Indian Institute for Transport Research (IITR), but with greater focus on local issues. The SITR should include a special transport statistics division that would liaison with the Indian Institute for Transportation Statistics. At maturity these institutes should have a staff of 50-100 professionals.
- b. At the state level, each ministry dealing with transport issues should establish a transport research department focusing on special needs of that state. The responsibility of the department would be to generate state level detailed plans, data needed for the same, evaluation of projects and policies, liaison with the Central Government, and funding of research projects at state-level institutions and universities.
- c. All megacities (population >5 million) must establish transportation planning research departments that could have responsibilities similar to state-level units.

ACADEMIC CENTRES OF EXCELLENCE

At present, most of the academic programmes in India related to transport capacity appear to be much less integrated than the global norm. Outside of India, these tracks are often presented as specialisations within a single Transport Engineering programme (See Annex). Brazil's University of Sao Paulo, for example, offers a single Transport Engineering Masters with specialisations in Transport Infrastructure Planning and Management, Transport Infrastructure Construction, and Spatial Infor-

Table 11.4
Suggested Number of Academic Centres of Excellence

SUBJECT	NUMBER BY 2020	NUMBER BY 2030
Urban transport	20	40
Highways	20	40
Rail	15	30
Air	5	10
Water and marine	5	10

mation. Transport and Sustainable Development as a combination seems to be most prevalent in Europe, perhaps reflecting that region's focus on transport policy as a part of climate change/environmental strategy. The London Centre for Transport Studies offers an MSc in Transport with specialisations in Business Management and Sustainable Development, as does the Paris Institute of Technology and the Institute of Transport Studies at University of Leeds. Australia's Planning and Transport Research Centre (PATREC) and South Africa's University of Capetown offer Transport Studies courses with a core focus on systems planning and clusters of electives in management and specialised planning topics. University of California, Berkeley offers a similar combination of core courses plus electives, in Transportation Engineering and Transport Systems Analysis.

Within India, this split seems to be between schools: specialised masters in transport planning within urban planning programs for the former and the latter training taking place in Civil Engineering departments. Specialised courses on transport management are within business schools, for example at the Indian Institute for Social Welfare and Business Management. Most of the courses are offered within particular departments, often urban planning or civil engineering, though there appears to be some tendency for more recently founded programmes to be linked to multiple departments or even multiple schools. There is clearly precedent for building specialised centres that can draw on faculty from different departments while avoiding getting locked into particular forms of teaching, class schedules, policy framing, or other aspects of particular departments than may complicate launching transport-related degree programmes and shorter courses.

Investments in transport research must be spread over a wider group of professionals. Government support for research appears to be primarily directed to designated public-sector research bodies focused on sectors rather than transport overall. Each Department dealing with transport and the Ministry of Human Resource Development must set

up academic centres of excellence. It is expected that the centres funded by transport ministries would be more focussed on applied research, whereas those set up by the Ministry of Human Resource Development would help provide graduate scholarships, extra faculty positions and infrastructure funds. These new centres should cover all modes of transport to deal with the following subjects and societal concerns:

- Energy sustainability and global warming
- Safety
- Health effects of transport
- Energy sources, availability and future technology assessment
- Integration of transportation modes
- Affordability and economic issues
- Modelling and simulation
- Needs of children, the aging and physically challenged population
- New materials
- Human factors, psychology and social implications of transport policies
- International issues and global logistics
- Policy analysis and cost effectiveness studies
- Influence of infrastructure design and technology on travel behaviour
- Economics

Such centres must of necessity be of interdisciplinary nature and be established based on open competition among academic institutions by inviting proposals for the same. Each centre must demonstrate its interdisciplinary nature by ensuring that the participating scientists are drawn from two or more departments and can be established in all academic institutions including medical colleges. The suggested number of centres to be established are given in Table 11.4.

The level of funding would be Rs 30-50 million per year per centre. In addition to equipment, supplies, travel and research funds, the funding must include 5-10 endowed permanent Chairs and 10-20 endowed post-graduate scholarships. The establishment of these centres must include funds for development of infrastructure and extra faculty positions equal to the number of endowed Chairs.

Table 11.5

Scholarship Proposed for Study in Transportation-Related Subjects

ORGANISATION	NUMBER OF NATIONAL SCHOLARSHIPS PER YEAR	NUMBER OF INTERNATIONAL SCHOLARSHIPS PER YEAR
Ministry of Road Transport and Highways	50	25
Ministry of Railways	50	25
Ministry of Civil Aviation	10	5
Ministry of Environment and Forests	40	20
Ministry of Heavy Industries and Public Enterprises	10	5
Ministry of New and Renewable Energy	10	5
Ministry of Shipping	20	10

KNOWLEDGE GENERATION IN OPERATING COMPANIES/ ORGANISATIONS/MUNICIPALITIES

Present operating companies like DMRC, BEST, DTC, etc., and municipalities, have very little knowledge generation capacity. Mechanisms have to be set up to revamp these organisations and make them much more professional. Each one of these organisations must have a knowledge generation unit that has a budget of about 3-5 per cent of the turnover of the organisation by 2020.

JOB OPPORTUNITIES FOR HIGHLY-TRAINED PROFESSIONALS IN THE TRANSPORT SECTOR

- a. Just the creation of research centres in academic institutions will not be sufficient for ensuring professionalisation of transportation services. Individuals trained at post-graduate levels must have job opportunities that excite and satisfy them. The creation of research centres as outlined above will create a part of this demand. However, the operating departments/organisations will also have to create a demand for highly qualified individuals who work in-house with different job responsibilities and working conditions.
- b. At present India produces approximately 1,000 PhDs per year in engineering, whereas China produces >7,000 per year. Most Chinese PhDs find jobs within China, whereas even this smaller number of PhDs in India have problems finding a satisfying job, especially one with an operational orientation. There needs to be strong demand creation for graduates with advanced degrees, in both research as well as operational organisations, so that the country could move systematically toward a sustainable transportation future.
- c. Central, state and local governments and agencies such as Railways, NHAI, State and City Road Transport Corporations, Port Trusts, Airport Authorities, NTPC, ONGC, etc.

would need to take the lead to house highly-trained personnel in relevant areas sectors such as Energy, Power, Environment, Integrated Transport, Urban Development, Planning, Economics and Finance and disciplines so that new technologies, management and operational systems are explored in transportation service delivery aimed at improving the quality of mobility as well as the efficiency of the transport system.

- d. Concrete policies at each agency would need to be worked out. Each agency and department should create 10-year projections for expanding the employment of higher-skilled operational staff including, MTechs and PhDs to a desirable level. This would need to be accompanied by a revision of salary and service conditions that suit people with a knowledge base (CSIR service conditions can be a starting point).

PRODUCTION OF THE WORKFORCE

Each ministry/department associated with transportation issues should establish scholarships, which can be awarded through open competition at a national level. Scholarships may be given with all expenses covered to those who are able to get admission to reputed Indian and foreign universities. Those availing of scholarships at international universities would have to sign a bond to serve an Indian organisation for three years upon graduating. Students opting to study at Indian universities should get scholarships without and bonds and constraints. The number of scholarships for study in transportation related subjects to be awarded by different ministries per year for the first five years after the launching of the scheme are given in Table 11.5.

SPONSORED MASTER'S AND BACHELOR'S DEGREE PROGRAMMES

All operating departments, institutions and corporations related with transportation should be required to sponsor about 2-5 per cent of their staff for obtain-

ing masters degrees in relevant subjects as fulltime students every year.

A task force should be constituted by the Planning Commission to prepare a report on the number of new special bachelor's and master's degree programmes that need to be set up at different institutions around the country for training of the workforce necessary over the next 10-year period. The taskforce would also assess the financial implications of starting these new courses and the source of funds for the same. The task force should be able to submit its report by the end of 2014, and programmes started by 2016.

IN-SERVICE TRAINING

The skills gap cannot be taken care of by the production of new professionals alone. Many of those already in service will be around for the next 15-20 years and it is essential that they have an opportunity to improve their skills and acquire knowledge necessary to apply modern techniques and technologies. In service training and knowledge acquisition requires three parallel efforts:

1. Periodic testing of engineers and technical personnel.

It is essential that India builds a pool of transport professionals. The existence of a large number of professionals will ensure competition among them to keep them honest and throw up a few outstanding individuals of international standing in each area of activity.

Each area of professional activity (e.g., civil engineering, mechanical engineering, electrical engineering and important sub disciplines) should require a mid-career evaluation of professional expertise after 7-10 years of service. The form of the evaluation may be based on modern education methods based on self-paced internet learning and testing methods with some practical evaluation. The purpose of this evaluation will not be to necessarily fail individuals, but to ensure that

individuals can advance in their careers only when they demonstrate they have kept up with the technical advancements in knowledge in their respective disciplines. A special task force should be set up to design the format, rules and procedures for these professional examinations and for Professional Certification by empowered agencies.

2. Short-term training programmes

All professionals should be required to participate short-term training programmes in areas for which policy movement is urgent and capacity gaps are significant at least once every five years. These courses could be one week to one month in length and organised by the department concerned with outside

experts or in collaboration with existing academic institutions. Efforts in this direction have already been instituted in the 12th Five Year Plan. What is needed is greater emphasis on quality and ensuring continuity in service of those trained so that they can put their knowledge to use. Short-term training programmes being offered in other countries should be evaluated for quality and relevance periodically and 25-30 per cent of officers eligible for such training sent out of the country to gain international experience.

3. Pursuing higher degrees

All professionals should be eligible for pursuing a course of studies at the Master's or PhD level at departmental expense after about five years of service. At any given time about 10 per cent of officers should be allowed to proceed on leave with appropriate aevaluation of the need for expertise and skills required. Adequate budget provisions would be necessary for about a third of such professionals being deputed to institutions outside India. Arrangements will have to be made to establish appropriate career opportunities and job responsibilities for persons acquiring higher qualifications. For example, some of them may be deputed to the new research and development organisations at the local, state or central level as proposed in this report. It is essential that professionals be given opportunity to place themselves where they fit best (on-line engineering responsibilities, management, research, etc.) as they mature mid-career onward.

LATERAL HIRING

Lateral hiring could also be a way to build critical expertise within the public sector as quickly as it is built in the country more broadly. As discussed here, India does not yet have significant reserves of transport planning capacity in the private sector, but these may be built faster than public expertise and thus ease of movement between public and private would ensure capacity flows to the areas of greatest need.

The Approach Paper of the 2nd Administrative Reforms Committee also emphasises the need to build a framework for lateral induction as policy complexity increases, including designating some policy offices requiring specific forms of expertise. Other working groups and expert committees such as the Planning Commission Working Group on Capacity Building in the 12th Plan have reiterated the value of opening hiring to appointments from outside the public sector in complex areas with significant gaps in public sector capacity.

SUMMARY

Transportation planning and policy implementation has become a very complex and contentious activ-

ity. This is partly because many infrastructure projects are capital intensive and invite narrow interest of lobbyists and technology providers, and partly because solutions to many issues are not very clear. In an age of instant information transfer, decisions can be based ahistorically on current fashions that may not suit our socio-economic environment. The fact that the future of energy availability and environmental concerns is highly uncertain makes the job even more difficult.

In this scenario, it is very important the country has a large number of professionals who are aware of all international developments in policy and technology and also have an in-depth knowledge of our local conditions and needs. The existence of a large number of such professionals will ensure competition among them to keep them honest and also throw up a few outstanding individuals of international standing in each area of activity.

At present, knowledge gaps exist in all areas of activity:

- Design, construction, operation, management, maintenance
- Safety
- Demand management
- Project management
- Use of ITS
- Finance

Future transportation planning and policy making will also require a much more sophisticated approach to set in place systems that ensure the consideration of climate change and safety issues as integral components of infrastructure and technology options.

At present, India fares poorly in terms of total knowledge output. When normalised for population levels in 2011, India's output appears poor in comparison with both Brazil and China. Even more worrisome is the fact that the gap between India and China has widened considerably in the past decade especially on topics dealing with railway technology safety and environment. This means that if we want to catch up with countries like China in 10 years with their present levels of productivity, we will have to grow at more than 10 per cent per year. We must plan to set up systems for local knowledge producing mechanisms that aid researchers in responding to demands of society.

Functioning transportation systems in any location involve interactions between individuals, socio-economic imperatives, technologies, geophysical structures, built environment, organisational capacities, political compulsions, knowledge limitations, influence of special interest groups, and historical path dependencies of societies.

International experience offers several relevant lessons for building expertise and a professional com-

India must invest in decision support systems so that capacity can be used for maximum effect. The institutional framework must also be able to convert information into knowledge.

munity. First, it is important to establish transport planning as a high-status occupation and applied science makes it easier to attract ongoing political and financial support as well as some of the most competent professionals. Second, it is important to decentralise the institutional system and build networks. Third, it is important to encourage transport stakeholders to learn by doing

'Capacity building' comprises three challenges: training individuals, building systems for research and development to update capacity, and ensuring that these individuals have the ability and incentives to be productive within teams and organisations. India must not only increase the supply of capacity by expanding the number and quality of opportunities to study transport planning and allied fields, but it must also ensure a strong demand side. The effective 'demand' for capacity will depend on employment policies that attract these transport planners to public sector work and also on public expenditure and programmatic policies that encourage ministries, state agencies, and metropolitan bodies to spend discerningly on capacity building. In addition, as some private sector infrastructure companies become large and engage in large transport projects, they can also be encouraged to use the services of transport planning specialists. The Government will also need to invest in transport research so that training, decision support, and policy action improve over time and adapt to changing opportunities and challenges. Capacity building should also be designed to also support India's efforts to integrate its many transport-related organisations with a common culture focused on transport systems across national, state, and metropolitan scales. This section discusses future requirements across these three dimensions.

There is little reliable data available for inter-city or urban passenger or freight travel patterns. In this situation, infrastructure investment has to be done on a fire-fighting basis with little knowledge of long-term consequences on efficiency, or financial and environmental stability. Technology choices have to be based on hunches and influenced by powerful supplier lobbies. This situation is likely to get worse in the face of accelerated economic growth and urbanisation, as political and public pressure for provision of transportation services will demand quick fixes. India must also invest in decision support systems so that available capacity can actually be exercised for maximum effect. The institutional framework must also be capable of converting information into transport knowledge A review of

If India is to emerge as an economic power by 2030, it needs to invest significantly in human resource institutions to exhibit much greater soft power than it does at present.

international practices in transportation research, training and development clearly shows that a large number of countries have established well-funded and professionally-staffed institutions at all levels and across disciplines.

It is quite clear that there is already a great shortage of trained manpower, along with absence of institutional support for policy making and technology development in India. We do not have any institutions within government departments and operating agencies, universities centres or stand-alone institutions in any area of transportation that compare favourably with institutions reviewed in previous sections except for an institution or two like the National Aerospace Laboratory. The research centres at academic institutions are sub-critical in the number of faculty members involved, and resources available. Except in a few centres, most of the academic activity is not interdisciplinary in nature, and there is almost a complete absence of involvement of professionals from the social sciences—economics, law, etc.

INVESTMENT IN INSTITUTIONS

The effort necessary for setting up institutions and structures needed for planning, decision-making and implementation for the next two decades will be quite substantial. This will require that funds be earmarked for these institutions as 1-2 per cent of investment for each transport sector. This is a very small amount to invest considering the challenges facing us. We have to start planning for these institutions now to catch up with other nations in a decade or so.

The number, size and type of institutions being recommended is based on international comparisons, in particular with countries with similar levels of development at present. Furthermore, if India is to emerge as an economic power by 2030, it needs to invest significantly in human resource institutions to exhibit much greater soft power than it does at present. As indicated earlier, India is significantly behind countries like China and Korea in knowledge production, skills, innovation and technology development at all levels and areas of transport operations. It has to be emphasised that scientific findings and innovation cannot be ordered. Capacity has to be built with a large number of professionals in all fields so that a few of them may come up with path-breaking ideas in the future.

International experience suggests that it takes more than a decade to build viable quality institutions. Demand has to be created for persons with expertise in these areas with availability of jobs in institutions. This sends a signal to academic institutions to start relevant academic programmes and for potential students to apply for the same. We present these institutions as distinct public and private entities, but collaboration is also important to ensure that transportation research is seen as neutral and credible, particularly if the recommended action on route planning for road and rail, subsidies for passenger transport, air quality regulation, reinvigorating different forms of mass transport and investment in non-motorised transport takes place.

STANDALONE NATIONAL INSTITUTIONS

(a) Indian Institute for Transport Research (IITR)

The Institute would be responsible for research on all aspects of transport and logistics by all modes. It will be expected to play a leading role in national transport policy and technology development. The Institution may be set up under the Ministry of Science and Technology and would work closely with the Office of Transport Strategy recommended by NTDP. IITR could develop 4-5 regional centres to focus on regional issues and coordination with regional authorities. At maturity, IITR should expect to employ about 300-500 professionals at the post-graduate level by the end of the 13th Five Year Plan period.

(b) Indian Institute for Transportation Statistics (IITS)

IITS will be responsible for acquiring, preserving, managing, disseminating transportation data, statistical analysis and associated information for use by central, state and city transportation departments, researchers and any other concerned agencies.

SCIENCE AND TECHNOLOGY CAPABILITY IN TRANSPORT MINISTRIES

(a) Research Institutions

Each Department associated with transport (air, water, road and railways) should establish a multidisciplinary research organisation for applied research on current concerns and future technology development. Elsewhere (Chapter 5, Volume II) we have recommended the formation of a unified Ministry of Transport. As soon as such a Ministry is established, it would become easier for these institutions to collaborate with each other.

- Indian Institute for Aviation Research
- Indian Maritime and Water Transport Research Institute
- Indian Institute for Intercity Road Transport
- Indian Institute for Urban Transport
- Railway Research and Development Institute

By the end of the 13th Five Year Plan each of these research institutes would have:

- 100-300 research professionals (60-70 per cent permanent employees of the institute and 30-40 per cent on deputation)
- Regional centres for coordination with state and city governments
- Advanced laboratories for technology development and testing
- Statutory responsibility for setting standards and regulations

(b) Department of Technology Development and Policy Analysis

Each Transport Department must set up an internal Division of Technology Development and Policy Analysis. The Department must be staffed by 20-50 professionals headed by an officer of the rank of Additional Secretary to the Government of India. However, two-thirds of the professionals working in the Department would be permanent employees with service conditions same as those of scientists working in the CSIR, and one third would be on deputation. These entities could collaborate intensively with the Office of Transport Strategy (OTS) recommended elsewhere (Chapter 5, Volume II)

STATE- AND CITY-LEVEL INSTITUTIONS

- a) All states should consider establishing a State Institute for Transport Research (SITR) with objectives similar to the Indian Institute for Transport Research (IITR), but with greater focus on local issues. The SITR should include a special transport statistics division that would liaison with the Indian Institute for Transportation Statistics. At maturity these institutes should have a staff of 50-100 professionals.
- b) At the state level the each ministry dealing with transport issues should establish a transport research department focusing on special needs of that state. The responsibility of the department would be to generate state level detailed plans, data needed for the same, evaluation of projects and policies, liaison with the Central Government, and funding of research projects at state-level institutions and universities.
- c) All megacities (population >5 million) must establish transportation planning research department that could have responsibilities similar to state level units.

ACADEMIC CENTRES OF EXCELLENCE

At present most of the academic programmes in India related to transport capacity appear to be much less integrated than the global norm. Each Ministry dealing with transport and the Ministry of Human Resource Development must set up academic centres

of excellence. It is expected that the centres funded by transport ministries would be more focussed on applied research, whereas those set up by the Ministry of Human Resource Development would help provide graduate scholarships, extra faculty positions and infrastructure funds.

Such centres must of necessity be of interdisciplinary nature and be established based on open competition among academic institutions by inviting proposals for the same. Each centre must demonstrate its interdisciplinary nature by ensuring that the participating scientists are drawn from two or more departments and can be established in all academic institutions including medical colleges. The suggested number of centres to be established are given in Table 11.4.

KNOWLEDGE GENERATION IN OPERATING COMPANIES/ORGANISATIONS/MUNICIPALITIES

Present operating companies like DMRC, BEST, DTC, etc., and municipalities, have very little knowledge generation capacity. Mechanisms have to be set up to revamp these organisations and make them much more professional. Each one of these organisations must have a knowledge generation unit that has a budget of about 3-5 per cent of the turnover of the organisation by 2020.

JOB OPPORTUNITIES FOR HIGHLY-TRAINED PROFESSIONALS IN THE TRANSPORT SECTOR

There needs to be strong demand creation for graduates with advanced degrees, in both research as well as operational organisations, so that the country could move systematically toward a sustainable transportation future. Concrete policies at each agency would need to be worked out. Each agency and department should create ten year projections for expanding the employment of higher-skilled operational staff including, MTechs and PhDs to a desirable level. This would need to be accompanied by a revision of salary and service conditions that suit people with a knowledge base (CSIR service conditions can be a starting point).

PRODUCTION OF THE WORKFORCE

Each Ministry associated with transportation issues should establish scholarships, which can be awarded through open competition at a national level. Scholarships may be given with all expenses covered to those who are able to get admission to reputed Indian and foreign universities.

The number of scholarships for study in transportation related subjects to be awarded by different ministries per year for the first five years after the launching of the scheme are given in Table 11.5.

SPONSORED MASTER'S AND BACHELOR'S DEGREE PROGRAMMES

All operating departments, institutions and corporations related with transportation should be required to sponsor about 2-5 per cent of their staff for obtaining masters degrees in relevant subjects as fulltime students every year.

A task force should be constituted by the Planning Commission to prepare a report on the number of new special bachelor's and master's degree programmes that need to be set up at different institutions around the country for training of the workforce necessary over the next 10-year period.

IN-SERVICE TRAINING

The skills gap cannot be taken care of by the production of new professionals alone. Many of those already in service will be around for the next 15-20 years and it is essential that they have an opportunity to improve their skills and acquire knowledge necessary to apply modern techniques and technologies. In service training and knowledge acquisition requires three parallel efforts:

1. Periodic testing of engineers and technical personnel.

Each area of professional activity (e.g., civil engineering, mechanical engineering, electrical engineering and important sub disciplines) should require a mid-career evaluation of professional expertise after 7-10 years of service. A special task force should be set up to design the format, rules and procedures for these professional examinations and for Professional Certification by empowered agencies.

2. Short-term training programmes

All professionals should be required to participate short-term training programmes in areas for which policy movement is urgent and capacity gaps are significant at least once every five years.

3. Pursuing higher degrees

All professionals should be eligible for pursuing a course of studies at the Master's or PhD level at departmental expense after about five years of service. At any given time about 10 per cent of officers should be allowed to proceed on leave with appropriate evaluation of the need for expertise and skills required.

LATERAL HIRING

Lateral hiring could also be a way to build critical expertise within the public sector as quickly as it is built in the country more broadly. As discussed previously, India does not yet have significant reserves of

transport planning capacity in the private sector, but these may be built faster than public expertise and thus ease of movement between public and private would ensure capacity flows to the areas of greatest need.

CONCLUSIONS

We have placed great emphasis on the importance of human resource development in all aspects of the transportation sector. This also reflects the difficulties we have faced in compiling this report as we have interacted with ministries and government agencies at the central, state and local levels, and with the best professionals available. At the same time, the ramping up of investment in all areas of transport is already taking place, and we are recommending a further enhancement in such investment over the next two decades. Corresponding with economic growth and higher income levels, aspirations of people for higher quality of transportation are also going up consistently. Accordingly, we are also witnessing increasing demands for investment in capital intensive projects such as high-speed trains (HST), limited access expressways, urban mass transit systems such as Metros, and the like. The decision making in such projects is now being done without adequate availability of data, nor adequate appreciation of the various trade offs involved in resource allocation between different modes and options.

It is in this context that we are recommending the establishment of new institutions connected with transport on a somewhat large scale. We are aware of various criticisms, which characterise these recommendations as being utopian and unrealistic. As we have documented, comparison even with other emerging market economies shows that the kind and size of institutions recommended are quite comparable with those already existing in these countries. Compared with the magnitude of overall investment envisaged in the transport sector, the investment in such institutions would amount not more than 1-2 per cent of GDP. The gains in better planning and execution of transport projects will far outweigh the cost of such investment in essential human resource development.

Of equal importance is a focused and sustained programme of upgrading existing personnel, most of whom will be in service over the next 20 years.

Transportation planning, engineering, design, execution must all be seen as exciting areas of work, as indeed they are. Thus, we recommend that the Planning Commission establish a Special Mission to carry forward the recommendations in this chapter on unified basis, within the 12th Plan period.

Annex

Transport Planning Curricula

NAME OF PROGRAMME	UNIVERSITY	COUNTRY	COURSES
Master of Transport	Monash University–Monash Institute of Transport Studies, Department of Civil Engineering	Australia	<p>Core Units: Traffic engineering fundamentals Quantitative methods Intelligent transport systems Transport modelling Infrastructure project and policy evaluation Transport planning and policy Transport economics</p> <p>Elective Units: Road traffic: Engineering and management Road safety engineering Parking policy and design Case studies in transport Fundamentals of urban public transport</p> <p>Link: http://monash.edu/pubs/handbooks/courses/3272.html</p>
Master of Transport Studies	Planning and Transportation Research Centre (PATREC), a collaboration between three public universities of Western Australia: Curtin University, Edith Cowan University and The University of Western Australia	Australia	<p>Core Units: Planning for Accessibility Transport Assessment & Evaluation Cities & Sustainability Transport Systems & Policy</p> <p>Elective Units: Global Distribution & Transportation Integrated Plan Making Principles of Enterprise Logistics Management Business Strategy Managing Change Contemporary Issues in Aviation Management Risk Management Advanced Transport Modelling Logistics Management Transport Safety Transport Research Methods</p> <p>Curriculum: http://humanities.curtin.edu.au/local/files/courses/308322/brochure.pdf PATREC Home Page: http://www.patrec.org/</p>
Masters in Transportation Planning	University of Sao Paulo	Brazil	<p>Offers three specialisations: - Transport Planning and Systems Operation - Infrastructure Construction and Project Management - Spatial Analysis for Transport</p> <p>Link: http://www.euni.de/tools/jobpopup.php?lang=en&option=showJobs&jobid=346190&jobtyp=5&jityp=2&university=University+of+S%C3%A3o+Paulo&country=BR&sid=46751&name=Transport+Engineering+%28Master%29</p>
Master of Engineering in Transport Studies Master of Philosophy in Transport Studies Postgraduate Diploma in Transport Studies Dissertation PhDs in Transport Studies	University of Cape Town	South Africa	<p>Core Courses: Transport demand analysis and project assessment Transport modelling Intermodal public transport planning and economics Integrated land use-transport planning Management of transport supply and demand</p> <p>Elective Courses: Intermodal public transport planning and economics Rail planning and operations management Bus planning and operations management Local area transport planning, management and design Non-motorised transportation</p> <p>Transport planning Link: http://www.cfts.uct.ac.za/study_2.html</p>
Master of Science and Doctor of Philosophy–Transport Engineering and Logistics	Transport Engineering and Logistics Department, Pontificia Universidad Católica de Chile	Chile	<p>Transport Economics Social Projects Evaluation Advanced Demand Traveling Models Engineering Econometric Models Transport Externalities Advanced Traffic Models Transport Networks Equilibrium Logistics Topics Highway Traffic and Queuing Theory Advanced Methods for Transport and Logistics Systems Urban Transport Systems Planning Urban Road Design Seminar</p> <p>Link: http://www.wold.ing.puc.cl/ict/</p>

NAME OF PROGRAMME	UNIVERSITY	COUNTRY	COURSES
MSc Transport and Planning	Cardiff University	United Kingdom	<p>Core Modules: Principles of Transport Economics Researching Transport Sustainable Transport Tools for Transport Analysis Transport and the City</p> <p>Optional Modules: Environmental Behaviours: Citizens, Consumers and Communities Environmental Management Local Food and Sustainable Development Space and Place: International Planning Practice Spatial Planning</p> <p>Link: http://www.cardiff.ac.uk/cplan/degreeprogrammes/postgraduate/mastersprogrammes/transportplanning/index.html</p>
MSc Transport MSc Transport with Business Management MSc Transport with Sustainable Development	Imperial College / University College (University Of London Centre For Transport Studies)	United Kingdom	<p>MSc Transport Core Units: Transport and its context Quantitative methods Transport engineering and operations Transport economics Transport demand and its modelling Transport policy</p> <p>Optional Units: Highway engineering Road traffic theory and its application Public transport Transport safety Quantitative techniques for transport engineering and planning Advanced transport modelling Understanding and modelling travel behaviour Transport and the environment Intelligent transport systems Design of accessible transport systems Freight transport Asset management, project planning and maintenance Design of roads, rail, bridges, tunnels and embankments Air traffic management Ports and maritime transport Urban street planning and design</p> <p>Business Management Extension Modules: Microeconomic Theory Principles of Accounting Project Management Business Environments and Construction Law</p> <p>Sustainable Development Extension Module: The concept of sustainable development Sustainable development and engineering innovation Applying the principles Special project</p> <p>Link: http://www.ulcts.cv.imperial.ac.uk/</p>
Master of Science (MS)/Master of Engineering (MEng)/MCP (City and Regional Planning)/PhD in Transportation Engineering	University of California, Berkeley	United States of America (USA)	<p>Core Courses: Transportation Policy, Planning and Development Operation of Transportation Facilities Systems Analysis in Transportation</p> <p>Transportation Engineering Courses: Design and Construction of Transportation Facilities Transportation Systems Engineering Infrastructure Planning and Management Intelligent Transportation Systems Highway Traffic Operations Public Transportation Systems Air Transportation Operations of Transportation Terminals Selected Topics in Air Transportation Transportation Systems Analysis Courses Transportation Economics Logistics Transportation Infrastructure Management Analysis of Transportation Data Behavioral Modeling for Engineering, Planning, and Policy Analysis Advanced Topics in Transportation Theory Transportation Planning Courses Transportation Planning Transportation Sustainability Traffic Safety and Injury Prevention Transportation and Land Use Planning Transportation Finance</p> <p>Link: http://www.ce.berkeley.edu/programs/trans</p>

NAME OF PROGRAMME	UNIVERSITY	COUNTRY	COURSES
Undergraduate Degree in Transportation Engineering/ Doctoral Degree Transportation Planning and Management	Beijing University of Technology	China	No information on coursework Link: http://bjut.edu.cn/bjut_en/colleges.jsp?columnID=222
Master of Engineering (Transport Option)/Master of Science (Transport and Sustainable Development)	Paris Institute of Technology	Paris, France	Master of Engineering (Transport Option): Common Core Courses: Introduction to management Statistics Introduction to law Fluid mechanics or soil mechanics Transport Option: Economics of transport Modelling of demand Transport safety Transport pricing Methods for territorial analysis Master of Science-Transport and Sustainable Development <ul style="list-style-type: none"> • Transport Stakes and Sustainable Development Development <ul style="list-style-type: none"> • Analysis and Prevision of Transport Supply and Demand • Transport, Energy and Environment • Transport and Social, Economic and Political Regulation <ul style="list-style-type: none"> • Management and communication • Projets Transport et Développement Durable • French (for not-French speaking students) • Professional internship Link: Master of Engineering (Transport Option): http://www.enpc.fr/english/academics/vet.htm?sr=2&ur=3 Master of Science-Transport and Sustainable Development: http://www.enpc.fr/english/enpc/tradd_gb.pdf
BSc Transport Management	Engineering & Applied Science, Aston University	Birmingham, UK	Year 1 Modules: Introduction to Logistics Planning & Controlling Logistics Law Principles of Economics Financial Accounting Study Skills Literature Review Project Marketing Goods & Services Introduction to Business Management Year 2 Modules Transport Planning Systems Environmental Economics Project Management Operational Research 1 Management Accounting European Transport Maritime Transport Database Management Multimodal Transport Management Implementing Transport Policy Environmental Managements & Audit Final Year Modules: Passenger Service Provision Traffic and Transport Engineering Human Resource Management Operational Research II Statistical Methods Air Transport International Trade Law Final Year Project GIS Transport Impact Assessment Link: http://www1.aston.ac.uk/eas/undergraduate/our-courses/bsc-transport-management/

NAME OF PROGRAMME	UNIVERSITY	COUNTRY	COURSES
BSc Management Transport & Logistics	Liverpool John Moores University	Liverpool, UK	<p>Year 1: Transport Systems and Policy; Introduction to Logistics; Principles of Law; Organisation, Economics and Finance; Study Skills.</p> <p>Year 2: Managing Transport Operations; Logistics Operations and Materials Management; International Trade and Commerce, Research Planning and Quantitative Methods.</p> <p>One option from: Law of Carriage of Goods; Port Policy; Employment Law and Human Resource Management.</p> <p>Year 3: Transport Policies and Practices; Project. Plus three options from: Multimodal Transport and Global Logistics; Port Strategy and Development; Applied Marketing and Strategy; Management of Finance and Investment Appraisal. Link: http://www.ljmu.ac.uk/courses/undergraduate/2012/course.asp?CourseId=NK24</p>
BSc (Hons) Transport and Logistics Management	University of Huddersfield	UK	<p>Year 1 Core modules:</p> <ul style="list-style-type: none"> • Transport: Challenges and Issues • Economics and Business Statistics • Principles of Logistics and Marketing • Professional Skills and Personal Development • Commercial Management <p>Option modules: Choose one from -</p> <ul style="list-style-type: none"> • Introduction to Air Transport • Fundamentals of Tourism • Languages <p>Year 2 Core modules:</p> <ul style="list-style-type: none"> • Logistics Management • Freight Transport Management • Managerial and Enterprise Skills • Passenger Transport Management • Logistics Planning Techniques and Applications <p>Option modules: Choose one from -</p> <ul style="list-style-type: none"> • Languages • European Business and Global Markets • Operations Management • The Travel and Tourism Industry • Airline Marketing and Operations Management <p>Year 3 Core modules:</p> <ul style="list-style-type: none"> • Strategic Management • Project • Strategic Supply Chain Management <p>Option modules: Choose two from -</p> <ul style="list-style-type: none"> • Retail Logistics • Languages • Sustainable Tourism • Global Logistics and Supply Chain Management • Supply Chain Modelling • Project, Quality and Production Management • Transport Economics and Policy <p>Link: http://www.hud.ac.uk/courses/2013-14/full-time/undergraduate/transport-and-logistics-management-bsc-hons/</p>
BSc (Hons) in Transportation and Logistics with Business Management	Malaysia University of Science And Technology	Malaysia	<p>Modules</p> <p>Introduction to Transportation Systems Fundamental of Operations Research Introduction to Supply Chains Sustainable Development and Transportation; Transportation Planning Computer Algorithms for Transportation and Logistics Introduction to Transportation Flow Systems Transportation Demand Analysis Transportation Policy Public Transport Systems Operations and Management Transportation Economics Air Transportation Management Maritime Transportation and Logistics Freight Transportation Link: http://www.must.edu.my/index.php?option=com_content&view=article&id=107&Itemid=167</p>

NAME OF PROGRAMME	UNIVERSITY	COUNTRY	COURSES																																										
MSc/PgDip/ PgCert Transport Planning and Management	Sheffield Hallam University	UK	Level one modules: Economy, society and sustainability Geographical information systems (GIS) and transport Global perspectives on regeneration Professional management skills Level two modules: Strategic land use and transport planning Financial policy and management Transport appraisal Level three modules: Applied research methods Dissertation Link: http://www.shu.ac.uk/prospectus/course/365/content/																																										
BA Geography with Transport Planning	Institute for Transport Studies, University of Leeds	UK	Year 1: Introduction to transport policy, in addition to the key themes of human and environmental geography. Year 2: Specialise in human geography, alongside transport studies. Link: http://www.its.leeds.ac.uk/courses/undergraduate/geography-with-transport-planning/																																										
BA Economics with Transport Studies			<p>Year 1</p> <table border="0"> <tr> <td>Compulsory Modules:</td> <td>Elective Modules include:</td> </tr> <tr> <td>Introduction to Transport Policy</td> <td>Economic Institutions (Labour)</td> </tr> <tr> <td>Information Technology & Communication Skills</td> <td>Economic Institutions (Industry)</td> </tr> <tr> <td>Maths and Stats for Business and Economics</td> <td>Introductory Financial Accounting</td> </tr> <tr> <td>Research Skills for Economists</td> <td>Introductory Management Accounting</td> </tr> <tr> <td>Economic Theory and Applications</td> <td>Understanding Social Enterprises</td> </tr> <tr> <td>Personal Tutorials for Economics</td> <td>Organisational Behaviour</td> </tr> <tr> <td>Instruments of Transport Policy</td> <td></td> </tr> </table> <p>Year 2</p> <table border="0"> <tr> <td>Compulsory Modules:</td> <td>Optional Modules include:</td> </tr> <tr> <td>Intermediate Microeconomics</td> <td>Business Economics</td> </tr> <tr> <td>Applied Economics</td> <td>Industrial Economics</td> </tr> <tr> <td>Intermediate Macroeconomics</td> <td>International Economic Environment</td> </tr> <tr> <td>Transport Economics</td> <td>Introduction to Econometrics</td> </tr> <tr> <td>Project Appraisal</td> <td>Transport Land Use and Development</td> </tr> <tr> <td></td> <td>Transport and the Environment</td> </tr> <tr> <td></td> <td>Transport and Society</td> </tr> </table> <p>Final year</p> <p>Compulsory Module: Transport Dissertation</p> <p>Optional Modules include:</p> <table border="0"> <tr> <td>Advanced Microeconomics</td> <td>Public Transport Policy and Practice</td> </tr> <tr> <td>Public Enterprise and Regulation</td> <td>Environmental Economics</td> </tr> <tr> <td>International Banking and Finance</td> <td>Topics in Transport</td> </tr> <tr> <td>Travel Activity and Social Analysis</td> <td>Physical Distribution and Logistics</td> </tr> <tr> <td>Advanced Macroeconomics</td> <td>The Economics of Unions</td> </tr> <tr> <td>Economics of Business & Corporate Strategy</td> <td>Current Topics in European Integration</td> </tr> </table>	Compulsory Modules:	Elective Modules include:	Introduction to Transport Policy	Economic Institutions (Labour)	Information Technology & Communication Skills	Economic Institutions (Industry)	Maths and Stats for Business and Economics	Introductory Financial Accounting	Research Skills for Economists	Introductory Management Accounting	Economic Theory and Applications	Understanding Social Enterprises	Personal Tutorials for Economics	Organisational Behaviour	Instruments of Transport Policy		Compulsory Modules:	Optional Modules include:	Intermediate Microeconomics	Business Economics	Applied Economics	Industrial Economics	Intermediate Macroeconomics	International Economic Environment	Transport Economics	Introduction to Econometrics	Project Appraisal	Transport Land Use and Development		Transport and the Environment		Transport and Society	Advanced Microeconomics	Public Transport Policy and Practice	Public Enterprise and Regulation	Environmental Economics	International Banking and Finance	Topics in Transport	Travel Activity and Social Analysis	Physical Distribution and Logistics	Advanced Macroeconomics	The Economics of Unions
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Economics of Business & Corporate Strategy	Current Topics in European Integration																																												

NAME OF PROGRAMME	UNIVERSITY	COUNTRY	COURSES
MSc Sustainability (Transport)	Institute for Transport Studies, University of Leeds	UK	<p>Compulsory modules Business, Environment and Sustainability Introduction to Sustainability Transport Planning and Policy Transport Data Collection and Analysis Sustainable Land-Use and Transport Planning Global Issues in Transport Transport Dissertation Optional modules: Climate Change: Impacts and Adaptation Environmental Governance and Sustainability Climate Change Mitigation Tools and Techniques for Integrated Ecological Economic Modelling Participatory Environmental Project/Policy Evaluation Green Logistics Analysing Transport and Society Public Transport Planning and Management Stated Preference Analysis Methods Traffic Network Modelling Transport Investment Appraisal Transport and Urban Pollution Transport in Development Safety of Road Transport Link:http://webprod1.leeds.ac.uk/catalogue/dynprogrammes.asp?Y=201011&P=MSC-TRN%2FSUS</p>
MSc (Eng) Transport Planning and Engineering			<p>Compulsory Modules Principles of Transport Engineering Principles of Transport Modelling Transport Planning & Policy Transport Data Collection & Analysis Dissertation Optional Modules Analysing Transport & Society</p> <p>Funding for Projects Global Issues in Transport Green Logistics Public Transport Planning & Management Road Geometry & Infrastructure Safety of Road Transport Stated Preference Analysis Methods Sustainable Land-Use & Transport Planning Traffic Management Transport & Urban Pollution Transport in Development Transport Investment Appraisal Traffic Network Modelling Link: http://www.its.leeds.ac.uk/courses/masters/msc-transport-planning-engineering/</p>
MA Transport Economics			<p>Compulsory Modules Principles of Transport Economics Welfare Economics & Cost-Benefit Analysis Transport Econometrics Principles of Transport Modelling Transport Data Collection & Analysis Economics of Transport Regulation Dissertation Optional Modules Analysing Transport & Society Funding for Projects Global Issues in Transport Green Logistics Public Transport Planning and Management Stated Preference Analysis Methods Transport in Development Transport Investment Appraisal Link: http://www.its.leeds.ac.uk/courses/masters/ma-transport-economics/</p>

NAME OF PROGRAMME	UNIVERSITY	COUNTRY	COURSES
MSc Transport Planning			Compulsory Modules Transport Planning & Policy Principles of Transport Modelling Understanding Travel Behaviour Transport Data Collection & Analysis Sustainable Land-Use & Transport Planning Dissertation Optional Modules Analysing Transport & Society Global Issues in Transport Green Logistics Public Transport Planning & Management Safety of Road Transport Stated Preference Analysis Methods Traffic Management Transport in Development Transport Investment Appraisal Transport & Urban Pollution Traffic Network Modelling Funding for Projects Link: http://www.its.leeds.ac.uk/courses/masters/msc-transport-planning/
Graduate Courses in Transportation Systems Engineering (classified under School of Civil and Environmental Engineering)	Georgia Tech (Georgia Institute of Technology)	Georgia, US	Courses include: Computer-Aided Site Engineering & Road Design Construction Engineering Management Construction Safety and Health Discrete Choice Analysis Environmental Impact Analysis Freight Planning Geometric Design GIS in Transportation Infrastructure Management: IT Applications Infrastructure Systems Multimodal Transportation Systems Pavement Technology Project Front End Planning and Monitoring Signalised Intersections & Networks Simulation Models in Transportation Spatial Analysis Statistical Analysis of Travel Demand Traffic Engineering Traffic Flow Theory Transportation Administration & Policy Analysis Transportation Energy & Air Quality Transportation Energy Infrastructure Management Transit Systems Planning & Design Urban Transportation Planning http://www.ce.gatech.edu/research/tse/courses
Rahall Appalachian Transportation Institute	Marshall University	West Virginia, US	Courses Relevant to Transportation offered at Different Departments: Principles of Domestic Transportation Marketing Physical Distribution Marketing Traffic Management Marketing Purchasing and Inventory Control Marketing Transportation Law and Public Policy Marketing Carrier Management Marketing Advanced Transportation Marketing Advanced Physical Distribution ISC Special Topics: Transportation and the Environment ISC Special Topics: Transportation and the Environment PS Physical Principles of Remote Sensing with Applications in Transportation (B) - Denotes baseline courses included in strategic plan from grant inception. For a full list of courses, go to: http://www.njrati.org/education/degree-programs/courses/
Master of Urban and Regional Planning, Specialisation in Transportation Planning	Portland State University	Portland, Oregon, US	Required Course: Urban Transportation: Problems and Policies Choose 3: Economics of Urban Transportation Urban Transportation Planning Transportation and Land Use Travel Demand Modeling Choose 1 (3 credits, minimum): (Note: if you take all four classes in the list above, you do not need to take a class from the list below.) Transportation Seminar (one credit, can take more than once)* Sustainable Transportation Geographic Applications in Planning Pedestrian and Bicycle Planning Cost Benefit Analysis in Transportation (1 credit, can only take once)* Transportation Safety Analysis Freight Transportation and Logistics

NAME OF PROGRAMME	UNIVERSITY	COUNTRY	COURSES
			Intelligent Transportation Systems Public Transportation Systems Transportation Operations http://www.pdx.edu/usp/urban-regional-planning-transportation
Transportation Policy and Planning Concentration, Urban Planning Program	Rutgers University	United States	Core Courses (select four of six) Urban Transportation Policy Analysis Urban Transportation Planning Transportation and the Environment Transportation and Land Use International Transport Policy Public Transit Planning and Management Elective Courses Security and Safety in Maritime Transportation and Port Operations Maritime Transportation Traffic Engineering Transportation Planning Traffic Operations Design of Transportation Facilities Transportation Systems Analysis Intelligent Transportation Systems Freight Transportation Systems Advanced Transportation Economics and Modeling Port Planning, Management and Operations State and Local Public Finance Comprehensive Planning Advanced Multivariate Methods Locational Conflict Introduction to GIS for Planning and Public Policy Program Evaluation Introduction to Planning and Design Zoning for Communities of Place Environmental Planning and Management Seminar in Urban Planning: Walking and Cycling Link: http://policy.rutgers.edu/academics/uppd/concentrations/transportation.php
Master of Urban Planning, Concentration in Land Use and Transportation Planning	University of Illinois, Urbana-Champaign	United States	(Recommended) foundation courses: Transportation Planning GIS for Planners Land Use Policy Growth Management and Regional Planning Environmental Planning Workshop (Recommended) Electives: Watershed Ecology and Planning State and Local Public Finance Urban Ecology Planning for Historic Preservation Land Resource Evaluation Economic Development Planning Sustainable Planning Seminar Environmental Planning Workshop Housing and Urban Policy Planning Neighborhood Planning Advanced Sustainable Planning Workshop Ecology for Land Restoration Watershed Hydrology Earth Systems Modeling Environment & Sustainable Development Environmental Policy Biological Modeling Spatial Ecosystem Modeling Link: http://www.urban.illinois.edu/academic-programs/MUP/concentrations/lut.html
Master of Science in Transportation (interdepartmental programme)	Massachusetts Institute of Technology		Transportation Subjects by Programme Area: Air Transportation: The Airline Industry Air Traffic Control Airline Management Air Transportation Operations Research Planning and Design of Airport Systems Analysis and Planning Methods: Demand Modeling Logistical & Transportation Planning Methods Computer Modeling: From Human Mobility to Transportation Networks Advanced Demand Modeling Computer Algorithms in Systems Engineering Transport Modeling Course Network Optimisation Logistics and Supply Chain Management: Logistical & Transportation Planning Methods Logistics Systems Case Studies in Logistics and Supply Chain Management International Supply Chain Management

NAME OF PROGRAMME	UNIVERSITY	COUNTRY	COURSES
			Logistics and Supply Chain Management Transportation Policy: Transportation Policy and Environmental Limits Transportation Policy and Planning Law, Technology, and Public Policy Environmental Law, Policy, and Economics: Pollution Prevention and Control Transportation Management: Case Studies in Logistics and Supply Chain Management Logistics and Supply Chain Management Airline Management Urban Transportation: Demand Modeling Computer Modeling: From Human Mobility to Transportation Networks An Introduction to Intelligent Transportation Systems Comparative Land Use and Transportation Urban Transportation Planning Transport Modeling Course Public Transportation Systems Cities and Regions: Urban Economics and Public Policy Comparative Land Use and Transportation Planning Advanced Seminar in Transportation Finance Link: http://cee.mit.edu/graduate/transportation/areas
Master of Science in Transportation and Urban Systems/Master of Transportation and Urban Systems/Certificate in Transportation and Urban Systems	North Dakota State University	North Dakota, US	Compilation of courses (required and elective) specific degree programmes: Spatial Analysis Focus: Introduction to Geographic Information Systems Advanced Geographic Information Systems Spatial Analysis in Transportation Transportation Planning Focus: Research in Transportation and Logistic Transportation Planning Information Systems Technologies Focus: Technology Advances and Logistics Emergency Response and Disaster Focus: Crisis Analysis and Homeland Security Enterprise Management Focus: Enterprise Resource Planning Organisational Change Management Electives: Logistics Systems International Logistics Management Advanced Supply Chain Planning Adaptive Planning in Logistics Logistics Research Methods Acquisition Contracts: Law & Management Transportation Systems Security Transportation Planning and Environmental Compliance Transportation System Modeling Urban Transportation Systems Analysis Context Sensitive Solutions Transportation Systems Laboratory Public Transportation Link: http://www.ndsu.edu/transportation/tus/courses/
Transportation Engineering Masters Program	University of Washington	United States	Required: Transportation Engineering Probability and Statistics Analytical Methods in Transportation One course from each of the following key areas: Planning: Transportation Survey Methods or Travel Demand Forecasting Operations and ITS: Traffic Systems Operations or Trans Data Management and Analysis Freight and Logistics: Freight Transportation or Freight Transportation and Logistics Electives: Pavement Design GIS for Civil Engineers Urban Transportation Planning and Design Infrastructure Construction Energy and the Environment Traffic Engineering Fundamentals Transportation and Construction Capstone Transportation Logistics Pavement Construction and Quality Control Link: http://www.ce.washington.edu/prospective/grads/transportation.html
MSc Transport Sustainability & Society.	University of East London	UK	Core Modules: Planning, Mobility and Sustainability, Mobility, Society, and Culture Optional modules: two of - Cycling in Society Comparative Mobilities

NAME OF PROGRAMME	UNIVERSITY	COUNTRY	COURSES
			<p>Unequal Mobilities Global Environmental Politics Transportation Engineering Sustainability and the Commons http://www.uel.ac.uk/lss/postgraduate/programmes/TSS.htm</p>
<p>MSc Intelligent Transport Systems & Intelligent Mobility</p> <p>MSc Transport Engineering & Operations</p> <p>MSc Transport & Business Management</p> <p>MSc Transportation Planning & Policy</p> <p>MSc Transport & the Environment</p>	Newcastle University	UK	<p>Modules: intelligent mobility—policy and practice, systems and services quantitative methods transport policy in practice Intelligent Transport Systems and e-Services; transport modelling road safety characteristics of public transport systems economic and environmental appraisal of transport activities Dissertation</p> <p>design of transport infrastructure railway management economics and practice transport planning for sustainable development air pollution and transport emission modelling for sustainability. http://www.ncl.ac.uk/ceg/study/postgraduate/taught/</p>
MSc/Postgraduate Diploma in Transport Engineering and Planning	University of Salford, Manchester	UK	<p>Courses: Transport Planning Principles The general aim of this module is to provide an introduction to the key concepts and methods which underlie the four-stage model central to the theory and practice of transport planning. More particular aims are as follows: a) to present a systematic representation of the demand for travel and the supply of transport; b) to provide experience in the application of one of the main systems of software (TRIPS) used in practice for transport planning; and c) to provide the basis for study in detail of the main methods used in transport planning. close Integrated Transport Planning The aims of this module are a) to present the principles and methods involved in planning coherently for all modes of transport; b) to illustrate the application of those principles through examination of case studies; and c) to review the measures available to reduce the use of the motor car and to promote the use of alternative modes. close Traffic Data Collection and Analysis In this module you will design, construct and assess standard traffic surveys and to apply statistical methods for analysing traffic data and interpreting results. close Transport systems design This module looks at the issues underlying current practice in the basic design of transport infrastructure for a range of transport modes including cycles, motor vehicles, rail and mass transit systems. close Transport Modelling You will study the key methods which comprise the four-stage model central to the theory and practice of transport planning: a) trip generation; b) trip distribution; c) mode choice; and d) highway-traffic and passenger-transport assignment. Estimation of trip-matrices from traffic-counts will also be introduced as an auxiliary method. close Traffic Management and Road Safety This module will teach you to analyse problems and propose outline solutions relating to the management and control of traffic, with an emphasis on road safety, environmental and amenity objectives. close Analysis of Highway Links and Junctions On completion of this module you should be able to analyse problems and propose outline solutions relating to the operation of highway links and junctions and to apply theoretical models in relation to traffic flow characteristics. close Appraisal of transport schemes This module will give you a systematic understanding and critical awareness of the current and innovative methods used to appraise and evaluate transport schemes, with specific reference to economic, environmental and safety issues and to give an opportunity to obtain practical experience in these methods. close MSc Project and Dissertation http://www.salford.ac.uk/courses/transport-engineering-and-planning?mode=cd</p>

NAME OF PROGRAMME	UNIVERSITY	COUNTRY	COURSES
MSc Transportation Planning & Engineering	University of Southampton	UK	Transportation Planning: Policies & Methods Transport Engineering: Analysis & Design Transport Data: Analysis & Techniques Transportation Planning: Practice Transport Economics Research Project http://www.southampton.ac.uk/engineering/postgraduate/taught_courses/msc_transportation_planning_and_engineering.page?
Traffic Engineering–Certificate Transport and Spatial Development - Short course Transport Assessment - Short course Transport Planning - Professional Development - a series of short courses Transport Planning - MSc/Postgraduate Diploma/ Postgraduate Certificate	University of West England, Bristol	UK	Courses: development control; junction design; economic and environmental appraisal of road schemes; road safety investigation; traffic management, signal control and data collection; transport administration policy and legislation the role of transport in encouraging economic development and regeneration, especially unintended effects the effect of increasing road capacity in inducing traffic, and the effects of reducing (or reallocating) road capacity in reducing traffic the effectiveness of travel plans and other so-called 'soft' instruments of transport policy http://www1.uwe.ac.uk/whatcanistudy/courses/professionalandshortcourses.aspx#T
MSc Transport Planning & Management	University of California, Los Angeles	US	Core Courses: (any two) Transportation, Land Use, and Urban Form Transportation Planning Introduction to Transportation Engineering Parking, Transportation, and Land Use http://publicaffairs.ucla.edu/content/transportation-policy-and-planning
Certificate in Transportation Systems	University of Southern California		Required Courses Transportation Engineering Traffic Engineering and Control Engineering Project Management Urban Transportation Planning and Management Institutional and Policy Issues in Transportation http://www.usc.edu/schools/price/programs/certificate/transportation_systems.html

Source: NTDP Research.

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