TRIPP BULLETIN
VOL 9. NO.2 MONSOON 2012
TRANSPORTATION RESEARCH & INJURY PREVENTION PROGRAMME
INDIAN INSTITUTE OF TECHNOLOGY DELHI

Ph.D. Scholars — *Current*

Traffic modelling on hill roads
Scholar:Achyut Das
Supervisors: *G. Tiwari and K R Rao*

Estimating properties of thoracic organs
Scholar:Anil Kalra
Supervisors: *A Chawla and S Mukherjee*

Issues in crash reconstruction
Scholar: Amrit Lal
Supervisors: *A Chawla and S Mukherjee*

Heat transfer characteristic in helmets
Scholar:Bhagwat Singh Shishodia
Supervisors: *S. Sanghi and P. Mahajan*

Traffic flow and risk analysis in mixed stream
Scholar: Gaurav Pandey
Supervisor: *K.R. Rao*

Demand models for bicycle traffic integrating landuse parameters
Scholar: Himani Jain
Supervisor: *G. Tiwari*

Pedestrian behaviour modelling
Scholar: Mariya Khatoon
Supervisors: *N Chatterjee and G. Tiwari*

Study of bone fracture characteristics
Scholar: Mike W J Arun
Supervisors: *A. Chawla and S. Mukherjee*

Congestion modelling and mitigation on urban arterials
Scholar: Mohan Rao
Supervisors: *K.R. Rao*

Road safety audit
Scholar: Navdeep Kumar Asija
Supervisors: G. Tiwari

Safety considerations in bicycle demand models
Scholar: Pankaj Prajapati
Supervisor: *G. Tiwari*

Estimation of externalities in public transport system
Scholar: Pradeep Singh Kharola
Supervisors: *G. Tiwari*

Transportation planning and environment
Scholar: P.V. Pradeep Kumar
Supervisor: *S.R. Kale*

Evaluation of road infrastructure for pedestrian safety
Scholar: Shalini Rankavat
Supervisor: *G. Tiwari*

Service level benchmarks for urban transport systems
Scholar: S K Lohia
Supervisors: *V. Upadhyay and G. Tiwari*

Public transportation planning for small and medium sized Indian cities
Scholar: S M Hassan Mahadavi
Supervisor: *K R Rao and G Tiwari*

Impact of informal landuse on travel demand
Scholar: S.S.L.N. Sarma
Supervisor: *G. Tiwari*

Road traffic injury prevention and highway safety
Scholar: Sumeet Gupta
Supervisor: *G. Tiwari*

Traffic forecasts for roads projects under PPP
Scholar:V.K. Shrivastava
Supervisors: *A Chawla and S Mukherjee*

Ph.D. Scholars — *Completed*

In-vivo measurement of constitutive properties
Scholar: Hemant N Warhatkar
Supervisors: *A. Chawla and S. Mukherjee*

Institutional arrangements for the provision of urban public transport
Scholar: O.P. Agarwal
Supervisors: *G. Tiwari and V. Upadhyay*

M.Tech. Projects — *Completed*

Characterisation of cardiac muscle and aorta under dynamic compression and tensile impact respectively
Student: K Raja Sekhar
Supervisors: *A Chawla and S Mukherjee*

Characterisation of diaphragm under impact
Student: Jitender Kumar
Supervisors: *A Chawla and S Mukherjee*

Development and validation of models for small and midium sized cars for pedestrian impact simulation
Student: Majnoj Kiran Sanku
Supervisors: *A Chawla and S Mukherjee*

Agent based simulation of the travel demand for Patna city, India
Student: AmitAgarwal
Supervisors: *K R Rao and Kai Nagel*

Comparison of road and rail based public transport system on the basis of LCA
Student: Ashok Kumar
Supervisors: *G Tiwari and K N Jha*

Analysis of roundabouts: A case study of Delhi
Student: Hitesh Choudhary
Supervisors: *K R Rao and S K Deb*

Pedestrian/ motion modelling at mass transit terminals: A case study of Delhi metro
Student: Jyoti Prashad
Supervisors: *K R Rao and G. Tiwari*

Safety audit of selected highway section
Student: Prem Sharma Lamsal
Supervisors: *K R Rao and G. Tiwari,*

Safety at road construction zones
Student: Md Sajid Iqbal
Supervisor: *G. Tiwari,*

Low carbon mobility plan: methodology and indicators
Student: Sudeep Grover
Supervisors: *G. Tiwari, and K R Rao*

The **Transportation Research and Injury Prevention Programme (TRIPP)** at the Indian Institute of Technology Delhi, is an interdisciplinary programme focussing on the reduction of adverse health effects of road transport. TRIPP attempts to integrate all issues concerned with transportation in order to promote safety, cleaner air, and energy conservation. Faculty members are involved in planning safer urban and inter-city transportation systems, and developing designs for vehicles, safety equipment and infrastructure for the future. Activities include applied research projects, special courses and workshops, and supervision of student projects at postgraduate and undergraduate levels. Projects are done in collaboration with associated departments and centres at IIT Delhi, government departments, industry and international agencies.

TRIPP BULLETIN
TRANSPORTATION RESEARCH & INJURY PREVENTION PROGRAMME
VOL 9. NO.2 MONSOON 2012

Excerpts from the High Court Judgement delivered in New Delhi on 18th October, 2012 on the BRT corridor from Ambedkar Nagar to Mool Chand Crossing

Judgment Reserved on: September 24, 2012
Judgment Pronounced on: October 18, 2012

WP (C) No.380/2012

NYAYA BHOOMI ..... Petitioner
Represented by: Mr.Arun Vohra, Advocate along with Lt.Col. B.B.Sharma (Representative of the petitioner)

versus

GNCT OF DELHI AND ANR ..... Respondents
Represented by: Mr.K.T.S.Tulsi, Sr.Advocate instructed by Ms.Zubeda Begum, Ms.Priyanka Agarwal & Ms.Sana Ansari, Advocates for GNCTD.
Mr.Sanjiv Sharma, Advocate along with Dr.S.Velmurugan, Principal Scientist, CRRI.
Mr.Prashant Bhushan, Advocate with Mr.Anupam Bharti, Advocate for applicant/Intervenor in C.M.No.6311/2012.

CORAM:
HON'BLE MR. JUSTICE PRADEEP NANDRAJOG
HON'BLE MR. JUSTICE MANMOHAN SINGH

Census data, on a projected estimate basis, would evidence that today i.e. in the year 2012, the resident population of Delhi is around 18.2 million. Add to it to a floating population of about 0.1 million. These are colossal figures.
With such a high density of urban population it has to be expected that the focal points for a planned development of Delhi must focus on the following critical areas:-
(i) Land Policy;
(ii) Redevelopment;
(iii) Shelter;
(iv) Housing for poor;
(v) Green Belt (Environment);
(vi) Health Infrastructure;
(vi) Educational facilities;
(vii) Transportation.

And that takes us to the subject at hand. A problem relating to transportation has fallen in our lap. Nyaya Bhoomi, a Non-Governmental Organization has instituted the instant petition, stated to be in public interest, and the problem highlighted is pertaining to a stretch of road spanning 5.6 km. The road commences from the South at Ambedkar Nagar and moves in the Northern direction towards Delhi Gate and the stretch in question is from Ambedkar Nagar to the Mool Chand crossing. It is highlighted that as a result of the BRT corridor travelling time between Ambedkar Nagar and Moolchand for cars has increased by 23 minutes resulting in 1.5 ltr extra petrol being consumed. It is however admitted that those who travel by bus have gained on the travelling time.

It would be advisable if we were to note a few undisputed facts. At the fore front is the fact that in India, Delhi is the only city which has the most extensive road network; at 21% of its geographical area. But it is over saturated being severely choked with vehicles; and for which fact the data provided in the writ petition by the writ petitioner is sufficient proof. In paragraph 11 of the writ petition it is brought out, as noted above, that as of the year 2010 as against 29,849 buses plying on the roads of Delhi other motorized vehicles were 63,75,033. Over the past few years the Government of NCT Delhi has invested very heavily in roads and flyovers. Today the city of Delhi has about 46 flyovers; and yet the carrying capacity of the roads is falling apart. The period between 1998 – 2003 witnessed an active intervention by the Supreme Court in response to Public Interest Litigations on account of data showing a dismal quality of air in the city of Delhi. The choking haze of air pollution and its impact on public health was brought to the notice of the Supreme Court, resulting in a spate of directives issued to move out polluting industries from Delhi and ensure that minimum emission standards were set for petrol and diesel driven vehicles. The Euro II, Euro III and Euro IV norms were enforced by the Supreme Court. Sulphur content in diesel and petrol was reduced from 500 ppm to 50 ppm. Lead free petrol, to enable application of catalytic convertors in cars; lowering of the benzene content in petrol to 1%; CNG as a fuel for public transport vehicles etc. were the measures introduced and happily the city of Delhi was able to arrest, and even lower, air pollution which dropped by about 24% by the year 2005. But unfortunately, the gains which were achieved between the WP (C) No.380/2012 Page 7 of 24 years 1998 – 2005, gradually and slowly, started losing out since air pollution levels started rising again.

The writ petition, itself has highlighted that number of people using personal vehicles for transporting themselves has proportionately risen far more than those who use public transport i.e. buses. In fact, this data has been used by learned counsel for the writ petitioner to urge scraping of BRT on the ground that scarce public space i.e. roads is being wasted by creating dedicated corridor for buses, which corridor remains empty most of the time, and against that cars and two wheelers jostled for space. The respondent would agree with the figures provided and do concede that if the current trend continues, by the year 2021 car ridership would increase by 106% and bus ridership would increase by only 28%, but would use this very data to urge that keeping in view the fact that road space cannot be augmented, there is no option other than to put into place a good public transport system, with BRT being an integral part thereof; for only then would the citizen of Delhi shift to public transport.

The writ petitioner, the respondents and the report submitted by CRRI on July 16, 2012 to this Court, unanimously bring out that whereas on an average each car plying on the roads of Delhi carries 1.5 persons the average persons carried in a bus are around 40 and during peak hours would be between 60 persons to 70 persons. All three agree that two cars occupy same space on the road as one bus, i.e., two cars transport only 3 persons as against 60 persons to 70 persons transported in a bus during peak hours and around 40 persons during non-peak hours. And this figure needs to be considered with a caveat. Whereas a car commences and terminates its journey with the same 1.5 persons, while plying a bus would drop and pick up many persons en-route and thus the average number of person found in a bus at a given point of time being 40 would not mean that the bus has transported only 40 persons. The number of persons transported along the route would be as high as up to 200.

Since the writ petitioner has very keenly relied upon the report submitted to this court by CRRI on July 16, 2012, we may note the undisputed positions noted in the report. The same is that 50% trips (persons travelling) are by a bus. In other words, of 100 people traveling on the roads in Delhi, 50 use a public transport. And this data urges the respondent is sufficient to jettison the argument advanced by the writ petitioner that space allocation on the roads has to be in proportionate to the number of buses vis-à-vis the number of other mechanized vehicles. Why not allocate the road space proportionate the number of consumers? Argues the respondent.

Peak hour passenger flows from Ambedkar Nagar to Moolchand

Up Direction: Ambedkar Nagar to Mool Chand						
Name of the Section	Cars	2-Whlr	Autos	Buses	SMVs	Total
Ambedkar Ngr - Pushpa Bhawan	1688	910	383	7167	127	10275
Pushpa Bhawan - Sheikh Sarai	3814	3089	1191	6632	966	15692
Sheikh Sarai-Chirag Delhi	3876	3490	1035	12403	980	21784
Chirag Delhi - Siri Fort	2970	3502	871	8122	651	16116
Siri Fort - GKI crossing	3912	2795	922	4531	245	12405
Down Direction: Moolchand to Ambedkar Nagar						
Pushpa Bhawan - Ambedkar Nagar	3259	2337	456	3137	274	9463
Sheikh Sarai - Pushpa Bhawan	3144	2027	868	4522	532	11092
Chirag Delhi - Sheikh Sarai	5378	3348	1046	7348	467	17587
Siri Fort - Chirag Delhi	3845	3029	985	4288	294	12440
GK I Crossing - Siri Fort	2523	2286	679	2921	189	8598

The CRRI report submitted to this Court makes a comparison of the BRT corridor in question with parallel corridors; being Aurobindo Marg and Khel Gaon Marg in terms of speed and travel time.

Since the two corridors are not BRT corridors and permit mixed traffic flow, learned counsel for the petitioner had highlighted that exfacie mixed traffic flow is better for the roads in Delhi.

In our view such a comparison would be faulty because the traffic volume on BRT corridor is 1,41,228 passenger vehicles as against 73,266 on Aurobindo Marg and 48,276 on Khel Gaon Marg.

Let us guide ourselves by the law on the subject.

The problems of Government are practical ones and may justify rough accommodations which at first blush may appear to be illogical and may perhaps even appear to be unscientific. But such criticism has not to be hastily expressed. What is best may not always be discernable; the wisdom of any choice may be disputed or condemned. Mere errors of Government are not subject to judicial review.

In the area of road transport, if an existing system is sought to be replaced by a more organized system, capable of better regulations and discipline, then this is an urban transport philosophy, reflected in the decision of the Government. Such a philosophy may have its merits and de-merits. But they are best left to the wisdom of the executive and in such matters of policy the accepted principle is that the Court should not interfere.

Moreover, in the context of the ever changing social scenario, the expertise of people dealing with the subject should not be lightly interfered with. The consequences of such interdiction can have large scale ramification and can put the clock back by a number of years. It is the principal purpose of a Government to promote the interest of the general public rather than to distribute public goods to restrictive private benefit.

We only wish to bring out the fact that the issue is not of a debate between a car and a bus or an individual car user and an individual bus user. It is also not a debate between a class of persons traveling by buses and a class of persons traveling by cars. Courts have not to encourage such kind of groupism. The issue is large: one of urban transport policy.

Under the Jawaharlal Nehru National Urban Renewal Mission (JNNURM), the grant by the Central Government through the Ministry of Urban Development of Delhi has been utilized 83% for expansion of roads and construction of flyovers. 15% has been spent on parking projects and only 2% to other transport projects. What does it reveal? Cars, cars and cars and nothing else. And yet the roads are bursting at the seams. It could well be argued that when more than 50% of the road passengers travel by buses it would be illogical and irrational to spend 98% of the grants under JNNURM with the targeted beneficiary being cars.

If roads get over-choked, there is bound to be traffic congestion and air pollution as also individuals getting stressed while either idling or moving slowly in cars. They must then realize that it is their compulsion to consume the medicine, which may be bitter, i.e., use public transport for the reason this is the only long term solution to their problem. The scattered evidence placed before us, taken together, clearly suggests that the Government has taken a conscious decision that road space should be made freely available to the entire citizenry. The policy promotes the interest of the general public rather than to distribute public space for restrictive private benefit. The argument in the writ petition that those who create wealth travel on the roads by cars and their time is precious is too egalitarian an argument and ignores that unless labour meaningfully participates hand in hand with the capital, by itself the capital would create no wealth.

The journey time for cars would continue to increase even if there is no BRT because the number of cars and two-wheelers on the roads of Delhi is increasing by the day and unless BRT is accepted by the citizens of Delhi, the journey time for cars to cover the necessary distance would continue to increase. Thus, air pollution is not directly attributable to the BRT corridor but is a result of excess number of cars on the roads which need to be brought down.

It is hoped and expected that as a responsible government, the Government of NCT Delhi would look into the specific problem at Chirag Delhi crossing and would take all remedial measures necessary to decongest the traffic at the Chirag Delhi crossing. Arguments were advanced before us that buses should ply on the left on the road, we note the same lest we are flooded with applications that said issue was not noted. Since it is a matter of policy, we cannot issue any direction but would highlight that a BRT corridor would require the buses to ply on the central median side because of the right turns which the buses have to take at the crossings and the signalizing put in the place

We dismiss the writ petition but without any order as to costs.

TRIPP BULLETIN
TRANSPORTATION RESEARCH & INJURY PREVENTION PROGRAMME
VOL 9 NO.2 MONSOON 2012

NEWS

Community design and the incidence of crashes involving pedestrians and motorists aged 75 and older

Source: Dumbaugh, E., Zhang, Y. & Wenhao, L. (2012) College Station, TX: University Transportation Center for Mobility, Texas Transportation Institute

"Pedestrian-scaled retail uses were found to have no effect on the incidence of crashes involving older pedestrians, either positive or negative. Nonetheless, given that such uses are associated with higher levels of utilitarian walking and cycling, and thus significantly higher levels of crash exposure, the failure of this variable to be associated with meaningful increases in pedestrian and cyclist crashes suggests that such uses may be an effective means for providing older adults with safe alternatives to driving. Combined with the finding that such uses may also enhance the safety of older motorists, this suggests that such environments may be a key means for ensuring safe mobility for older adults. Nevertheless, this too is an area where future research is needed.This study finds that many of the elements of conventional community design practice, such as arterial thoroughfares, strip commercial uses, and big-box stores, are major risk factors for older adults, while networks of lower-speed streets and the design of pedestrian-scaled retail uses appear to be promising strategies for ensuring safe mobility for older adults ... Because they are typically located at arterials, big-box stores exacerbate the pre-existing hazards pedestrians face with traffic along arterials ... Big-box stores typically have large parking lots that pedestrians and motorists alike must walk across to access the store, creating further opportunities for vehicle pedestrian collisions."

Electric vehicles: A tentative economic and environmental evaluation

Source: Prud'homme, R & Koning, M. (2012) Transport Policy, 23, 60-69.

"The conclusions of this analysis are not encouraging for the success of the purely electric car. On the basis of available information on costs and performances, it appears that the present 100% electric car fares much less well than a standard conventional fuel car. Over the lifetime of a car, it will cost some 12,000 euros more to the consumer, and 15,000 euros more to society. These numbers take into account the cost of local pollution and of the noise caused by fuel cars ... The implied cost of saving one ton of $C0_2$ranges from about 900 euros to infinity (in extreme cases, the electric car would increase $C0_2$emissions, with an average of 2,500 euros. This is a particularly costly way of reducing $C0_2$emissions ... Even in the most "optimistic" scenarios, $C0_2$gains remain low: they are increased by a few tons over the life time of the car by a better (or much better) electricity efficiency, and decreased by an increase in the carbon content of the electricity used. The idea that the electric car could be a general substitute to the fuel car is not acceptable. It can only, at best, be a niche market.

FUTURE EVENTS

2013 Transportation Research Board 92nd Annual Meeting

The Transportation Research Board (TRB) 92nd Annual Meeting will be held in Washington, D.C. at the Washington Marriott Wardman Park, Omni Shoreham, and Washington Hilton hotels. The program will attract more than 11,000 transportation professionals from around the world to Washington, D.C., January 13-17, 2013. The TRB Annual Meeting program covers all transportation modes, with more than 4,000 presentations in nearly 650 sessions and workshops addressing topics of interest to all attendees—policy makers, administrators, practitioners, researchers, and representatives of government, industry, and academic institutions. A number of sessions and workshops will address the spotlight theme for 2013: Deploying Transportation Research - Doing Things Smarter, Better, Faster.

http://www.trb.org/AnnualMeeting2013/AnnualMeeting2013.aspx

4th International Conference on Urban Traffic Safety

The City of Edmonton's Office of Traffic Safety, in partnership with the Edmonton Police Commission, is hosting Edmonton's Fifth Annual International Conference on Urban Traffic Safety April 29-May 1, 2013, Shaw Conference Centre, Edmonton, Alberta, Canada. With worldwide leading traffic experts, the conference is intended to inspire creative ideas and innovative approaches to address the 21st century needs and challenges of urban traffic safety in communities around the world. Keynote addresses and sessions will help focus the discussion and provide a basis for further action.

http://www.trafficsafetyconference.com/index.html

13th World Conference on Transportation Research 2013

The 13th WCTR, will be held in Rio de Janeiro, Brazil, on July 15-18, 2013. Before the main conference, there will be the WCTRS Young Researchers' Conference, which will be held on July 14, 2013 and will be free to young researchers who are also participating in the main conference.

http://www2.wctr2013rio.com

Course Announcement

The Transportation Research and Injury Prevention Programme (TRIPP) at the Indian Institute of Technology Delhi, is organizing an eight day **"International Course on Transportation Planning and Safety"**. The course will be held in New Delhi, India, from 3 - 10 December 2012. The course will have a common component for the first three days, followed by two parallel modules on Traffic Safety and Biomechanics and Crashworthiness.

Details of the course can be accessed from -http://tripp.iitd.ernet.in

Establishment funds have been received from
Ministry of Industry, Government of India
Asian Institute of Transport Development, India
Tata Motors, India
Volvo Research and Educational Foundations(VREF), Sweden

Endowments for perpetual Chairs
CONFER, India: TRIPP Chair for Transportation Planning
Ministry of Urban Development, India: MoUD Chair for Urban Transport & Traffic Planning
VREF: Volvo Chair for Transportation Planning for Control of Accident and Pollution

Transportation Research and Injury Prevention Programme
Room MS 808 (Main Building)
Indian Institute of Technology
Hauz Khas,
New Delhi 110016, India
Phone: 91-11-26596361, 26858703
Fax: 91-11-26858703, 26851169
Email: ird8541@cbme.iitd.ernet.in
http://tripp.iitd.ernet.in

TRIPP BULLETIN
VOL 9 NO.2 MONSOON 2012
TRANSPORTATION RESEARCH & INJURY PREVENTION PROGRAMME
INDIAN INSTITUTE OF TECHNOLOGY DELHI

Excerpts from a Ph.D. Dissertation : A TRIPP BULLETIN INSERT

Title: Institutional arrangements for the provision of urban public transport

Scholar: O.P. Agarwal

Supervisors: G. Tiwari and V. Upadhyay

Department: Department of Humanities and Social Sciences

Urban transport plays a critical role in the economic development of modern societies and the quality of life of their citizens. Unfortunately, cities around the world, more so in the developing world, are facing serious problems of congestion, air pollution, safety and energy security. Urban transport is also a rapidly increasing contributor to Green House Gas (GHG) emissions, a globally increasing concern. This trend is projected to continue, if remedial measures are not taken.

Persuading people to shift to public transport is an effective answer to these problems, as, on per unit of travel demand, public transport uses less road space, consumes less fuel and emits less pollutant. However, this requires that public transport be safe, convenient, affordable and clean. This is turn requires good institutional arrangements for organizing, regulating and managing such systems on a comprehensive basis.

It is in the above context that this research seeks to identify the best options for regulating and managing the public transport systems in a city. More specifically, it seeks to:

1. Identify the different institutional arrangements adopted for the regulation, management and delivery of urban public transport services.

2. Study which institutional arrangement results in a better performance of the public transport system.

3. Suggest possible changes in the current institutional arrangements for three Indian cities of different size classifications.

Answers to the research questions were sought by comparing the systems of urban public transport governance (regulation, management and delivery system) with the performance of the public transport systems in a sample of 20 cities around the world. It was expected that such a comparison would enable an identification of certain attributes of the governance system that contributed to good performance.

In analyzing the governance of urban public transport, a three tier framework of the different functions that need to be performed was adopted. The three tier structure comprised strategic functions, tactical functions and operational functions. The main questions researched was who performed each of these functions and how the different agencies performing these functions were inter-related.

Indicators to evaluate the performance of the public transport system were considered from three perspectives – the user, the operator and the larger society. The indicators studied were the Boardings to Population Ratio (BPR), Coverage, Affordability, Cost Recovery, and Air quality.

The study of the governance systems showed that the models for providing urban public transport services could be classified into three models, with one of them having two variants as given below:

- Model 1 involves a single monolithic entity that plans and operates all public transport services.
- Model 2 involves a separation of planning and coordination from operations with a separate entity undertaking planning and coordination and operations being with completely different entities. Within the model, there are two variants:
  - > Loose coordination variant where there are multiple operators, most of whom undertake their own service planning, but are answerable to the planning and coordination entity for overall performance and integration with other modes.
  - > Tight coordination variant, where the planning and coordination entity undertakes demand assessment and service planning, following which it procures services under binding contracts. Thus, operator's compete "For" the market and are answerable to the planning entity under contractual agreement.
- Model 3 involves multiple operators undertaking their own planning and operating services based on permits or authorization from a public entity. There is no entity for coordinated planning or coordination of the services and there is competition amongst the operators "In" the market.

The findings show that a regulatory and management system that has a single service planning and oversight agency, with multiple and separate operating agencies, who complete "For" the market, performs best. Monolithic service planning and operating systems as well as systems where individual operators plan their own services were the lowest ranked.

It also finds that coordinated planning, separated from operations, is a more important determinant of public transport performance than public or private operation of such services.

Unfortunately, most Indian cities fall into one or other of the two lowest performing management categories. No Indian city has a single and separate planning entity; either they have a monolithic operating company that plans its own services, or they have separate operators each of whom plans and operates in isolation of others. This needs to change and an over-arching planning entity needs to be set up, with operations being carried out by separate agencies, under tight contractual arrangements.

Accordingly, recommendations have been made for the governance structure for urban public transport in Delhi, Pune and Guwahati to be modified to have unified planning entities, with operations being separated from the planning process.

Urban transport must meet people's needs to access employment, education, healthcare and recreation. It must also meet the need for an efficient movement of goods within as well as in and out of the city. Providing urban transport with such qualities is an important goal of any government.

Unfortunately, cities around the world, more so in the developing world, are facing serious problems of congestion, air pollution, safety and energy security. Rapid motorization, caused by an ever increasing preference for personal motor vehicles over public transport, has been the cause for this. Improved incomes coupled with the natural desire to demonstrate the improved economic status has led to a much faster growth in motor vehicles than in the urban population. Although, on an average, the population of India's six major metropolises increased by about 1.9 times during 1981 to 2001, the number of vehicles went up by nearly 8 times during the same period.

TRIPP BULLETIN
VOL 9 NO.2 MONSOON 2012
TRANSPORTATION RESEARCH & INJURY PREVENTION PROGRAMME
INDIAN INSTITUTE OF TECHNOLOGY DELHI

Continued from overleaf:

It is well acknowledged that greater use of public transport is an effective answer to these problems as it occupies less road space, consumes less energy and emits less pollutants, on a per passenger-km basis when compared to personal motor vehicles. Whitelegg (1997) has examined the issue of space requirements for busses, cars and scooters, taking into account the requirements for parking as well as movement. He finds that on a per capita basis a motorized two-wheeler, carrying one person, uses 7 times the space used by a bus carrying about 50 people. Similarly, a car carrying about 1.25 persons, on average, uses 30 times the space used by a bus. Further, Vasconcellos (2001) observes that one of the most wasteful characteristics of automobiles is that they remain parked from 20 to 22 hours per day, thereby using up parking space that could otherwise have been used for alternative purposes.

In terms of fuel consumption, typical manufacturer specifications in India state that a 12 metre diesel bus would be able to travel about 4.5 km to a litre of fuel whereas a motor cycle and a car would be able to travel almost 65 km and 16 km respectively for every litre of petrol. (Tata bus fuel efficiency from Tatas website and motor cycle / car fuel efficiency from Honda motors India website – pulsar motor cycle and Honda city car). If we take the average occupancy of a bus as 50, of a motor cycle as 1 and of a car as 1.25, the fuel consumption per passenger-km comes to 0.0005 litres for a bus, 0.0154 litres for a motor and 0.078 for a car. Thus a motor cycle and a car consume 3.8 times and 15.6 times as much fuel respectively as a bus. The emission of pollutants would also be broadly in this proportion.

Thus, public buses and trains are far more efficient in terms of space used, energy consumed and emissions than motorized two-wheelers and cars. Hence, public transport modes are clearly the most desirable. If we look at buses alone, the per capita availability of buses in India has gone up from year to year, having increased from 94.2 per million people in 1951 to 617.3 per million people in 2001. Yet, the share of buses in the total fleet of motor vehicles has declined from 11% in 1951 to only 1.1% in 2001.

Clearly, there has been a decline in the use of public transport, with an increasing preference for personal motor vehicles. Given the serious problems of congestion and deteriorating air quality, these trends need to be slowed down, if not reversed.

For public transport to be able to attract those who can afford personal vehicles, it needs to be of much better quality. This would normally mean higher costs and hence will be unaffordable to the poor. Therefore, the challenge is in making it more acceptable to those who can afford personal motor vehicles and yet ensuring that it remains affordable to those who cannot afford their own vehicles. This requires that scientifically designed and integrated, multi-modal public transport systems be put in place and operated in a highly cost effective manner, securing revenues from sources beyond fares alone. Given the pressures on the public budget, as well as a need for cost effective operations, a structured involvement of the private sector seems to have become inevitable.

The provision of a good public transport system requires several functions to be carried out in a systematic and coordinated manner. Examples from around the world indicate several institutional and organizational options for these to be carried out. While at one end are systems that are entirely operated and managed by a public entity, at the other are systems that are very loosely regulated and provided entirely by private entities. There are a range of intermediate possibilities as well.

One of the most important tasks faced by city authorities is to find an efficient organizational form to manage and regulate the urban transport system. This involves decisions on matters such as public vs. private ownership/operations, number of operators, the size of each operator, the type of regulation, if any, etc.

It is in the above context that this research seeks to find answers to the best options for regulating, managing and delivering public transport services in a city (also referred to, for simplicity, at several places in this dissertation, as the governance system for public transport).

Towards this end, the institutional arrangements for the regulation, management and delivery of public transport services in a sample of 20 cities around the world have been studied. The performance of the public transport system in these cities has also been studied. A possible linkage between the institutional arrangements and the performance of the public transport system has sought to be established. Frameworks for studying the institutional arrangements and the performance of public transport have been developed and data collected accordingly.

Any study of institutions would require a study of institutional change. Technology has been a very important reason for institutional change, though institutional change may lag behind technological change. According to Johnson (1988), continuously changing institutions are contradictions, while institutional rigidity in the long run is a threat to the introduction of novelty in the system. There are different ways in which institutional change takes place and there are different forces behind such change. Elster (1983) and Knight (1992) believe that there are three basic reasons for change in institutional structures. First are accidental changes. No natural or societal forces seem to be behind them and there are no prominent causal mechanisms. They just happen, though they are rare in formal institutions. Second is change that comes as a part of evolution, especially applicable in biological analogues. The principles of natural selection apply in such cases. According to Veblen (1919) radical technical change and technological revolution has been one such selection mechanism, which has repeatedly broken institutional barriers and provoked institutional change. These views are supported by Freeman and Perez (1988) in their theory of techno-economic paradigms. Edquist and Johnson (2000) argued that every innovation that is a feature of a market economy leads to change in institutions through motivating a different kind of interactive learning between various agents involved in the process of development, commercialization and the use of such technology. The third cause of change can be a product of intentional intervention. In other words, the change might be a product of the deliberate interventions of purposive goal seeking agents. Those agents might be either isolated individuals or organized interest groups

The research shows that the tight coordination variant of Model 2 is the best method of regulating, managing and delivering public transport services in a city. Under this, there is a single agency that coordinates all public transport services and plans the services that are required. Based on such coordinated planning it contracts operations from a number of operators and monitors their performance. This is because such an arrangement allows improved integration of services and better consumer focus in planning, yet retaining the efficiency of a competitive market..