VTI konferens 18A, 2001

Proceedings of the Conference

Road Safety on Three Continents

International Conference in Moscow, Russia,
19–21 September, 2001

Swedish National Road and Transport Research Institute

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Preface

The international conference Traffic Safety on Three Continents in Moscow, 19–21 September 2001, was organised jointly by the Swedish National Road and Transport Research Institute (VTI), the State Scientific and Research Institute of Motor Transport in Moscow (NIIAT), U.S. Transportation Research Board (TRB), the South African Council for Scientific Industrial Research (CSIR), South Africa, and Forum of European Road Safety Research Institutes (FERSI).

The Moscow conference was the 12th in this conference series. Earlier annual conferences have been held in Sweden, Germany, France, the United Kingdom, the Netherlands, Czech Republic, Portugal and South Africa.

Conference sessions covered a number of road traffic safety issues:

- Advanced road safety technology
- Road safety audits
- Policy and programmes
- Traffic engineering
- Vulnerable and old road users
- Alcohol, drugs and enforcement
- Human performance and education
- Behaviour and attention
- Data and models
- Cost and environment
- Speed and speed management

Linköping in November 2001

Kenneth Asp

Calibrating the run-of the road accident models by full-scale impact tests
Kari Laakso, Helsinki University of Technology, Finland

Traffic safety on urban streets – The problem and how to assess it
Thomas Jonsson, Lund University, Sweden

Use of statistical diagnostics and pattern recognition methodologies in developing safety improvement strategies
B. Allery, Colorado Department of Transportation, USA

Session 11. COST AND ENVIRONMENT

Risk factor profile and the cost of traffic injury in a tertiary hospital in Kenya
Saidi Hassan, University of Nairobi, Kenya

Economic effectiveness of road safety measures: problems of evaluation
Elena Oleshchenko, S:t Petersburg State University, Russia

Sweden´s vision zero – the least mourned traffic casualty
Arne Karyd, University of Linköping, Sweden

Methods for estimating road accident costs – A comparision of costs for a fatal casualty in different countries
Anna Trawén, University of Lund, Sweden

Designing a safe residential environment for children
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Sustainable transport policies in metropolitan cities: The way forward
Khaled A. Abbas, Egyptian National Institute of Transport, Egypt

Session 12. SPEED AND SPEED MANAGEMENT

Danish experiences with speed zones/variable speed limits
Lárus Ágústsson, Danish Road Directorate, Denmark

Intelligent speed adaptation – effects on driving behaviour
Mari Päätalo, VTT, Finland

The effect of weather controlled speed limits on driver behaviour on a two-lane road
Pirkko Rämä, VTT, Finland

Driving speed relative to the speed limit and relative to the perception of safe, enjoyable and economical speed
David Shinar, Ben Gurion University, Israel

ENVIRONMENTALLY SUSTAINABLE TRANSPORT STRATEGIES: THE WAY FORWARD IN METROPOLITAN CITIES

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ABSTRACT

This paper is concerned with one of the three requirements of a sustainable transport system, namely the environmental dimension. It starts by presenting components and interactions of the transport and traffic systems using causal diagrams. Generic traffic problems are identified and their causes categorized. A classification of demand and supply-based policies and measures that can be used in designing environmentally sustainable transport strategies is depicted. Such strategies are targeted towards minimizing the generic traffic problems encountered in metropolitan cities i.e. traffic congestion, accidents, environmental degradation and energy inefficiencies. In this paper, Travel Demand and Land Use Management are considered as two of the basic pillars for designing environmentally sustainable transport strategies. Criteria for comparing demand versus supply-based policies are suggested. These are applied to assess the benefits and limitations of each policy, hence assisting decision makers in the prioritisation and choice of such policies.

1. INTRODUCTION

Countries all over the world have been, for years, aspiring for economic and social development. In recent years, the term sustainability was introduced to incorporate the environmental as well as the social and economic aspects of development. A number of definitions for sustainability were presented in the literature, see WCED (1987), Daly (1991), Pearce and Warford (1993). In simple terms sustainability reflects a concern for reducing resource and material consumption to ensure the ability of future generations to sustain themselves. A recent World Bank report, see Word Bank (1996), stated that for a transport policy to be effective, it must satisfy three main sustainability requirements.

a) First, it must ensure that a continuing capability exists to support an improved material standard of living. This corresponds to the concept of economic and financial sustainability.
b) Second, it must generate the greatest possible improvement in the general quality of life, not merely an increase in traded goods. This relates to the concept of environmental and ecological sustainability.
c) Third, the benefits that transport produces must be shared equitably by all sections of the community. This is termed as social sustainability.

In light of the above, it seems plausible to suggest that the mission statement of a transport system is to meet the society economic and social needs by securing reasonable levels of accessibility and mobility for passengers and freight as well as contributing to the economic growth and prosperity of nations. This should be accomplished by providing a sustainable transport system. Such a system can be described as being adequate, efficient, safe and equitable. It should be planned, designed, implemented, operated, maintained, managed and controlled in a manner that attempts to achieve the above mission while minimizing generic traffic problems such as congestion, waste in resource consumption especially energy, loss of life, personal injury, damage to transport modes, and degradation of the environment

This paper is concerned with one of the three requirements of a sustainable transport system, namely the environmental dimension. Travel Demand Management (TDM) and Land Use Management (LUM) are considered as two of the basic pillars for designing environmentally sustainable transport strategies. Other ingredients, not covered in this paper, include transport supply management and technology implementation. According to Greene and Wegener (1997), in Europe there is less reliance on technological solutions to mitigate environmental impacts of motorized mobility, but more willingness to discuss fundamental alternatives to motorized transport by car restraint measures, substitute transport modes or less mobility-inducing land use patterns. In North America, the emphasis is on technological approaches, whereas because of the dependence of the spatial organization of American society on car and air travel, supply and demand management have only recently been given more attention. A discussion of some of the factors affecting the provision of sustainable transport systems in the developing world is presented in Faiz, 2000.

The main objectives of this paper can be stated as follows:
1. To present components and interactions of the transport and traffic systems
2. To identify generic traffic problems and classify their main causes
3. To develop a comprehensive classification of policies and measures that can be used in designing environmentally sustainable transport strategies.
4. To identify a set of criteria to be used as a basis for the prioritization and choice of such policies and apply such criteria in the assessment of supply versus demand-based policies.

2. TRANSPORT AND TRAFFIC SYSTEMS: COMPONENTS AND INTERACTIONS

Typical of many market oriented systems, the transport system is composed of demand and supply components interacting together to provide mobility and accessibility to travelers and goods. As shown in figure 1, the demand for travel is a derived demand resulting from:
- Social and economic development
- Demographic (population) changes
- Land use type, patterns and growth
- Vehicle and particularly private cars ownership
- Level of utilization of private cars

The world's population is continuously rising with a greater proportion living in towns and cities. Economic and social developments are influencing people to own more cars and travel more. Economic growth also results in more goods being transported and hence an increase in freight traffic. A discussion of some of these factors, in a general context, is presented in Laconte (1995) and Bayliss (1995). In order to meet the demand for travel, transport infrastructure is constructed and transport facilities are provided. As shown in figure 1, travel demand is being met by a supply of transport services in terms of modes providing mobility to travelers and goods as well as networks providing accessibility to these available modes. Transport services are provided and traffic flows are generated as a result of the interaction of travel demand with the transport supply.

In many parts of the world, and particularly in urban areas, travel demand is growing at very fast rates. On the other hand, the provision of transport modes and networks is constrained by limited funding and inefficiencies in planning, design, construction (purchase), operation maintenance and management. This growing demand accompanied by inadequacies of transport supply leads to several mobility (service) and accessibility (traffic) related problems.

A schematic representation of the main components and interactions of the traffic system is shown in figure 2. The figure shows the traffic system to be composed of the following:

- A network of roads, described in terms of length, capacity, condition and intensity.
- Road supporting facilities (sometimes referred to as road furniture), that include signs and markings, lighting poles, channelisation islands, etc. These can be described in terms of number, location and condition.
- Traffic control devices such as traffic signals, regulatory signs and markings, etc. These can also be described in terms of number, location and condition.
- Transit, pedestrian and cycling facilities, described in terms of length, capacity, condition, and intensity.
- Different types of vehicles, described in terms of number, condition and technology.
- Drivers, Waiting passengers and pedestrians classified according to gender, age, condition, traffic experience and behavior.
- Traffic rules and regulations
- Traffic police, classified in terms of age, condition, traffic experience and behavior, as well as enforcement powers.

All of these elements, including the operation of traffic control devices and enforcement of traffic rules and regulation by the traffic police, interact together, and result in traffic and pedestrians' flows, passengers' movements at transit stops/stations, as well as the deleterious ***traffic problems.***

3. MAIN TRAFFIC PROBLEMS AND CAUSES

Traffic problems are an eventual outcome of the interaction of the different components of the traffic system. The most significant traffic problems can be identified as follows:

- Traffic queues at road links and intersections leading to traffic congestion and delays. This is portrayed in degradation in levels of services, where drivers and passengers feel discomfort, frustrated and stressed. This also leads to an increase in vehicle operating costs, energy consumption, exhaust emissions and noise pollution and possibly leading to accidents occurrence.
- Migration of congestion to local roads, i.e. traffic cutting through neighborhood roads.
- Occurrence of traffic incidences and conflicts at road links and intersections.
- Problems with access to and from development sites.
- Parking problems leading to queues, traffic congestion and delays.
- Traffic accidents, where these can either be accidents involving fatalities, serious injuries, slight injuries or damage only accidents.
- Environmental effects including air and noise pollution as well as visual intrusion
- Difficulties in pedestrian mobility, whether while walking on sidewalks or during crossing roads
- Pedestrians' traffic accidents
- Traffic problems affecting public transport modes in terms of queues leading to congestion and delays.
- Traffic problems affecting freight transport modes, the most significant of which include:
  - Freight industry unable to service its markets efficiently
  - Just in time delivery schedules becoming difficult to maintain and higher stock levels must be maintained
  - Fuel is wasted, engine life is shortened and vehicle maintenance costs are increased
- Other traffic related problems include:
  - Impaired community access, where people are unable to guarantee arriving at work or home on time and journeys becoming increasingly unreliable
  - Emergency services are impeded where police, fire and ambulance vehicles are unable to function in an efficient manner
  - Economic growth is hindered and quality of life being eroded

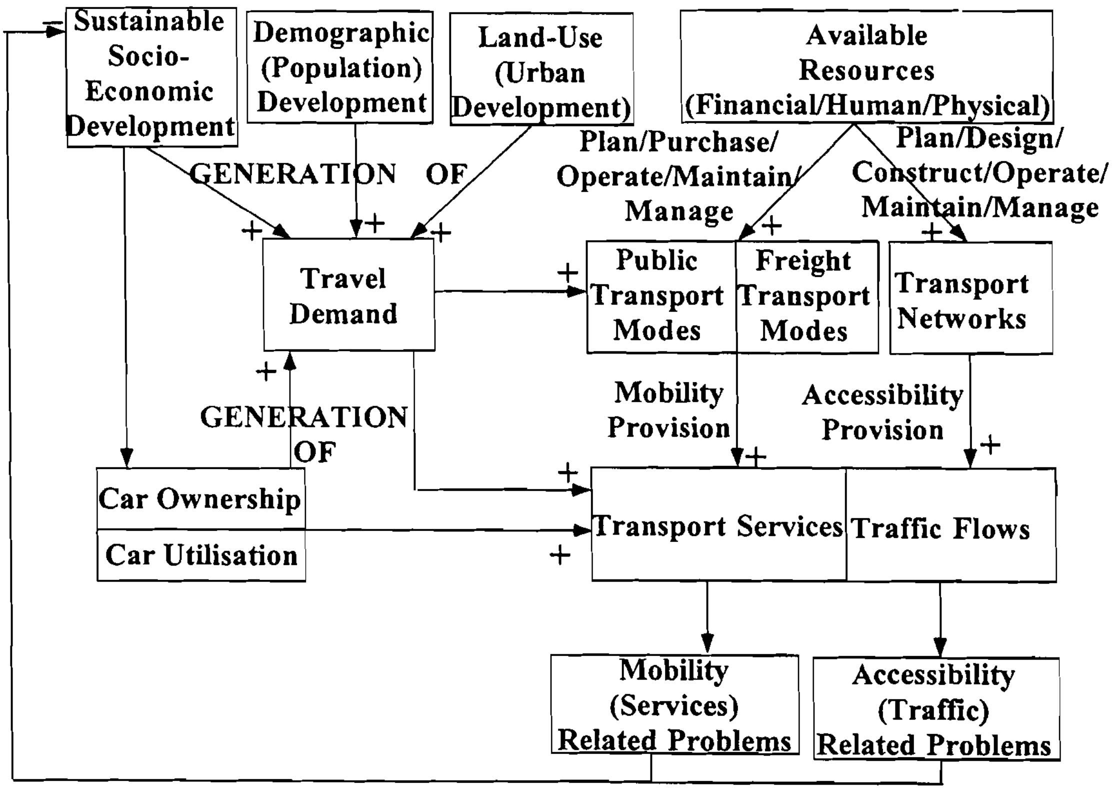

Figure 1: The Transport System: Components and Interactions

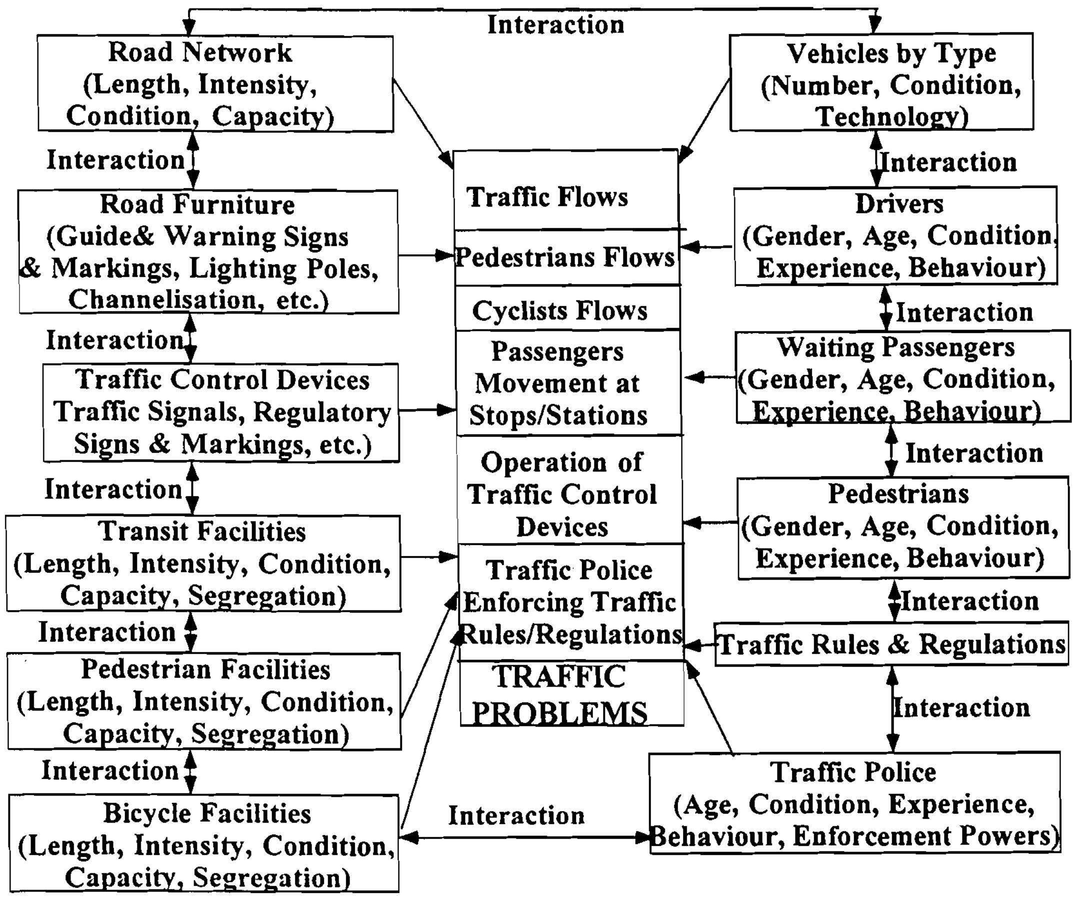

Figure 2: The Traffic System: Components and Interactions

3.1. Main Causes of Traffic Problems

The main causes of traffic problems can be classified into two main broad categories. The first is demand related i.e. causing an increase in demand or creating an unorganized demand. The second is supply related i.e. due to inadequate capacities or inadequate planning, design construction, operation and maintenance.

Demand related causes of traffic problems

- Population increase
- Socio-economic development
- Increase in vehicle ownership
- Increase in utilization of private cars
- Decrease in utilization of public and non-motorized transport modes
- Increase in solo driving
- Increase in average trip length
- Increase in road freight traffic
- Lack of adequate land use and urban development planning
- Deficiency in behavior of road users, particularly in developing countries. Examples include illegal and double-parking, poor driving discipline, disrespect to traffic signals, disrespect to other road users, etc.
- Heterogeneous traffic mixes with respect to speed. This phenomenon is typical of many cities in developing countries.
- Deficiency in demand forecasting methods, mostly leading to under-forecasting. In many developing countries, future demand is not even being forecasted.

Supply related causes of traffic problems

Many of the following supply related causes are more specific to developing countries. These include:

- Inadequate road network capacity
- Lack of efficient planning, design, construction, operation and maintenance of roads and intersections.
- Inefficient planning, design, installation, operation and maintenance of traffic control devices and supporting facilities
- Lack of efficient planning, design, implementation, operation and maintenance of transit, pedestrian, and cycling facilities
- Lack of efficient planning, design, implementation, operation and maintenance of parking areas and access points to development areas
- Procedures for incidents (including accidents) detection and management are almost not existent.
- Deficiency in traffic rules and regulations and their enforcement.
- Lack of tight vehicle inspection and licensing procedures
- Lack of environmental management procedures including accident management

4. TDM AND LUM: BASIS FOR DESIGNING ENVIRONMENTALLY SUSTAINABLE TRANSPORT STRATEGIES

In this paper, Travel Demand and Land Use Management are considered as two of the basic pillars for designing environmentally sustainable transport strategies. Such strategies are targeted towards minimizing the generic traffic problems encountered in metropolitan cities i.e. traffic congestion, accidents, environmental degradation and waste of energy.

The traditional approach for tackling traffic problems has been, for years, to add more capacity to the network supply system through widening existing roads and constructing new ones, thus allowing for better traffic conditions. However, this proved to have several limitations, in terms of absorbing an enormous amount of scarce financial and land resources, and possibly increasing the environmental and safety hazards. Above all, this approach has frequently been reported to ultimately cause the generation of new and suppressed traffic, see ECMT, (1998). In the UK, the SACTRA report concluded that traffic levels are influenced by the provision of road capacity, where increasing capacity will induce some traffic see SACTRA, (1994). On the other hand, Cairns et al, (1998) report that removing capacity will suppress some road traffic. In many countries, where resources are becoming limited, the tendency has been to adopt policies and measures that enable the utilization of the road network in the most efficient and optimum manner. Such approach is known as Traffic Management and Control. Both of the above approaches can be grouped under the heading supply-based strategies, see figure 3.

In recent years, a significant change in thinking had emerged. This advocates demand-based strategies, see figure 3, whereby policies and measures that affect the pattern of the demand for people to travel are selected and implemented. Such measures are known as Travel Demand Management (TDM). TDM can be defined as a set of programs/packages integrating a combination of policies, measures and actions with the objective of maximizing the people and freight moving capability of the transportation system. The primary purpose of TDM is to reduce the impact of travel on the transport system by improving the efficiency of demand for travel. This can be done by first making alternative high occupancy and non-motorized modes available. This should be accompanied by applying incentive, disincentive and other measures that are meant to modify car users' behavior towards increasing car usage efficiency, shifting to other high occupancy and non-motorized transport modes, spreading the demand over time and space and reducing the amount and need for car travel.

Incentive measures are mainly concerned with encouraging riders to share their motor vehicles, and making available and attractive a wide variety of high occupancy and non-motorized mobility options for those who wish to travel. These are meant to maximize travelers' moving capability of using the transportation system. Disincentive measures, using physical, regulatory and pricing restraints, are meant to discourage users of Single Occupancy Vehicles (SOV) and possibly induce them to shift to other Heavy Occupancy Vehicles (HOV) modes. Other measures include temporal and spatial peak spreading measures as well as trip reduction measures. All in all, this is expected to ultimately reduce the number of vehicles and specifically SOV using the road system at any given location and point in time, see figure 4. Many TDM measures involve some sort of behavior change to commuters. Such TDM measures should be supported by sound marketing strategies, and tools see Everett and Ozanne, (1993) and Hartgen and Casey, (1990). Adapted from Jones, (1999), the following presents a list of generic objectives that TDM programs aim to achieve.

1. Increase in average vehicle occupancies
2. Shift mode of travel from low occupancy modes (cars) to high occupancy modes (public transport systems including vans, buses, bus way transit, tram, light rail transit, suburban rail, metro) and non-motorized sustainable modes (walking and cycling), This is known as Modal Shift
3. Distribute trips to times with spare network capacity. This is known as Temporal Shift.
4. Distribute trips to places with spare network capacity. This is known as Spatial Shift.
5. Reduce the need to travel and hence number of trips

TDM measures are aimed at relieving traffic problems resulting from the transport system over the medium term. It is generally accepted that trip making patterns, volumes and model distributions are largely a function of the spatial distribution, type and intensity of use of land. Of greater complexity is the development of long-term environmentally sustainable strategies. The other significant demand based strategy, known as LUM focuses on the root of the traffic problems. Its primary purposes are to control the trip generating characteristics of land use and to promote land use patterns that support TDM. LUM measures are meant to redistribute, consolidate, and reduce the length and need for trips.

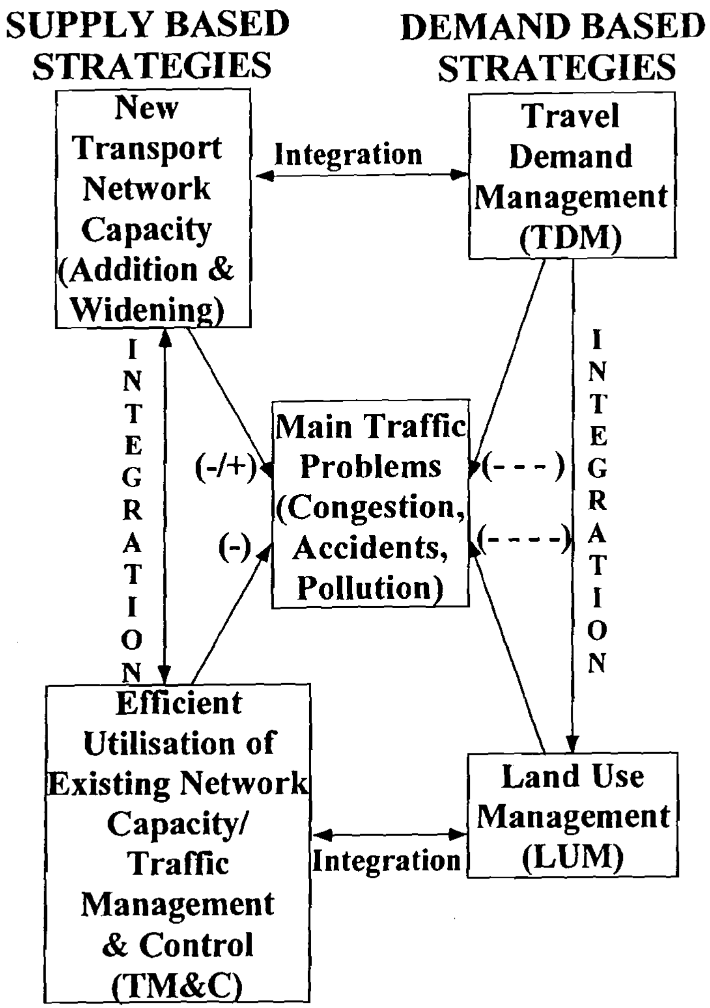

Figure 3: Supply and Demand Based Strategies for Relieving Traffic Problems

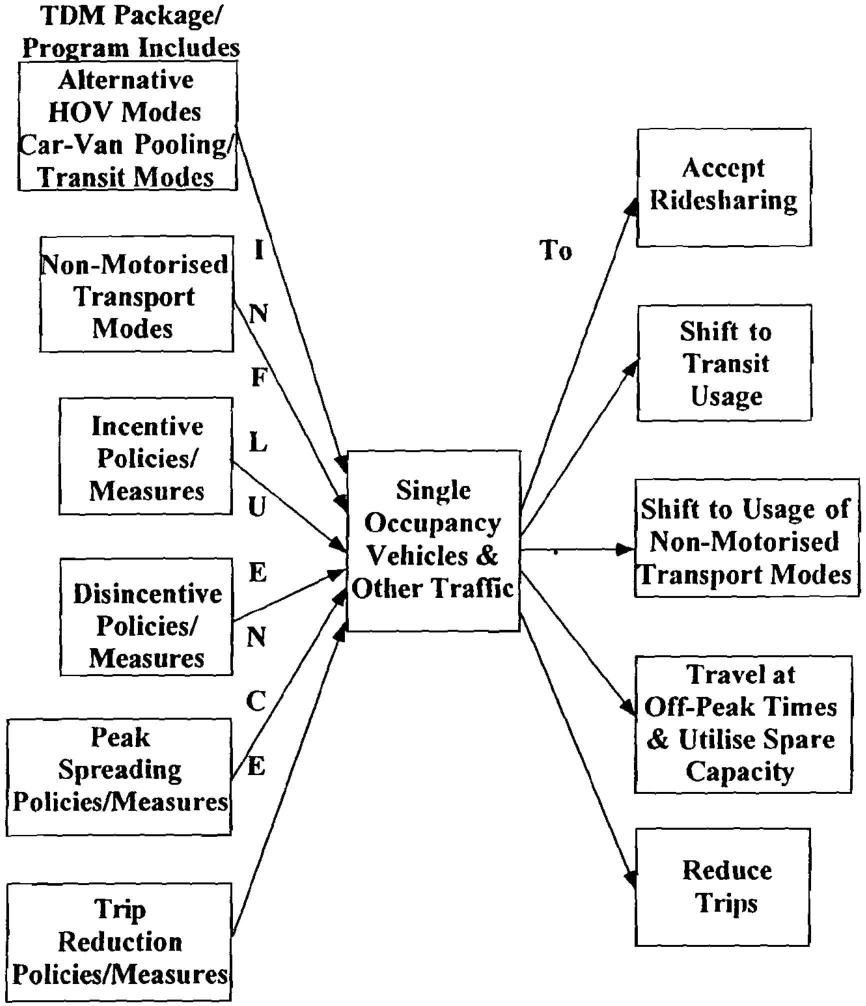

Figure 4: Main Components of a Travel Demand Management Program/Package

The main objectives of LUM can be summarized as follows:
1. Reduce need for travel by controlling trip generating characteristics
2. Reduce average trip lengths
3. Encourage trip consolidation such as trip chaining
4. Promote land use patterns that support transit usage
5. Promote land use patterns that support walking and cycling

In the following section a classification of TDM and LUM policies and measures is presented. This is meant to act as the basis for the design of an environmentally sustainable transport strategy.

5. CLASSIFICATION OF TDM AND LUM POLICIES AND MEASURES

A comprehensive classification of demand and supply-based policies and measures that can be used in designing environmentally sustainable transport strategies is presented in this section. The literature includes several classifications of congestion management policies and measures, see IHT, (1996), OECD, (1994) and ECMT, (1996) for a representation of the European classification, see AUSTROADS (1995) for a representation of the Australian classification and see USDOT, (1993), (1994), Berman and Radow, (1997), Meyer, (1999) for a representation of the American classification. The paper develops in tables 1 and 2 a classification and itemization of TDM and LUM policies and measures. TDM policies and measures are classified into 4 main categories and 8 subclasses as follows:

- Incentive policies and measures to encourage High Occupancy Vehicles (HOV), transit and non motorized modes, these are sub classified into:
  Policies and measures targeted towards increasing vehicles' occupancies.
  Policies and measures targeted to encourage the use of transit modes
  Policies and measures targeted to encourage the use of nonmotorised modes.
  Supporting preferential treatment policies and measures.

- Disincentive policies and measures to discourage Single Occupancy Vehicles (SOV) and Car trips, these include:
  Physical restraint measures
  Regulatory restraint measures
  Pricing restraint measures
  Other government related disincentives
- Peak spreading policies and measures
- Trip reduction policies and measures

As for LUM policies and measures, these are also classified into 4 main categories as follows:
- Land use and zoning policies to reduce need for travel, number of trips and average length of trips.
- Land use policies to promote transit usage
- Land use policies to promote usage of non motorized modes
- Other supporting policies

The paper also develops in table 3 a semantic comparative assessment of supply versus demand-based strategies. This assessment is based on the identification of 17 generic criteria. Such assessment is meant to assist in establishing the different impacts of the various approaches and hence in decisions on whether and when to use and implement such policies in designing an environmentally sustainable transport strategy.

Table 1: Classification and Itemisation of Travel Demand Management (TDM) Policies and Measures for Designing Environmentally Sustainable Transport Strategies

TRAVEL DEMAND MANAGEMENT (TDM) POLICIES AND MEASURES									
Incentive Policies & Measures to Encourage HOV, Transit & Non Motorised Modes				Disincentive Policies & Measures to Discourage SOV & Car Trips				Peak Spreading	Trip Reduction
Vehicle Occupancy Increase	Encourage Transit Modes	Encourage Nonmotorised Modes	Preferential Treatment	Physical Restraint	Regulatory Restraint	Pricing Restraint	Government Related		
-Car Pooling -Van Pooling -Rideshare Matching -Park & Ride Facilities -Rideshare Financial Incentives by Employees Including Transport Allowances, Subsidies, Leased Cars/Vans, Auto Service -Guarantee for Ride Home in Emergency	-Improved Services -New Services (Premium, Express, etc.) -Park & Ride Facilities -Transit Pass Programs -Integration of Transit Modes -Transit Financial Incentives by Employees Including Transport Allowances -Transit Shuttles -Mass Transit -Transit Subsidies	-Directness of Bicycle/Walk Routings -Safe Design of Crossing Facilities -Strict Enforcement -Enhane Bike & Walk Access to Transit Modes -Bicycle Shelters & Lockers -Bike Onboard Transit Modes -Bikers Changing Facilities -Incentives e.g Walk/Cycle Allowances, Subsidies, Leased Bicycles	-HOV Lanes -Bus Lanes -Bicycle Lanes -Bicycle Crossings -Pedestrian Areas/Roads -Pedestrian Sidewalks -Pedestrian Crossings -Traffic Signal Preemption for Buses -HOV Exclusive Parking -HOV Differential Parking Fees -HOV Differential Fares/Tolls	-Traffic Collars/ Throats -Traffic Cells/ Mazes -Traffic Calming Measures -Road Closures -Auto Restricted Zones -Parking Space Limits	-Entry Restriction by: Vehicle Types/ Licence Plate Numbers/ Time of Day/ Vehicle Occupants/ Journey Purpose -Parking Restriction by: Vehicle Types/ Time of Day -Restriction on Parking Duration	-Area Entry Fees -Congestion Pricing -Toll Roads -Parking Fees	-Increase Fuel Taxes -Increase Car Ownership/ Licensing Fees -Vehicle Licensing on Assuring Permanent Parking Space	-Differential Fares/Tolls -Differential Parking Fees -Staggered Working Hours -Flexible Working Hours -Pre-Trip Driver Information -Auto Guide System	-Tele-Working --Tele-Shopping -Tele-Banking -Tele-Conferencing -Compressed Working Weeks -Promotion of School Bus Transport for all School Children

Table 2: Classification and Itemisation of Land Use Management (LUM) Policies and Measures for Designing Environmentally Sustainable Transport Strategies

LAND USE MANAGEMENT POLICIES & MEASURES			
Land Use & Zoning Policies to Reduce Need for Travel, Number of Trips & Average Length of Trips	Land Use Policies To Promote Transit Usage	Land Use Policies To Promote Usage of Non-Motorised Modes	Other Supporting Policies
* Diverse Mix of Land Use Patterns * More Compact Sub-Urbans * A Balance of Housing, Jobs, and Services in Close Proximity * Work within Walking/Cycling Distance from Residents * Workers Being Able to Make Miday Trips (to restaurants/ banks/child care centres/ dry cleaners/drug stores/ post offices) on Foot, using Bicycle, or by Public Transit * Urban Limit Lines	* Friendly & Hospitable Site Design & Amenities that Promote Transit Usage * Work Sites Located to Provide Easy Access for Transit Users	* Friendly & Hospitable (Aesthetically Pleasing) Areas Characterised by Sidewalks/Street Lighting/ Signs/Landscaping/ * Safe Pedestrian activity & Absence of Vacant Lots * Integration of Diverse Mix of Land Use Functions Within Reasonable Distances of One Another * Sufficient Setbacks in Buildings and Location of Accesses Taking Consideration of Cyclists & Pedestrians * Work Sites Located to Provide Easy Access for Pedestrians and Bicyclists	* Conditional Approvals for Site Development Requiring On-Site Traffic Mitigation Programs * Developers to Provide Sufficient Parking Spaces at their Development Sites

Table 3: Comparative Assessment of Supply Versus Demand Based Strategies for Relieving Traffic Problems

Transport/Travel/Traffic Management Strategies	Supply Based		Demand Based	
Comparison Criteria	Addition of Road Capacity	Traffic Management & Control	Land Use Management	Travel Demand Management
1. Implementation Cost	High	Low/Medium	Medium	Low/Medium
2. Implementation Time	Long	Short/Medium	Long	Short/Medium
3. Immediate Effects on Relieving Congestion	High	Medium	Low	Low
4. Long Term Effects on Relieving Congestion	Medium	Low	High	High
5. Sustainability of Relieving Congestion	Medium	Short	Long	Long
6. Effect on Delay	Reduce/Increase	Reduce	Minimize	Minimize
7. Effect on Traffic Accidents	Reduce/Increase	Reduce	Minimize	Minimize
8. Effect on Exhaust Emissions	Reduce/Increase	Reduce	Minimize	Minimize
9. Effect on Noise Pollution	Reduce/Increase	Reduce	Minimize	Minimize
10. Effect on Energy Consumption	Reduce/Increase	Reduce	Minimize	Minimize
11. Effect on Land Take	High	No	Efficient	Medium
12. Maintenance Costs	High	Medium		Low/Medium
13. Ease of Maintenance	Difficult	Medium		Easy
14. Political Desirability	High	Medium	Low	Low
15. Acceptability by Car users	High	Medium	Low	Low
16. Acceptability by Public Transport Users	Low	Medium	High	High
17. Acceptability by Pedestrians/Cyclists	Low	Medium	High	High

6. CONCLUSION

In addition to the desirable outcomes of the transport system in terms of mobility and accessibility, traffic congestion and other negative outcomes also result of this complex system. This paper developed a classification of policies and measures that can be used for designing environmentally sustainable transport strategies. Such a strategy is one, which attempts to achieve the necessary levels of mobility and accessibility, while taking into consideration the relief of traffic-related problems. It is recognized that the intensity of traffic problems could be minimized if the criterion of mobility was targeted to the movement of people rather than being oriented to the movement of vehicles.

The paper developed a semantic comparative assessment of supply versus demand-based strategies. This assessment was based on the identification of 17 generic criteria. Such assessment is meant to assist in establishing the different impacts of the various approaches and hence assisting decision makers in prioritizing and choice on whether and when to use and implement such policies in designing an environmentally sustainable transport strategy. In the course of achieving the above core objectives of this paper, components and interactions of the transport and traffic systems were explored. Generic traffic problems and their causes were also identified and classified.

This paper advocates the development of an environmentally sustainable transport strategy composed of ingredients of TDM and LUM policies, measures and actions. Such strategy should be directed towards:

- increasing vehicle occupancy through ridesharing
- encouraging shift to transit modes
- encouraging shift to non-motorized transport modes
- exercising preferential treatment for ridesharing, transit and non-motorized transport
- discouraging traffic in general and SOV in particular
- shifting trips to times and places with spare network capacity
- reducing need to travel
- reducing average trip lengths
- adopting LUM conducive to usage of transit modes
- adopting LUM conducive to usage of non-motorized transport modes

Such strategy cannot be a random combination of TDM and LUM tools. Which measures are selected will depend on the type and intensity of the traffic problems at hand as well as on the environment in which these will be implemented. In this context, it is crucial to realize the importance of conducting transport planning within the general framework of sustainable development. A truly effective environmentally sustainable transport system is one that provides efficient alternatives to the traveler and then reinforces the travel decision by implementing incentives and disincentives that are clearly perceived by the individual making the decision to travel. It has to be noted that TDM approaches are medium term solutions to traffic problems. The long-term solution to traffic problems lies in making land use changes, which also is the hardest to implement. Structuring communities so that people live closer to their jobs and they do not need to rely heavily on their cars for other activities is the surest way to attain an environmentally sustainable transport system.

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