A Contribution to Urban Transport System Analyses and Planning in Developing Countries

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1. Introduction

The purpose of this chapter is to provide a contemporary statement of existing approaches to transport-land use planning in urban and regional areas to advise practising transport planners and students. The chapter concentrates on the knowledge that are available for the synthesis, analysis, and evaluation of alternative land use-transport-systems plans and regulations. First, the transportation planner must develop an understanding of the planning process before attempting to address herself to the broader polices issues. The first objective of this chapter is to provide transportation planners with an understanding of the land-use models and their application to urban and regional planning problems. The final objective covers policy, regulations and plans.

Absence of physical space between people and firms is the definition of Economists to cities. Cities appear to supply the necessity to eliminate transport costs. Density lowers the costs of interacting with other people and speeds the flow of goods, people and ideas. The location and structure of cities is driven by the desire to eliminate transport costs. In this context, transportation technologies have been the primary determinant of the location and structure of cities. There is increasing concern across the world about increasing traffic congestion and the costs it imposes, particularly on accessibility, the environment, other social factors, such as accidents, and the economy in general. Growing personal car-mileage is engendering the well-known effects on the environment and transport systems, especially roads, which are not able to cope with the increasing amounts of traffic. Further development of innovative, integrated and well-balanced policies is strongly needed. Strong and ongoing growth in mobility, especially in road traffic, means that transport trends are unsustainable if only current policies are pursued: with constraints on resources, space, safety and the environment there are only limited possibilities to extend transport supply to safeguard accessibility. It is quite clear that the need for travel cannot really be avoided; it is crucial for the performance of social and economic functions in any society. People are not travelling much more often than twenty years ago, but they are travelling further and with greater use of the private car. Increasing car ownership is a central component of this (Transland, 2000). There is a lack of knowledge about the interaction between land use and transport and the related planning consequences. Institutional demands for integrated policymaking is another problem. In this context, we approach in the following sections a systematic view of a transportation system planning and analysis, and its relations with land use polices, indicating the natural evolution of the cities, it's intrinsic relations with transports and the needs to intervention and control by regulations polices.

2. Phases of Urban Development

The phases of urban development has a link with the economic development of transportation. They are: (a) Initial capitalism phase; (b) Industrial development; and (c) Big traffic problem on the cities.

There is an hypothesis that the city is a spatial expression of certain economic structure and productions relations as follows: (a) Feudalism - It had only one administrative centre of the autarchic production that also acted as producing centre of small services. Space reduced with commutes in the majority by foot; (b) Mercantilism - The city starts to be a centre of commercial interchange and a centre administrator of commercial interchanges. One becomes producing centre of manufactures and services. The centre expands and foot did the commutes (distances about 5km.); and (c) Industrial Capitalism - The city becomes centre of industrial production. It has an intensification of the social division of the work producing concentration of workmanship hand and demographic growth. The city is centre of the public, private administration, of finances and advertising.

There are Advantages of agglomerations with direct communication with other producers and central offices agencies of public and private sectors: suppliers, administrative facilities, banks, competition partnership, infrastructure of services like telecommunications, light, force, post offices. Accessibility to market and workers: attraction for the diversity of services, transportation facilities. We can nominate the spatial effects of industrial capitalism as follows: (a) Big Urban Expansion; (b) Land use and occupation with variables urban functions; and (c) Development of bulk transportation to supply, manufactures, etc.

Cities in the new world have traditionally been transportation hubs. When colonisation began, the function of cities tended to be facilitating the flow of the wealth of the new world to the markets of the old world. As such, cities located either close to the sources of wealth or in natural transport hubs. Thus, Lima located near the mineral wealth of Peru. Salvador da Bahia, Rio de Janeiro and Buenos Aires were all ports. The major cities of the U.S.—New York, Boston, San Francisco and New Orleans—were all located in places where rivers meet the sea to take maximum advantage of water born transit. Even more generally, the world was dotted with smaller cities that serviced an agricultural hinterland. Because transportation costs were high, it made sense to have commercial and manufacturing centres that were physically close to the vast majority of people who worked the land. Medium sized cities dotted the landscape because they needed to be close to the farmers.

Gradually, rail networks created a reduction in transport costs and made the locations of cities more flexible. Late 19th century cities like Chicago and São Paulo grew as railroad hubs. Rail also made it possible to have fewer, bigger cities that were further from the farmland. The mechanisation of agriculture also meant that fewer people were required to work the farms, so there was less need to medium sized cities that were close to farmland.

The 20th century has seen this process continues. Trucks and improvements in rail have further reduced transport costs. The advantage of water-born transport, particularly for intra-national transport, has further disappeared. The result of this transformation can be

seen throughout the world. In the 19th century, urban areas did well if they had advantages that favoured producers. In the 21st century, urban areas will do well if they attract potential consumers. This shift has already created a massive dislocation within the USA as the colder cities of the rustbelt have been replaced by the newer edge cities of the sunbelt.
As such, national transportation infrastructure will tend to be extremely important for the changing urban landscape. Continuing improvements in transportation will certainly continue to change the growth of cities. However, as important as this process is, it does not necessitate a new, government approach to transportation policy. As long as the government continues to develop highways that are hopefully paid for by their users this process of urban change will continue, probably in a reasonably efficient manner.

2.1 Phase 1 - Initial Phase of Capitalism

Phase characterised by little industrial development, little unity of production and low demographic density. Spatially we have: (a) Production centralised in a old historic centre inner circle; (b) Disposition workmanship near productions centres; (c) Industrial location as a function of territorial supply of production factors like transportation facilities; and (d) Public and private administration and financial centre in the city centre (Fig. 1).

2.2 Phase 2 - Big Industrial Development

From the third part of century XIX, in the European cities a bigger development of the industrial production with new characteristics was observed: (a) Bigger social division of the work; (b) Concentration of the production; (c) Bigger units manufacturer; (d) Bigger concentration of workmanship and demand for mass transport; (e) Economies of scale and agglomeration; (f) Bigger volume of production and transport; (g) Expansion of the tertiary sector (wholesale trading, banks, private and public administration), necessitating of contacts right-handers and consequent agglomeration in the centre of the city; (h) Social stratification and space segregation; and (i) Development of mass transportation networks (trams with animal traction, urban railroad network, electric tram)(Fig. 2).

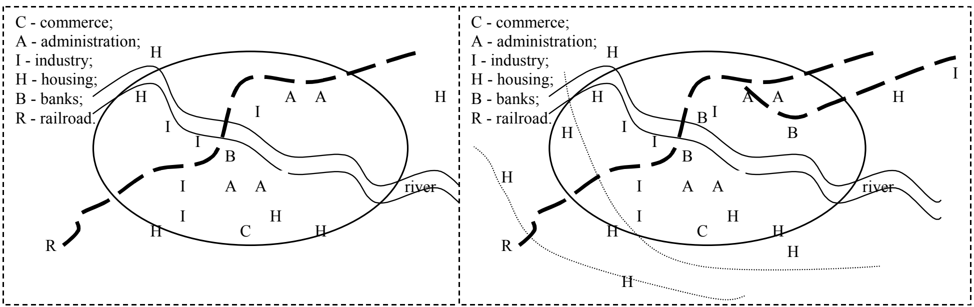

Fig. 1 and 2. Initial phase of capitalism, and big industrial development

2.3 Phase 3 - Surface Transport Development

With the growth of automobile industry, mainly after the end of 1st. World War, a new age of urban occupation appears, conditioned by the development of roadway modality, with growth of automobile consumption and, after a 2nd. World War, a growth in the buses consumption. As a consequence we have: (a) Occupation of the spaces between the transport axles; (b) Growth of the urban periphery; (c) Expansion of the road net and the demand for parking; (d) Ideal of the "motorised city" and the "proper car"; and (e) Intensification of the functional separation of land use implying in: bigger concentration of the tertiary sector in the centre, expansion of the economic functions of the tertiary, increment of the economic concentration, requirement of qualified workmanship, and demand for radial flows of transport (Fig. 3).

2.4 Phase 4 - Big Traffic Problems on the Cities

After a phase of full development of the individual transport, from middle of years 50, the cities of the first world had evidenced that: "The individual transport acted as narcotic of the functioning of the urban economic system". As a consequence we can see: (a) Growing problems of congestion and security; (b) Reduction of accessibility to the city centre; (c) Lost times in transit; (d) Demand access restriction to markets and for workers mainly to central areas; (e) Changes in land use with growing demand for urban network what cause a concurrency with tertiary sector; and (f) Hanging of central areas (Fig. 4).

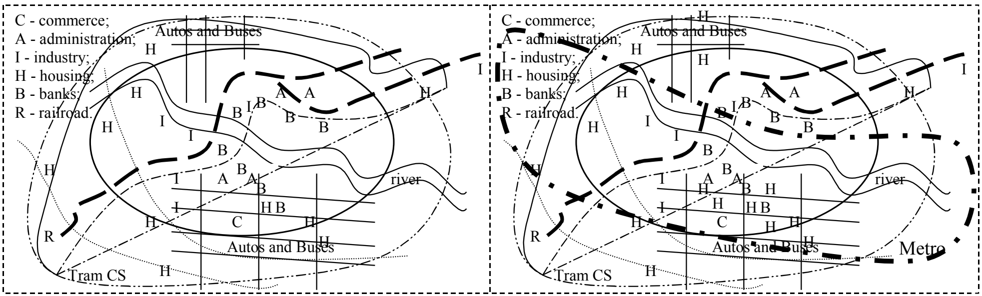

Fig. 3 and 4. Surface transport development, and big traffic problems on the cities

From this conclusions the trends was consider mass transportation as a necessity to achieve development of urban economic system. This kind of transport allows: (a) Growth of accessibility to consumption centres; (b) Growth of accessibility to workersmanships; (c) Facility to flow of goods; (d) Turn bigger the influence area of city centres; and (e) Add new regions to urban system – conurbation.

The mass transportation systems like subways (Metro) and urban surface train – tram, have a new mission and several big cities retrieve big constructions of this kind of systems.

3. Urban Centralisation and Transports

Analysing the dynamics that defines a differentiated occupation of the tertiary sector of the economy in the urban context and its consequences for the transports we can see the importance of this relations.

3.1 The Tertiary Sector of the Economy

Characterised by the service sector, provides services to general population, including: (a) Public administration and services; (b) Private administration and services; (c) Financial sector; (d) Business sector in wholesale and retail; (e) Fun and entertainment (movies, television, radio, music, theatre, etc.); (h) Health; and (i) others services.

In most developed and developing countries, a growing proportion of workers are devoted to the tertiary sector. In the U.S., tertiary workers compose more than 80% of the labour force. The Law of Land Use of a city regulates where the urban activities can take place inner the city. When allow or nor certain activities in certain quarters, the law tries to give to the city a desired occupation. If the law does not impose restrictions to the busy area for the tertiary Sector and, it does not charge regulatory taxes for the land transference and building, the free market goes to function. In these conditions the income-producing activities, as of the tertiary one they go if imposing on less income-producing, or not income-producing as the housing. Gradual the not economic activities are banished from certain centres giving place to the sector of services. This sector needs centrality and also: (a) Agglomeration advantages; (b) Economic growths; and (c) Land Use Regulation.

3.2 Concurrency Between Secondary and Tertiary Sector

The tertiary sector is more dependent of central location, while the industrial sector is more ground dependent for the mechanised production. The industrial sector can be regional, national or international, in contrast of the retailing that is local. The conclusion is that the secondary sector searches the periphery, leaving free space in the centre for the tertiary sector, whereas the elementary school is basically agricultural. In the competition for the spaces, to if more valuing the ground for the increase of the demand in the points central offices, paid the activity of bigger return, in the case the tertiary one. In such a way the housing, leisure and small commerce go being banished of the urban centres. A social problem appear when the less gains, more far and expensive is do activities of work, leisure, etc. In case that it has not measured of control of the public power this comes to be a strong incentive to the in slums process (*favelização*).

4. Spatial Dynamic of Land Use and Transportation

The better way to understand and evaluate a transportation system is to know the spatial dynamic of land use and transportation (Fig. 5).

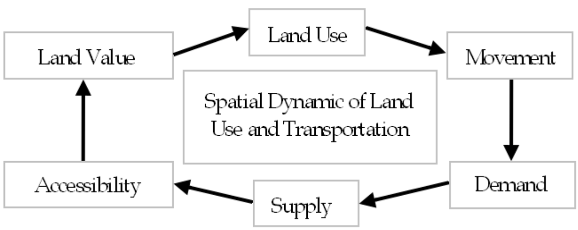

Fig. 5. Spatial dynamic of land use and transportation

The components can be described as: (a) Land Use - is understanding as a joint of activities realised, to live and work, fulfilling the necessities of food, live, generate exceeding to trade and then achieve the grade of auto-sustain. This role of activities can be classified in one or more of three sectors of the economies that will establish the dynamic of occupation and space utilisation. Each activity that takes place in an urban or rural space does demand movement that are derivatives of travel necessities to do business, work and play; (b) Movement - the movements that occur in one space are derivatives of an interrelationship

between the role of complementary activities classified in: housing, work, business or a combination between them, involving bulk or passenger; (c) Transportation demand - the social economic activities get movement's necessity, which generates a demand for transportation systems until the desirable service could be reached; (d) Transportation Supply - can be viewed as a response of a physical or political environment to demand attempting and is related to initial conditions of regional supply of this facilities like rivers, sees, geography and whether, or some interventions that must be taking place by the man to provide the integration between regions and complementarities or trades; (e) Accessibility - the supply of transportation systems generate facilities to feasible in one greater scale the intensity and diversity of land use, supplying not only the initial potential but creating news opportunities of use, differing some times absolutely of which that generates them; and (f) Land Value - increasing accessibility costs trade-offs decreasing transportation costs and increasing land value, changing the role of activities and creating new land use.
This new activities will taking gradually the spaces of older that will take place in another space or disappear of this region, turning goods or services incoming from another regions, establishing a new pattern of interrelationship between regions. This characterises the spatial dynamic of land use and transportation.
In Fig. 6 we see that this cycle of activities does not end. The changes in land use will create new patterns of movements that will demand new transportation systems, changing the land value, and so on.

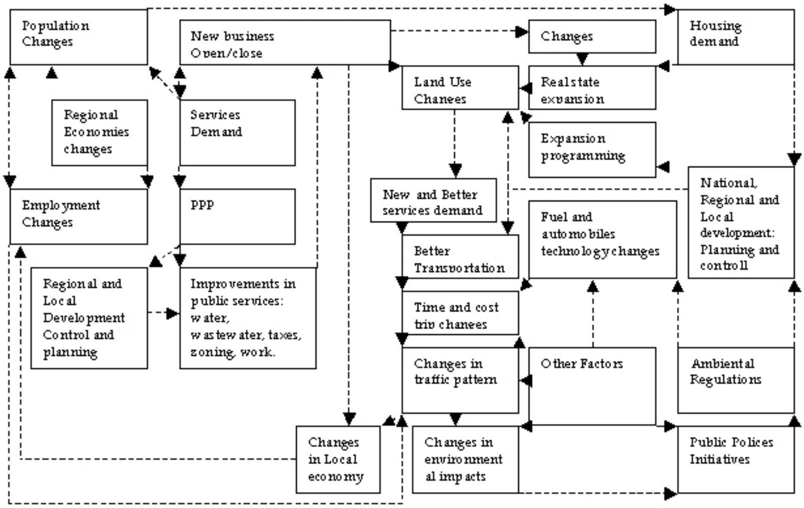

Fig. 6. Local and regional dynamic originated from relationships between transportation and land use

5. Theory of Land-Use Transport Interaction

Theories on the two-way interaction between urban land use and transport address the location and mobility responses of private actors (households, firms and travellers) to changes in the urban land use and transport system at the urban-regional level. That urban land use and transport are closely inter-linked is common wisdom among planners and the public. That the spatial separation of human activities creates the need for travel and goods transport is the underlying principle of transport analysis and forecasting. Following this principle, it is easily understood that the sub urbanisation of cities is connected with increasing spatial division of labour, and hence with ever increasing mobility. However, the reverse impact from transport to land use is less well known. There is some vague understanding that the evolution from the dense urban fabric of medieval cities, where almost all daily mobility was on foot, to the vast expansion of modern metropolitan areas with their massive volumes of regional traffic would not have been possible without the development of first the railway and later the private automobile, which has made every corner of the metropolitan area almost equally suitable as a place to live or work. However, exactly how the development of the transport system influences the location decisions of landlords, investors, firms and households is not clearly understood even by many urban planners. The recognition that trip and location decisions co-determine each other and that therefore transport and land-use planning needed to be co-ordinated led to the notion of the "land-use transport feedback cycle" (Fig. 7).

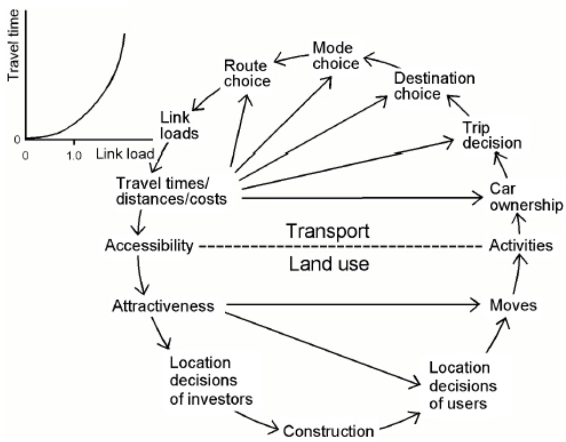

Fig. 7. The "Land-use transport feedback cycle" (Transland, 2000)

The major theoretical approaches to explain this two-way interaction of land use and transport in metropolitan areas include technical theories (urban mobility systems), economic theories (cities as markets) and social theories (society and urban space). A variety of 'ideal' land-use transport systems as optimal solutions to urban land-use and transportation problems have been formulated since the late 19th century. These systems vary with regard to spatial structure, residential density, distribution of land uses and predominant transport mode. Attempts to determine the 'ideal' land-use transport system in contemporary cities have yielded different results. While it has almost become common wisdom that systems involving dispersed development are much less favourable with regard to average trip length, energy consumption, greenhouse gas emissions and land take, there is no unequivocal evidence for the advantages of either compact-city or decentralised-concentration policies. The results of empirical studies of land-use transport interaction conclude that residential density has been shown to be inversely related to trip length (Transland, 2000).

Centralisation of employment results in longer trips, while trip lengths are shorter in areas with a balanced residents-to-workers ratio. American studies confirm that attractive neighbourhood facilities also contribute to shorter average trip lengths. The theoretical insight that distance of residential locations to employment centres is an important determinant of average trip length has been confirmed empirically. The larger a city is, the shorter are mean travel distances, with the exception of some of the largest metropolises. None of the studies reported a significant impact of any factor on trip frequency. Residential and employment density as well as large agglomeration size and rapid access to public-transport stops of a location were found to be positively correlated with the modal share of public transport. 'Traditional' neighbourhoods showed a higher share of non-car modes. Accessibility was reported to be of varying importance for different types of land uses. It is an essential location factor for retail, office and residential uses. Locations with high accessibility tend to be developed faster than other areas.

The value of accessibility to manufacturing industries varies considerably, depending mainly on the goods produced. In general, ubiquitous improvements in accessibility invoke a more dispersed spatial organisation of land uses. Regarding impacts of transport policies on transport patterns, causal relationships are relatively undisputed, and empirical studies largely agree on the impact mechanisms. While travel cost and travel time tend to have a negative impact on trip length, high accessibility of a location generates longer work and leisure trips. Studies on changes in trip frequency are only known for travel time improvements, where time savings were found to result in more trips being made. Mode choice depends on the relative attractiveness of a mode compared to all other modes. The fastest and cheapest mode is likely to have the highest modal share. However, offering public transport free of charge will not induce a significant mode switch of car drivers, rather of walkers and cyclists.

6. Review of Current Transport and Land Use Planning Issues

The review covered both technical, behavioural and institutional issues, i.e. impacts of local land-use policies on the behaviour of travellers and, vice versa, impacts of transport policies on the location behaviour of households and firms within urban regions ('What'), as well as issues of co-ordination of land use and transport policies in different national and regional institutional contexts ('How').

Urban land-use transport models incorporate the most essential processes of spatial development including land use and transport. A number of integrated land-use transport models are in use today. There are significant variations among the models as concerns overall structure, comprehensiveness, theoretical foundations, modelling techniques, dynamics, data requirements and model calibration.

The transport sub models used in current land-use transport models do not apply state-of-the-art activity-based modelling techniques but the traditional four-step travel demand model sequence (Ben-Akiva, 1974; Ben-Akiva & Lerman, 1985; and Ben-Akiva et al., 1996), which is inadequate for modelling behavioural responses to many currently applied travel demand management policies. It is a limitation.

In the future, the integration of environmental sub models for air quality, traffic noise, and land takes and biotopes are likely to play a prominent role. Issues of spatial equity and socio-economic distributions are expected to gain similar importance in model building.

Different policies affecting the location of workplaces including the construction of peripheral industrial estates and out-of-town shopping centres as well as an equal distribution of employment and population were investigated. It was found that decentralisation of facilities negatively affects the economy of the inner city while trip length and mode choice depend on the specific location and spatial configuration of population and facilities in the decentralised areas. When examining housing policies, neither the centralisation of population nor residential development in sub centres were found to have a significant impact on key transport indicators.

Land use planning policies have a major impact not only on spatial development but also on travel patterns. Development restrictions, e.g. a green belt around the city, can retard the sub urbanisation of population and workplaces thus strengthening the economy of the city centre. The construction of an outer ring road results in further decentralisation, relief of congestion and increasing travel distances. New public transport lines have little impact on location choice but tend to strengthen the inner-city economy. Introducing speed limits results in shorter trips and increased use of public transport. The effect of increased fuel taxes on the number and length of car trips is particularly strong. Significant fuel tax increases curb the further dispersal of residences and workplaces. Higher downtown parking fees generate negative economic effects in the centre and make out-of-town shopping centres more attractive. Public transport use free of charge reinforces a pattern of centralised employment and decentralised residential locations. Volume and length of car trips remain by and large unaffected by this measure. The ESTEEM study (1998) showed that the share of automotive travel in modal choice decreases with increasing size for cities above a threshold of 750,000 inhabitants. For cities below the threshold, a slightly positive relationship between city size and car use was found.

7. Transportation Planning

Urban and regional transportation planning process is very important because turn land use sustainable. The transportation planning process will generate a legislation allowing monitoring and control land use as it was planned. A sustainable development can be defined as the development that assures the satisfaction the needs of population, without jeopardising the capacity of the future generations to satisfy the own ones: (a) To assure that the standard of life (rent available) of all the inhabitants surpasses the survival threshold; (b) To assure a good quality of life to the population, as far as access to basic grants and rights (education, health, environmental quality, historical patrimony, house, etc.); (c) To assure the equality opportunities, the right to the own culture and the rest of fundamental rights of the person; and (d) To promote that the obtaining of a certain level of development for the present population does not imply to subordinate that the future inhabitants cannot accede to resemblance or better levels of development and, in particular, to assure that the natural and cultural patrimony is not reduced.

In order to grant sustainability in the development processes it is essential: Information, awareness, commitment and public participation in the fixation of objectives and activities, and in the co taking responsibility in the profit of those with the materialisation of the same. It interesting at this point present the differences between growth and development: (a) Growth - the concentration is over the quantitative increases of different social variables; and (b) Development - it implies the improvement of the "standard of life" and of the

"quality of life" of the people. Therefore, not only it incorporates aspects of quantitative nature, but essentially of qualitative nature.
There is a creation of sustainability when promoting the integration of transport and land use planning. Three main dimensions of comprehensive sustainability which cannot be seen in isolation are identified: Environment, Society and Economy. Economic efficiency is one part of the sustainable triangle (Fig. 8) and it will be influenced by integrated land use and transport patterns. The integrated approach of Transland mainly targets on creating spatial urban patterns as well as transport patterns which fit into these spatial structures in order to ensure the development of sustainability.

Fig. 8. Sustainable triangle (Transland, 2000)

The "Developing the citizens network" (1998) by the EU sets practical methods for making transport systems more sustainable and shifting away from excessive dependency on private car use: (a) Raising the quality and accessibility of public transport services; (b) Making walking and cycling more attractive; (c) Reducing the demand for travel, for example by reversing the trend of dispersing of functions to places which are hard to reach except by car; (d) Removing psychological barriers to the use of alternatives to cars and winning public support for policies to encourage more use of these alternatives; and (e) Making transport an essential component to strategies of spatial planning (Williams, 2005).
The integration of land use and transport planning can only provide a partial contribution to the implementation of sustainability, with impact on sustainable development within the areas of ecology, economy and society. An integrated planning approach develops structures in which ecological, social and economic sustainability can be promoted. Two basic strategic goals can be identified: (a) Land use goal - "fulfilling land use needs occupying fewer space in a better way"; (b) Transport goal - "fulfilling travel needs through environmentally friendly modes".
Sustainable mobility can be achieved considering the following chain of goals/actions: (a) Improve accessibility and the use of the space; (b) Increase the environment-friendly modes share (public transport, cycling, walking); (c) Reduce congestion; (d) Improve safety; (e) Reduce air pollution, noise, and visual nuisance; (f) Developing and maintaining a wealthy and healthy urban economy; and (g) Ensuring social equity and transport opportunities for all community sectors.
Diagnostics consists of a check-up, or evaluation of traffic and transportation existing systems including traffic generation hubs: housing, shopping centres, economic activities, etc. The planning starts with a data collection and a diagnosis of all existing transportation systems and zoning legislation. Planners will be able then to design the new pattern of land use according with the existing and future infrastructure.

8. Transportation Planning Process

A Systematic view of a transportation planning process can be explained in a simple steps as follows: (a) Determining the study area; (b) Establishing of desirable transportation and traffic conditions in the year project; (c) Determining existing studies and planning; (d) Check up of actual situation; (e) Determining actual flow pattern on the multimode transportation network; (f) Evaluation of network capacity and reserve to future projected demand flows; (g) Proposals of improvements and magnifying and implantation of transport subsystems; (h) Plan review; (i) Master plan; and (j) Indication of the financing sources. All areas of performance are described in the next section.

8.1 Transportation Planning - Areas of Performance

Urban Transportation Planning perform transportation systems conception as a hole, starting from a transportation demand forecasting and the development scenarios definitions of transportation systems. The transportation engineering performs a tools development to organise city traffic so that the planning process turn effective. The management and operation of public transportation systems perform procedures to grant the functionality of public transit systems and manager the system to achieve the desired goals and objectives reflected by operational performances of such systems. The transportation network modelling is commonly represented by graph theory and network theory for system modelling and analyses the flow distribution in a transportation network. Some examples of network analyses are: CTA Project (by Area Traffic Control - Transyt); and Transcad-GIS-GPS (http://www.apontador.com.br; Googlemaps).

8.2 Common Transit and Transportation Systems

Improvements in transportation have created a major change in the location of cities, but the connection between transport technologies and the internal structure of cities is at least as large. Traditional European towns were built for people who got around by using their feet. These cities were extremely dense. Generally homes and jobs could not be further apart than the distance that could be covered on foot. Markets also had to be small and local. The rise of public transportation permitted a change in urban form. Buses and subways still mean that people need to live in dense areas, but there can be much greater distance between home and work. After all, public transportation is a very time intensive technology. People don't want to get on a bus every time they have tea with a friend or go to the market. However, they will spend significant time periods getting to work. A typical bus or car city is a dispersed high-density city. The Brazilian *Favelas* are a perfect example of these phenomena. They are high-density areas that permit walking as a means of locomotion, but they are linked to employment by public transportation routes. Generally small buses—jitneys—permit these poorer Brazilians to get to their jobs.

American edge cities—suburbs with major employment centres—are cities designed exclusively around automobiles. These cities require not just one car in every garage, but several. Each mobile member of the household must have their own car to do anything. These cities are built at much lower densities. Driving three or four miles to the nearest grocery store is not, after all, a hardship. At their best, they offer lower density living with quick access to jobs and shops on relatively empty roads. While many academics find the suburban lifestyle sterile, there is no question that consumers who can afford it appear to greatly enjoy its many amenities. Within the U.S., the walking cities of the 19th century were gradually replaced by the public transportation cities of the early 20th century. By 1900, less than 7% of Americans used public transportation to get to work. Since 1950, America has seen a dramatic sub urbanisation of first people and then jobs. The typical job is now far from the city centre and the typical person lives even further out. As result, Americans consume unbelievably large amounts of housing relative to almost any other country.

Why don't more people in the U.S. use public transportation? Public transportation, despite its widespread availability in many cities, is used only by the poorest Americans outside of a few large cities. The reason for this is that public transportation is an extremely expensive technology for the average user—when cost is measured properly, including the opportunity cost of time. Commuting times for public transport users are much higher than commuting times for drivers. This time cost comes primarily from the fixed time cost of public transportation—this is the cost of getting to the pickup spot, waiting for the bus or train, and getting from the drop-off spot to the final destination.

Few other countries have fully followed the American example, although Canada and Australia probably come closest. European countries have massively taxed gasoline and massively subsidised public transportation. The impact of this has been to stop European cities from evolving towards car-oriented places. Latin American cities have not fully followed the U.S. model because automobiles remain too expensive for the vast majority of citizens. Will Brazil move towards the American edge city model? It seems likely that Brazil will continue to get richer. If this process continues then it seems almost inevitable that car ownership will rise significantly and urban land use patterns will start to come closer to the U.S. model. There are two potential barriers to this transformation: increasing gas prices and government regulation. Some experts believe that increasing use of fossil fuels will push the price of gasoline up many times. The historical record suggests that high prices will tend to create striking technological responses. In the short run, higher prices will be offset by conservation technologies (more efficient car engines). In the long run, higher gas prices will be offset by alternative fuels with can also power cars (like ethanol in Brazil). The probable hypothesis is that cars will remain cost effective even as fossil fuels get used up. Government regulation is of greater concern, especially in the short run. European countries have created an entirely different urban landscape than the U.S. through their different gas taxes and public transport policy. Brazil can, in principle, follow this course and keep cities dense and focused on buses, surface light rail (tram and streetcar) and subways.

One possibility is put taxes on certain types of drivers but a biased government policy against cars and car cities is contrary to the principles of economics. While the government certainly has no obligation to subsidise the car, economics tells us that consumers are better judges of what makes them happy than governments. Even if some urban analysts dislike the world of suburbs, it seems like an outrageous piece of governmental restriction on freedom to try to deny consumers their ability to choose how to live and how to commute.

To planning the general network that will supply the necessities for desired and planned land uses pattern, for a determined region, the planners usually utilises a methodological well know tool called Four Step Method: (a) *Trip Generation* - provides the linkage between land use and travel patterns. Existing land use and travel are linked utilising techniques such as cross-classifications, trip rates or regression analysis. These relationships are then applied to estimate future travel based on the forecasted change in land use; (b) *Trip Distribution* - is the process of distributing the trips generated in each zone to all the possible destination zones available. As in trip generation, there are several types of models for accomplishing this: growth factor models, intervening-opportunity models, and gravity models. In the gravity model, the number of trips between two zones is directly proportional to the product of the number of trips produced in one zone and attracted in the other, and inversely proportional to the degree of separation between the two zones, represented as a function of travel times; (c) *Modal Split* - is the process of assigning person-trips to available modes of transportation. There are three major factors that need to be considered in this analysis: characteristics of the traveller, characteristics of the trip, and characteristics of the transportation systems. The types of techniques that have been used in the development of modal-split models include regression analysis, diversion curves, and cross-classification. A different modelling approach is also utilised that consider the probability that an individual will chose a particular alternative is a function of the characteristics of the individual and of the overall desirability of the chosen alternative relative to all other alternatives, and (d) *Traffic Assignment* - constitutes assigning the distributed volumes of trips, by mode, to individual network links. The basis for this assignment procedure is that the choice of rout is basically a decision to minimise total travel time through a transportation network. There are several techniques that can be used in the assignment procedure: minimum path, minimum path with capacity restraint, multiroute probabilistic assignment. All have this basis for this operation.

8.3 Desirable Transportation System Characteristics

Starting from the zoning plan is possible to determine all desirable characteristics to the news transportation systems that must be supplied in each stage of the development process as: (a) Road Hierarchy - road system must be designed in agreement with the road hierarchy, establishing curbs, grades and width in accordance of designed vehicle to each urban and rural area geometry (lane width, parking designs, bikeways, sidewalks cross walkers, structural, arterials, collectors and local streets). A transportation system must be put together with another systems and designed itself in a hierarchical way (Green Book, 2004); (b) Mobility/accessibility - this structure contrast mobility with accessibility and has inverse interrelationship. Local systems must be high accessibility and low mobility wit low speeds, collecting and distributing people and goods to arterials systems that must have low accessibility and high mobility. Street networks connecting the remain of the city by collectors and arterials, considering distances between them like: Arterials major – 6 km, Arterials minors – 2 km, Collectors – 1 km, and Locals – 100 to 200m. This systems must preserve the roads connectivity providing binaries systems always as possible; (c) Inter modality and terminals integration - the systems must be integrated itself, across common terminals or at least closets ones, to perform a high utilisation of each vocation and capacity; (d) Traffic Calming in local areas - the people must walk safe, comfortable, without noise; and (e) Grade separation evaluation in all collector-arterials intersections - the lost time must be minimised with the adequate design and continuous evaluation of grade separations in each intersection.

9. Transportation Demand Forecasting

Knew as allocation models: (a) Network modelling using graph theory; (b) Determine the shortest paths; (c) Network traffic loading; (d) All or Nothing allocation model; (e) Stochastic models; (f) Capacity constrained models; and (g) Network equilibrium models.

These models are very complex and utilise mathematics techniques to mitigate a system optimised traffic pattern in the entire network. The allocation process needs data like origin/destination by transportation modality. This flow separation by different modes is performed with use of modal split techniques. This kind of models consider characteristics of transportation modals and vehicles, and user characteristics like: trip motivation, income, age, sex, etc. Then is possible estimate how transportation flows split between modes. The results are then loaded into matrices origin/destination O-D. These matrices are estimated by trip distribution models utilisation.

This stage require data like number of trips living each zone an arriving in each zone, well like trip cost, measured by time, distance, etc., between each pair of centroids. Trip generation is defined as the estimation of a number of people living and entering a specific traffic zone by interval of the day and trip motivation. In order to build these models is necessary information about socio-economic level of population and what kind of activities these people realises. Is also necessary to get demographic data and to perform one analyses of distribution of peoples like where they live, work, play, buy, etc. Then, is necessary to perform a study of land use and, urban activities and determine how and where the urban equipment are located: schools, work, shopping, others.

Figure 9 shows the hierarchy of studies levels to approach transportation problems. So, considering local problems, the problem abroad is inner a greater system. When approach a local problem is important to see that this problem can be inserted in a bigger one and then, must be analysed in a major level of planning.

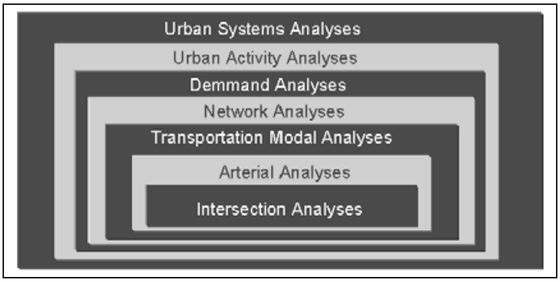

Fig. 9. Hierarchy of transportation planning system check-up

10. A Traffic Problem

The traffic problems must be approached, for example, as a problem that could be solved with local interventions, like: (a) Signalisation on street; (b) Light signals studies; (c) Traffic and pedestrian counting; (d) Phases definitions; and (e) Phases calculating (Fig 10).

The study can indicate physical changes like changes in sidewalk design or the necessity of grade separations intersections, separating flows at different levels. The problem analyses can indicate that local changes are ineffective to the problem solution and that is necessary an arterial intervention that can include: (a) Parking control at long of way; (b) Control access; (c) Speed limit control and green wave studies for transit; (d) Physical changes in arterial level; (e) Turn arterial cross section greater or smallest; (f) Duplication; and (g) Different levels intersections (Fig. 11).

Fig. 10 and 11. Node from an arterial, and arterial presented as a set of nodes and links

The problems can be greater in hierarchy like an intervention in arterial system couldn’t solve the problems by itself, being necessary to perform a network analyses. In this case the traffic pattern on network is studied, and the network interventions must be done.
The urban network analyses start by defining the study region that is then divides in traffic zones (Fig. 12). This is necessary because is impossible to approach a continuous region but divided in traffic zones to be able to apply the well know models. After zoning, a hub is attributed in each zone. The models consider that each traffic is generated/attracted in hubs. The data base must contain points of origin/destination of passenger cars and transit, network design, volume, capacity and link controls, bus lines and its stops, frequency and vehicle capacity, the model is applied to estimate the pattern of traffic flow over the network, between each origin/destination hubs. By the results the annalist must determine: (a) Street changes; (b) Changes in bus lines; (c) Exclusive and priority lanes; (d) Building of bridges, tunnel and other facilities; and (e) Metropolitan subway construction/expansion. Figure 13 shows the macro area to be analysed.

Fig. 12 and 13. Zone and original arterial, and macro area to be analysed

11. Transportation Demand Analyses in Urban Areas

In Transportation Planning is very important consider that: “The transportation is a mean activity utilised to achieve an end activity”. The trips are realised to enable the realisation of activities in a space separated equipment. The main question is to assure the realisations of activities. The transportation and urban systems must, in an integrated way, services to this goal. It can be achieved with an integrated urban planning that must include: (a) Land Use Planning; (b) The acts over urban activities; and (c) The acts over the transportation systems.
There is a natural market failure in the transport sector. Individuals who commute to work don’t internalise the effect that their commuting decision will have on other commuters. Every driver imposes a cost on every other driver. This means that too many people use the

roads especially during peak hours. As long as roads are publicly managed (which is not necessary—private roads are a real possibility), this calls for a policy response. The best policy responses to the congestion externality all use the price system. Because the market failure is that drivers don't pay for the congestion they create, the best policy response will be to create tolls, or other charges that make them pay for this congestion. One price system response to congestion is a standard road toll. Ideally, these tolls will differ by time of day to reflect the different level of congestion on the road over time. Modern transponder technology means that highway tolls can be collected quickly and efficiently. In dense city streets, highway tolls will be harder to collect. In these cases, an approach like cordon pricing is generally more effective. Cordon pricing works by charging drivers to use city streets during peak time periods. One way of implementing this technology is to make drivers pay on a monthly basis for the privilege of using city streets during peak hours. Drivers then display a sticker in their window to show that they have paid the toll, and drivers caught without this sticker must pay a fee. This type of cordon pricing has been used in Singapore and elsewhere effectively. Non-price controls are almost always much less effective and more costly socially. An example is the control based in car license that restrict some cars from driving on some days. License plate numbers are used as a means of determining who is allowed to drive on which day. These proposals are inefficient because they imply that a major part of the automobile stock must lay idle for one day. Furthermore, they don't allow the people who would particularly want to drive on that day to drive even if those drivers would happily pay for the social cost of their driving. For much of the population, these car-based approaches are fairly irrelevant since they use public transportation. For this group, the key to faster commute times is improving public transportation. In general, the economic literature on public transportation has been quite clear. Buses are much more efficient than trains or subways for intra-city transport. Instead of extremely expensive extensions to the subway system, minor subsidisation of the bus network will reap much more beneficial results. In cases where traffic is extreme, it may even make sense to build tunnels for buses to drive under ground. In general, subways are almost never cost effective and sold to the public on the bases of vastly over-inflated rider ship estimates. They are particularly inefficient for cities like São Paulo or Rio de Janeiro.

12. Transports and Urban Activities - The Demand for Density

The defining characteristic of cities is density—the physical proximity of people. People come to cities and pay the higher costs for urban land because they want to be close to other people, or to other resources in the city. Economists think of the advantages of cities as coming from the elimination of transport costs for goods, people and ideas.

Physical proximity facilitates the interaction of economic actors. As such, the location and structure of cities is intimately linked to transportation technologies. The growth and decline of cities over time tends to be closely linked to changes in transportation technologies. Over the past 100 years there has been a massive improvement in transportation technologies that have greatly changed the urban landscape. In this section, I review the impact of improvements in transportation on the location and structure of cities. First, I review the impact of improvements in inter-urban transport technologies. Second, I review the impact of changes in intra-urban transportation. The inherent desire and need to perform different activities at different places implies a need for travel in any society.

The crucial planning challenge is to arrive at an optimal spatial organisation of activities (maximising opportunities) and a well balanced transport network linking these activities in an efficient and sustainable way. Therefore, land use and transport planning are highly related by nature. Finding the right balance is a delicate task in urban areas especially, with their complex activity patterns and their evident spatial and environmental constraints. Travel patterns of persons and goods are the results of equilibrium between preferences of people and companies (travel demand) and the travel conditions resulting from the supply of transport facilities and spatial patterns of activities. These preferences and conditions will determine the travel choices with respect to trip distances (distribution), mode choice and time of travel. The relation between transports and urban activities measures the specific activities and equipment distribution. Considering the activities versus required equipment, we have: (a) Work; (b) Studies; (c) Shopping; (d) Private questions; (e) Business; and (f) Play.
The distribution of land uses (residential, industrial or commercial) over the urban area determines the locations of human activities such as living, working, shopping, education or leisure. The distribution of human activities in space requires spatial interactions or trips in the transport system to overcome the distance between the locations of activities.
The distribution of infrastructure in the transport system creates opportunities for spatial interactions and can be measured as accessibility. The distribution of accessibility in space co-determines location decisions and so results in changes of the land-use system.
Considering commuting as a mean to an end, transportation facilities can be viewed from the logic presented in Fig. 14.

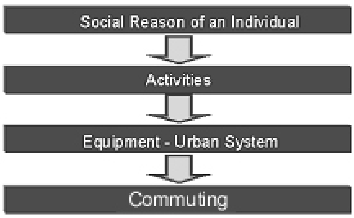

Fig. 14. Transportation facilities as a mean to an end

The society attributes to each person one status express by main activity like work, study, etc. With this attribution people have the alternative run a set of activities. By activity, we understands that's, related with urban equipment. Live, work, buy, etc., are sets of activities realised in appropriated locals like farmers, offices, industries, universities, that here are calling urban equipment. The equipment, proper to different activities, are dispersed in the urban area, and separated by variables distances. Transportation vehicles cover such distances in general. The change of activity, during the day, implies in change of the equipment and commute, covering a distance between both. The necessity of play an activity is the cause and the commute is the effect of activity played.
The social reason can be defined from the following social characteristics: (a) Age; (b) Sex; (c) Occupation; (d) Income Level; and (e) Qualification Grade. In Transportation Demand Analyses are important the characteristics that will impact individuals activities pattern and them in the number of commutes. The social and cultural environment must be taken in account. As example, in the most cultural developed countries a lower class of people goes more to theatre than in development ones. Table 1 shows an example of potential activities distribution of each social group.