A REVIEW OF URBAN TRANSPORT SCENARIO IN BENGALURU CITY

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Abstract
Cities are a host to a number of activities which are made accessible and attainable through different means of transport. Transportation plays a key role in shaping the cities and in influencing their locations. Transport also facilitates the growth and interactions in the city. The identity of a city is not only in terms of its people, places but also in terms of transport that people depend upon. For example,Kolkata (earlier Calcutta) was known as the "tram city" or Pune as the "cycle city". As the city size increases, trip lengths and the per capita trip rates also increase. The trip length refers to the average distance involved on an average trip. Increasing trip length is an indication of urban sprawl. For the study Bengaluru city is taken as it is the fifth most populate urban agglomeration in the country. Bengaluru is a multifaceted city with a radial urban form. It is also a city which has major transport issues and concerns. The demographic, economic, land use profile, transport scenario and travel a characteristic of the city is discussed in this study. The study has accumulated facts, figures, and perspectives from different studies and has tried to put provide the multi-dimensional aspects of the city in a nutshell.

Key Words: Modal Split, Congestion, Trip Length, Motorisation Index.

INTRODUCTION
Cities are centres of activities, decision making centres, residential, employment, and recreation hub. According to Lee (2007) a city may be thought of "as physical and social mechanism to acquire and deliver essential natural services, such as clean water, to a concentrated human population. The physical part of this mechanism is often called infrastructure, while the social part includes markets, government, and community organizations" (p.6).

Economically, transport is the life blood of cities. Transport provides opportunities for growth in jobs, trade, and commerce in cities. Socially, transport is the means of accessibility to health, education and social services that are essential for welfare (World Bank, 2002).

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Transportation historically has been key to economic growth, welfare of the public, accessibility to employment, amenities of life, public safety and security, and social cohesion within a population. While transportation provides these many benefits, however it also has negative impacts, particularly in its energy consumption and degradation of the urban environment through lowered air quality, increased temperatures, increased noise, and fragmentation of neighborhood (Moavenzadeh, and Markow,2007. p.1).

The historic pattern of urban growth which gives rise to different urban forms are categorized as walking, transit and automobile cities by Newman and Kenworthy

Walking cities: the first 10,000 years of urban life
Until around 1850, European cities were dependent on walking and other slow modes of circulation. Destinations within a city had to be around half an hour's travelling distance to remain accessible, so the size of cities was limited by this constraint. Cities are typically small and dense with mixed land use.

Transit Cities: from the 1850's onwards
The advent of steam and electric power for railways and trams brought faster travel and therefore enabled larger cities. Cities could extend along transport corridors, but remained fairly dense and of mixed use. Beyond those linear developments, alking and horse drawn transport dominated.

Automobile Cities: from the Mid-Twentieth Century
Widespread ownership of private cars allowed expansion and development of cities. Greater speeds allowed even more expansion, development densities fell. Cities spread over large geographical areas, especially where constraints of pre-existing land use were weak like in USA and Australia. Buses and Para transit modes provided accessibility for non- car users and enabled cities to grow even when the population did not have access to car.
Source: Cox.2010.

INTRODUCTION TO BENGALURU CITY
Bangalore (now known as Bengaluru) is the capital of Karnataka (Fig 1) and is the fifth most populate urban agglomeration in the country. Bengaluru is a multifaceted city. Initially known as the Garden City and for its cantonment area of defence, with time, it has transformed into an industrial and software centre of India. It is also a centre for bio-technology. Bengaluru is known as the Silicon Valley of India (due to several information technology units established there) and the Detroit of east (significant presence of the automobile industry).

Fig 1 :Map showing Bengaluru

Source: Maps of India

Bangalore Metropolitan Area (BMA) consists of the Municipal Corporation (BMP), the Bangalore Development Authority (BDA) and seven City Municipal Councils. The Bangalore Metropolitan Regional Development Authority (BMRDA) is an autonomous body set up for the planning, co-ordinating and supervising the development of areas within the Bangalore Metropolitan Region (BMR). The BMR comprises of Bengaluru urban district, Bengaluru rural district and Ramanagara district. Apart from BMA, the rest of Bengaluru Metropolitan Region is divided into five Area Planning Zones (APZ's) and six InterstitialZones (IZ's). The BMA covers an area of 1219.50 sq.km of area. The Bengaluru Urban district came into being in 1986, with the partition of Bengaluru district into Bengaluru Urban and Bengaluru Rural districts.

Bengaluru Urban has four taluks: Bengaluru North, Bengaluru East, Bengaluru South and Anekal. The city of Bengaluru is situated in the Bengaluru Urban district. The Bengaluru Urban district has 17 hoblies, 668 villages and 9 Municipal corporations. The Electronics City which is a hub of Bengaluru's Information Technology companies is situated in AnekalTaluk.

DEMOGRAPHIC PROFILE
The city is looked after by Bruhat Bengaluru MahanagaraPalike (BBMP,Greater Bangalore Municipal Corporation).The population of Bengaluru has grown in leaps and bounds. According to the 2001 census, the population of Bengaluru Urban

Agglomeration was 57.01 lakhs and it rose to 84.99 lakh in 2011. The 49.07% growth rate in the last decade, 2001-2011, continues to prove to be a stress on scarce resources.

ECONOMIC PROFILE
Bengaluru has metamorphosed with time. Since the 1950s, the city witnessed rapid industrialisation due the establishment of public sector undertakings (PSUs). The PSUs in Bengaluru are the Hindustan Aeronautics Limited(HAL), Bharat Heavy Electricals Limited(BHEL), Bharat Earth Movers Limited(BEML), Hindustan Machine Tools(HMT), only to name a few.In 1970, the industrial townships were merged with Bengaluru and 1990 saw the establishment of computer and technology services units. The employment opportunities provided increased the city size and population.
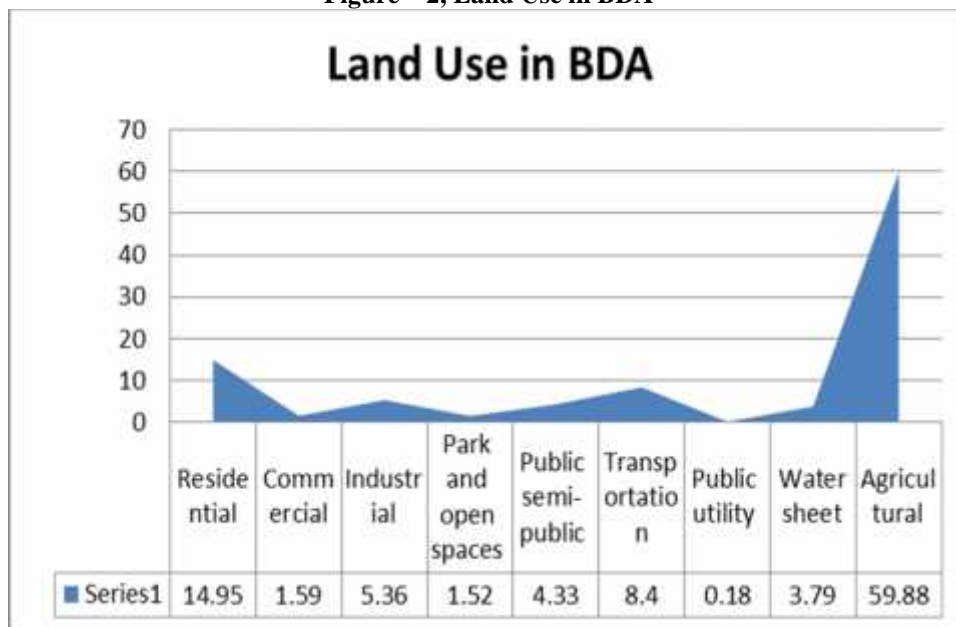
LAND USE
According to JnNURM(2006)the city has five major zones:

1st Zone-Core Area: This zone consist of Administrative Centres, Commercial Activity, Central Business District (CBD) and Housing.
2nd Zone-Peri-Central Area: This zone covers the core area. It has older, planned and residential area. It has some public sector undertakings.
3rd Zone-Recent Extensions : This part of the city is an extension of the main city and has developed in the five to seven years. It is on either side of the outer ring road. It lacks infrastructure facilities and is also called "shadow area".
4th Zone-New Layouts :It is developed on the peripheries of the city. It constitutes agricultural land, vacant land and has pockets of area which are developed. There are posh enclaves at Hosur Road, Whitefield and Yelahanka.
5th Zone-Green Belt and Agricultural Area: This constitutes the outskirts of the city. It has agricultural land, villages as part of this zone.

The land use pattern in BDA is shown in Fig 2 below

Figure – 2, Land Use in BDA

	Reside ntial	Comm ercial	Industr ial	Park and open spaces	Public semi- public	Transp ortatio n	Public utility	Water sheet	Agricul tural
■ Series1	14.95	1.59	5.36	1.52	4.33	8.4	0.18	3.79	59.88

Source: JnNURM, 2006.

TRANSPORT SCENARIO IN THE CITY

MODAL SPLIT
According to JnNURM(2006) the number of registered motor vehicles has crossed 2.5 million and is growing at a rate of over 12% per annum. The two wheelers, which constitute about 72% of the total registered vehicles, are growing at a rate of about 13% per annum. Lately, cars have been growing even faster than two wheelers. Vehicle ownership has grown from 58

to 365 per 1000 population from 1981 to 2006 (RITES,2007)Table1 given below indicates the growth of motor vehicles in Bengaluru.

Table 1 :Growth of Vehicles in Bengaluru City

Vehicles	1999	2010
Two-wheeler	423658	1,418,582
Cars	47559	246,215
Jeeps	10028	39,520
Omni Buses	609	950
Tractors	822	17,234
Tailors	697	9831
Others	769	3922
Total Non-Transport	**484142**	**1,736,254**

Source: MoRTH, 2012

Bengaluru has witnessed a tremendous increase in personalised vehicles (Fig 3). In 1991, there were 108 two-wheeler per 1000 population which increased to 205 in 2002 Cars have increased from 21 per 1000 in 1991 to 44 in 2002. The doubling of the number of personalised vehicle is an indication that with increase in household incomes, people prefer personalised vehicles to public transport, the reason being that personalised transport maximises individual mobility, freedom of choice and versatility that public transport cannot match (Pangotra and Sharma, 2006).

Figure 3:Growth of Vehicles in Bengaluru
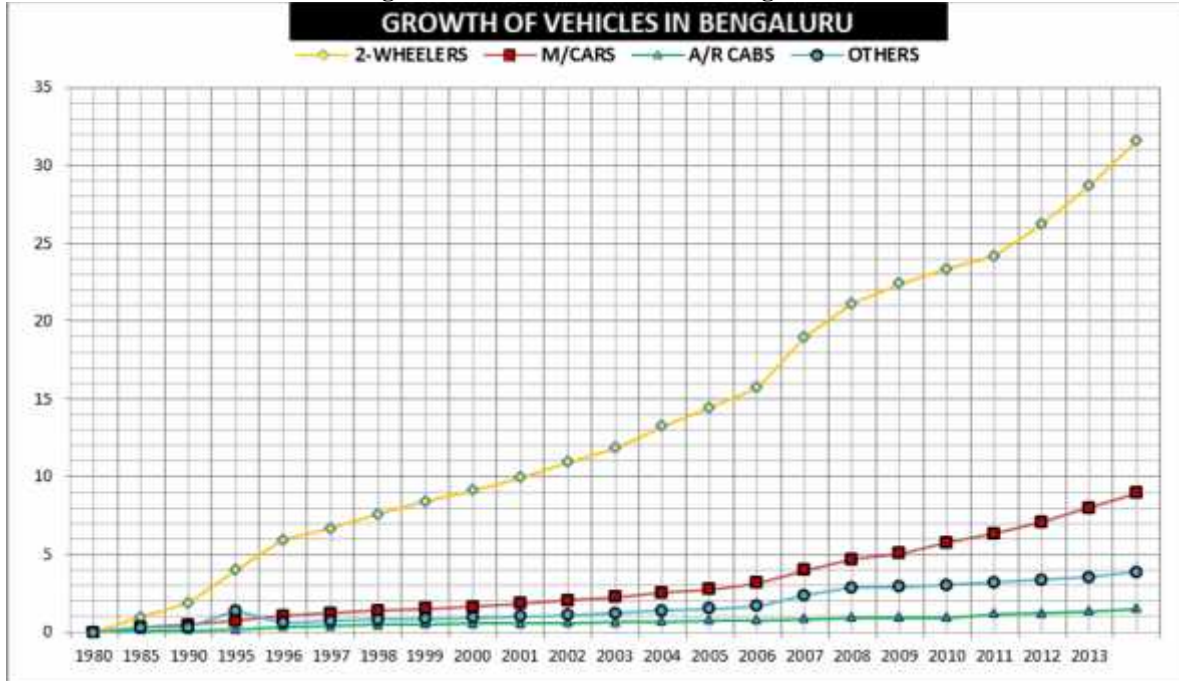
Source: http://rto.kar.nic.in/(2014)

PUBLIC TRANSPORT

Public transport is available in terms of bus services. Bangalore Metropolitan Transport Corporation (BMTC) provides bus services in the city. BMTC is owned and operated by the Karnataka State Government. As on Jan 2014, BMTC operated a fleet of about 6,666buses undertaking 83,688 trips, to service over 4.95 million passengers

Table -2 , Selected Parameters of BMTC

Parameter	2008-09	2009-10	2010-11	2011-12	2012-13
Traffic Revenue(Rs In Lakhs)	90749.87	101229.1	121123.5	138624.6	151600.2
% Growth	13.2	11.5	19.7	14.4	9.4
Margin on Traffic Revenue(Rs. Lakhs)	-2232.6	-3566.12	-3880.31	-6459.97	-23448.9

Source: www.bmtc.com

Table 2 indicates over the years the traffic revenue is declining. Lesser traffic revenue is an indication of lesser usage by people among other aspects.

Motorisation index indicates the number of vehicles per 1000 person. The index indicates the rise in vehicular number. Motorisation index of Bengaluru increased from 59.74 (1980) to 148.92 (1990) to 360 in 2006. Gota and Mutalik(2007) showed that 61.62% of households in Bengaluru have private vehicles. The number of vehicles per household is 1.7 and the number of vehicles per household already having a vehicle is 2.76. This indicatesthat households have multiple ownership of vehicles. This multiple ownership is due to"more increase in number of employed persons per family or due to gradual shifting of mode from two wheeler category to car or from small car category to premium segment." (Gota and Mutalik, 2007, p.2).

AUTO-RICKSHAWS

Auto-rickshaws which are also called as three-seaters ply in the city. Table 3 below shows the number of auto-rickshaw cabs registered and used in Bengaluru city between 1980 and 2010. Based on these figures, the average growth rate in the last five years (2005-2010) is 9-10%.

Table 3:Growth of Auto-Rickshaw Cabs inBengaluru

Year	A/R Cabs (March end figures in lakhs)
1980	0.10
1985	0.11
1990	0.15
1995	0.34
2000	0.58
2005	0.76
2010	1.20

Source: http://rto.kar.nic.in/

Note: It in unclear whether these numbers include only three seaters autos or include 4-6 seaters LMV Cabs

CONGESTION

The increased usage of personalised vehicles has very high repercussions on individuals and society. The average Bangalore an spends more than 240 hours stuck in traffic every year.Limited road space and high use of personalised vehicles have resulted in congestion. The impact of traffic congestions is reflected in the reduction in vehicle speeds. The average speed of vehicles is 12-18km per hour (RITES, 2007).

To ease congestion, technology can be put to use.Technology enables collection of information about traffic conditions and to share the information with road users. Bangalore Transport Information System (BTIS), launched in mid-2007, is based on application of technology for road users. BTIS provides information on bus routes, enables users to find car pool partners, gives information about traffic conditions, directions to places and about accident zones. Technology has also enabled traffic violators to be booked by police. Infrastructure is made to respond to information collected, for example by changing signal lights based on the number of vehicles at signal junctions.

AGE OF VEHICLES

Age of vehicles does have an impact on the amount of emission. According to the EMPRI, 2003, 9.49% of two-wheeler, 90.63% of cars, 6.94% of auto rickshaws and 35.97% of commercial vehicles are aged vehicles. Aged vehicles consume greater fuel per unit and involve greater maintenance. It also means there is greater emission, causing greater pollution.

VEHICLE MIX ON ROADS

A combination of motorised and non-motorised vehicle are struggling for limited road space. This struggle tend to reduce speed, increase travel time and cause greater fuel consumption and emission of carbon dioxide, hydrocarbon and oxides of nitrogen.

INTERSECTIONS

A number of roads in Bengaluru have a numerous intersections. At intersections, speeds of vehicles vary. In most cases, people are forced to slow down. This slowing has meant greater emission.

MULTI-AGENCY FUNCTIONING

There are several government agencies involved in one or other aspect of Bengaluru's traffic and transportation issues: BBMP, BMTC for buses, Bengaluru Traffic Police, BMRC for the Metro, the RTO for new vehicles, BDA, the National Highways, State PWD, Railways and so on. Co-ordinating and functioning of all these agencies is difficult. There is a need for an apex organisation which co-ordinates and overlooks the activity. The activity is not restricted to transport alone, but also to land-use and transport planning and integration of the two.

Bengaluru has a radial pattern of road network converging in the core areas of the city. The road network in the central parts of the city has developed organically but has inadequate right-of way. The intersections are spaced closely. These reasons cause the problem of traffic delays. There is also a ring road (called Outer Ring Road of about 62 km) which cuts across the various radial roads. Most of the major roads in Bengaluru have V/C ratios > 1.0indicating high congestion, low speeds and high delays.

BENGALURU METRO

The Metro in Bengaluru was proposed along two major corridors. The East-West corridor was to be 18.10km long, whereas the North-South corridor would be of 14.90km length. The corridors will be a combination of underground and elevated structures. This first phase of Bengaluru Metro, consisting of two corridors of double line electrified, would essentially cover a total of 41 km. Out of the total length of 41 km, 6.76 km. would be underground near City Railway Station, VidhanaSoudha (up to BRV), Majestic (Leprosy Hospital, Magadi Road) and City Market and the rest will be at an elevated level. The total estimated cost of works is expected to of the order of Rs. 7250 crores with a delay cost of 50 lakh per day. The Metro commenced its operations in a phased manner on October 2011. Currently, on the East-West corridor, only the Baiyappanahalli-Mahatma Gandhi Road section is functional. The coaches are air conditioned and have three carriages that accommodate about 1000 people.

According to Dash(2006), the positive impact of the Metro rail project can be expected to be:
1) Quick service and safety
2) Reduced traffic density on roads
3) Reduced fuel consumption by automobile sector & accompanying import saving
4) Reduction in road accidents
5) Reduction in air pollution and noise levels
6) Employment Opportunities
7) Enhanced rural economy
8) Saving in productive man-hours due to rapid mode of transport
9) Reduction in greenhouse gases emission
10) Reduced need for expansion of roads, laying new roads, flyovers etc
11) Boost to industry, trade commerce, communication and culture
12) Reduction in consumption of fossil fuel

TRAVEL CHARACTERISTICS

The household interview surveys conducted by RITES (2007) of 2600 households gave a fairly good idea of travel characteristics in the city. Some details are provided below.

Trip Purpose: Home based work trips account for 28.79%, home based education trips account for 11.80% and home based other trip account for 10.28%. An analysis of trips by mode of travel indicates that a majority of trips (41 to 45%) were performed by bus, followed by two-wheeler (29 to 32%).

The surveys also revealed some insights on the trips by mode and trip length undertaken by the households. Table 4 below gives the break up between the modes and the distance (km) travelled in percentages.

Table 4: Distribution of Trips by Mode and Trip Length inBengaluru

Trip Length(km)	Bus	Car	Two-wheeler	Three-wheeler	Cycle	Walk
0-2	0.02	.006	19	0	8.1	72
2-5	12.2	2.9	50.4	29.6	4.7	0.2
5-10	11.2	12.6	60.3	13.8	2.1	0
10-15	68	7.5	15	9.2	0.3	0
15-20	68.1	7.4	15.	9.2	0.3	0
20-35	83	4.4	11.2	1.4	0	0
>35	85	11.9	0	3.1	0	0

Source: RITES (2007).

The following observations can derived from the table:
- For very short distances, people prefer walking (72%)
- Cycle is a very popular mode of travel for short distance i.e .up to 5km.
- The usage of two-wheeler has been continuously increasing, especially up to 20km.For very long distances two-wheeler is not preferred.
- People prefer the use of buses for long distance.
- People tend to use less of car for short distances.

Trip Length: In Bengaluru, development has taken place in several directions. Thus, the inner CBD has split up and activities have moved to multiple Periphery Business Districts (PBDs).This has increased trip lengths undertaken by people. According to RITES (2007), the average trip length is 10.57km.

Household Income is increasing. People tend to move to comfortable & personalised modes of transport(World Bank, 2002).

Pedestrian Traffic is the highest on weekends and holidays on Brigade Road, M.G Road and Gandhi Bazar Road. On week days, it is maximum between 5pm and 6pm and between 10am and 11am.

Parking is limited. The demand for parking is highest on MG Road, Brigade Road and Commercial Street. Pay and Park is provided on street and off street. On street parking causes traffic delays. People often slow their vehicles looking for a traffic slot and time is also spent in parking the vehicle and removing the vehicle. All these varied activities delay other vehicles plying on the road.

SOLUTIONS
Some solutions are short term where as others are long term. An integration of land use and transport planning would help in overcoming a lot of problems. The internationally accepted Avoid-Shift-Improve framework would help. **Avoid** unnecessary travel-**Shift** to public modes-**Improve** transport technology. The city need to accept the E's strategy that is **E**valuation of the travel situation prevalent, **E**ngineer solutions that suite the city requirement, **E**ducate and **E**ncourage people to follow the different measures and strictly **E**nforce the measures.

In the last decade, there has been a growing realization amongst US transportation planners that smart growth could probably provide long term sustainable solutions to transportation related challenges. Smart Growth relies on mixing a wide variety of

land uses (houses, offices, shops) in a small urban area, to efficiently manage (not curb) travel demand. Research conducted by US' Environmental Protection Agency (EPA) theorized and proved that travel demand is significantly influenced by 5 important "Ds" of development: **Density of land uses** (high density areas attract more public transport usage since it is cheaper than personalized mode); **Diversity of land use** (more diverse the land uses, lesser the need to travel); **Design elements** (footpaths and safe roadway crossings for pedestrians, safe and efficient bicycle paths, and a closely spaced grid-like roadway network); **Destinations** (attractiveness of area) and **Distance to transit services** (closer a transit stop, higher the probability of a transit trip).

BIBLIOGRAPHY
1. Cox, Peter.(2010). Moving People: Sustainable Transport Development, Books for Change, Bangalore.
2. Dash,S. (2006). Driving Bangalore Forward-"Namma Metro". *Urban Transport Journal*, Vol.17, No.1, pp.23-35.
3. Gota,S., and Mutalik,P.(2007). Congestion to demotorisation-A paradigm shift for Bangalore Retrieved from http://cleanairinitiative.org/portal/system/files/72398_resource_1.pdf .
4. JnNURM.(2006). City Development Plan for Bangalore.
5. Lee, K.N. (2007). An urbanizing world. *State of the world, Our Urban Future.* World Watch Institute, W.W. Norton &Company (pp.3-20).
6. Moavenzadeh,F and Markow, M.J.(2007). Moving Millions, Transport Strategies for Sustainable Development in Megacities. Springer.
7. MoRTH (2012). Road Transport Year Book (2010-11) Transport Research wing, Ministry of Road Transport & Highways Government of India. New Delhi.
8. Pangotra,P and Sharma,S.(2006). Modeling Travel Demand in a Metropolitan City.W.P.No.2006-03-06, IIM Ahmedabad .
9. World Bank.(2002). Cities on the move: A World Bank urban transport strategy review.
10. RITES. (2007). Comprehensive Traffic and Transportation Plan for Bangalore .
11. http://rto.kar.nic.in/.
12. http://www.mybmtc.com/bmtc_glance.