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Planning for Non Motarised Transport System and Efficacy of Contemporary Urban Land Use Planning in Mysuru City, Karnataka

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Abstract - **The urban planning is attempting to promote economically productive, environmentally safe and socially inclusive planning under sustainable planning strategies for towns and cities for mitigating the climate change impacts and also for the future needs. The priority of Non-Motorized Transport (NMT) becoming an important urban planning prerequisite among the existing priorities of urban transportation under the planning approach of integrated urban transport system. In most of the Indian cities the Public Bicycle Sharing system becoming an first priority option in the present context, the same has been deliberately retrofitted into the existing urban fabrics of many cities, but in most of the cities it has failed in spite of it, in the same planning format repeatedly attempted without thinking on the reasons for failure. In Indian urban context a study is required in the cities where the Non-Motorized Transport system are introduced or reintroduced to explore reasons for failure. In this paper a study has been conducted of understanding the planning problems for introducing Non-Motorized Transport under bicycle sharing systems and problems of the bicycle users. An attempt has been made propose planning strategies and recommend planning & design solutions for effective utilization and integration of bicycle sharing system in the urban context of Mysuru city of Karnataka state, India.**

KEY WORDS: Climate Change, Urban Planning, Sustainable Land Use Planning, Non-Motorized Transport, Policies, Mitigation.

INTRODUCTION:

Planning Sustainable Cities: Global Report on Human Settlements of 2009 looks at ways to reform urban planning to meet the major urban challenges of the twenty-first century include the rapid growth of many cities and the decline of others, as they have directly and indirectly responsible for causing sever climate changes and the contemporary urban planning around the world has largely failed to address these challenges to mitigate the impact climate changes. This report documents many effective and equitable examples of sustainable urbanization that are helping to define a new role for urban planning in promoting economically productive, environmentally safe and socially inclusive towns and cities for the future needs. According to the studies in the report the effectiveness of urban planning as a tool for dealing with the unprecedented challenges facing 21st-century cities and for enhancing sustainable urbanization it is realized that in many parts of the world, urban planning systems have changed very little and are often contributes to many urban problems rather than functioning as tools for human and environmental improvement and to play new role of urban planning in promoting sustainable urban development.

The Global Report argues that future urban planning must take place within an understanding of the factors shaping 21st-century cities, including: the environmental challenges of climate change and cities' excessive dependence on fossil fuel-powered cars; the demographic challenges of rapid urbanization, rapid growth of small- and medium-sized towns and an expanding youth population in cities of developing nations, and, in developed nations, the challenges of shrinking cities, ageing and the increasing multicultural composition of cities.

An important conclusion of the Global Report is that, even though urban planning has changed relatively little in most countries since its emergence about 100 years ago, a number of countries have adopted some innovative approaches in recent decades. These include strategic spatial planning, use of spatial planning from the neighborhood level, to cities and regional level to face the

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challenges of new urbanism and climate change. However, it is remarked that in many developing countries, older forms of master planning have persisted and the most obvious problem everywhere in cities of developing is that the spatial planning has failed to accommodate the ways of life of the majority of inhabitants in rapidly growing cities. So the conservation of heritage, mitigation of urban flood and impact of climate change, urban planning strategies against urban heat island and green house gas, encouraging Non-Motorized Transport [NMT] to reduce carbon production and many urban issues are still not resolved to satisfactory level as the older forms of master planning failed because of lack of support from the of land use planning standards and principles practiced from the past and carried the same till to the existing practice. Thus, there is a need of exploring an effective ways for satisfying the present demands of urban planning prerequisites.

The future urban planning for shaping 21st-century cities, to face the environmental challenges of climate change and cities' excessive dependence on fossil fuel-powered cars as well as the demographic challenges of rapid urbanization, and an expanding youth population in cities certainly demands the Non-Motorized Transport (NMT) as an important urban planning prerequisite among the existing priorities of urban planning prerequisite as a best alternative to meet the challenges of shrinking cities, ageing and the increasing multicultural composition of cities.

Non-Motorised Transport (NMT) includes mainly walking, cycling and cycle rickshaws, but cycle rickshaws are not common in all cities. All of them are green modes of transport: their carbon footprint is low; energy consumption is minimal and their local emissions are zero. In addition, they are not dependent on fossil fuels and therefore inexpensive compared to motorized transport. Many studies have observed that Low-income households in India largely depend on NMT in their daily life. Also, active transportation in the form of walking and cycling has immense health benefits. Still, NMT is all too often neglected as a substantial mobility option in favour of capital and infrastructure intensive modes of transport.
Most Indian cities are still compact in their design with high population densities and mixed land use and these are ideal preconditions for NMT as a substantial form of mobility for shorter trips and as a feeder to mass transportation services. Indian cities are expected to exceed 800 million inhabitants by 2050. The growing demand for mobility and the increasing motorization rates are putting strain on the existing resources and are resulting in highly polluted and congested cites. In addition, the Indian real estate market is witnessing acceleration in many green field housing development projects to cater for the growing upper middle class which tends to follow the model of low-density development and suburban sprawl. It has thus become imperative to address the growing challenges in urban transportation and to maintain and further develop NMT as a key element in the transport system. [NTDCP Final Report 2014]

REVIEW OF LITERATURE:

Copenhagen, a flat seaport city, is Denmark's capital and is located in the easternmost part of
the country on the islands of Sjælland or Zealand and Amager. During the last decades, the City of Copenhagen has embarked on a conscious transition pathway towards becoming a 'City of Cyclists.' As a result of bold policies, infrastructure provision and ingenious campaigns cycling has seen considerable growth in the Danish capital, numbers of trips more than doubling between the 1980s and the 2010s. With its high levels of cycling in 2014 bicycles accounted for 30 per cent of all trips that started or stopped within the city Copenhagen has received attention as a role model among bicycle planners, policy makers and activists. Meanwhile, scholars are seeking to understand and explain the Copenhagen success story. The transition towards cycling in Copenhagen had 'its roots in an existing bicycle culture,' while 'infrastructure development could be based on an existing network of bicycle tracks and lanes.' 'This made it easier for the city to establish a common vision of Copenhagen as a bicycle capital, and to treat the bicycle as a transport mode equal to the car, in turn justifying investment in bicycle infrastructure and the re-distribution of urban space in favor of the bicycle has been created through planning interventions by taking care of safety to bicycle riders as one of the primary factors.'

The study has examined the ways in which the urban development of Copenhagen, its transport infrastructure, and cycling practices have co-evolved in the long term. Infrastructures of urban transport are thus not neutral. They have been shaped by social actors in processes where cultural values, social relations, politics and power are closely interwoven. The designers skill of making use the potential technology and their preferences, competencies, motives and aspirations and inscribe these in the integrated urban planning approaches. In spite of the sheer numbers of cyclists, combined with the lack of adequate public transport, the success of NMT have acknowledged the importance of cycling for a well-functioning city by both politicians and municipal engineers with all social actors backed them as a win-win-measure, combing the safety of cyclists with the free flow of cars; although in the urban setting they were realized in particular in the suburbs. Thus Cycling in Copenhagen is not merely a question of travel time efficiency for

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busy commuters; it enhances the quality of life and enjoyment of the city, and there is room for everyone. The Green Cycle Routes make a valuable contribution in this regard. [Martin Emanuel, 2018]

A report on *'Copenhagen City Of Cyclists The Bicycle Account of* 2015, by The City of Copenhagen Technical and Environmental Administration of Copenhagen, Denmark says In recent years the City of Copenhagen has increased capacity and hence passability: cycle tracks have been widened, contraflow cycling has been introduced in several sections, and bicycle/pedestrian bridges have been opened. Travel times have been shortened by an average of 7% since 2012. In addition, the number of kilometers cycled per day in Copenhagen continues to rise; on a weekday 1.34 million km are cycled now. A good cycling infrastructure, shorter travel times and enhanced safety and security are major factors in determining why so many people choose to cycle in Copenhagen. However, there are also other factors: mild winters have encouraged more people to cycle all year round, and the traffic jams caused by the roadworks in connection with the Metro construction have made it easier to travel through many parts of the city by bicycle rather than by car. General information and promotional campaigns also seem to have contributed to the positive trend.

Today the transport systems in many cities around the world create many problems, especially through their focus on motorized traffic. These problems consist, among other things, of pollution, congestion, health issues, and social exclusion. Cycling offers part of a solution as an active mode of transport that is inexpensive, healthy, free from local emissions,
and consumes very little space compared to motorized traffic. Smaller and larger cities around the world are working to realize the potential of cycling in order to decrease congestion and pollution and to increase their citizens' health. In Denmark and Sweden, cycling is already a substantial part of everyday mobility in several cities. A study of comparison of cycling cultures in Stockholm and Copenhagen By Sonja Haustein et al[2019], focuses on two central Scandinavian cities – Copenhagen and Stockholm – that are generally thought to be culturally close but have deviated with respect to cycling policies and infrastructure. Based on a survey including inhabitants of Copenhagen and Stockholm, this study investigated whether cyclists in Copenhagen and Stockholm experience the transport systems in the two cities differently, and to what extent cycling perceptions can explain differences in cycling level (minutes of cycling) among cyclists. Cycling levels are much higher in Copenhagen than Stockholm, and cyclists in Copenhagen perceive a higher prioritization in traffic, feel safer, and perceive a higher ability to reach their destinations by bike. Using ordered logit models, the study has examined the effect of different factors on cycling level among cyclists in both cities. Those who live in Copenhagen have higher levels of cycling even when other independent variables are included in the study model. Other significant factors were employment, which increased cycling, and car access, which decreased cycling. Being female was related to higher cycling levels in Copenhagen, but not in Stockholm.

Promoting cycling through targeted policies requires an understanding of the single determinants of cycling and a recognition of the local and structural conditions of a specific city, including the associated infrastructure, planning policies, politics, and mobility patterns and how they work together in forming a specific mobility culture.

The difference may be related to an overall cycling culture, which the study found in Copenhagen but not in Stockholm. Historically, Copenhagen and Stockholm have followed different trajectories with respect to cycling policies, which today seem to be inscribed into the citizens' priorities on which modes should receive priority in traffic and which modes they prioritize themselves. The resulting mobility cultures appear to be poorly described by individual level metrics as attempted in this study. Understanding the wider set of factors that form a cycling culture would be highly valuable to cities around the world that are aiming to stimulate cycling. Future studies should aim for additional comparisons across cultural contexts to study the basis for cycling and mobility cultures, their rigidity or changeability, as well as their role as preconditions for travel choices. [Sonja Haustein et al, 2019]

One of the city of Copenhagen's primary tasks is to create a cohesive cycling network across the city enabling people to move freely from place to place. This includes such different measures as the Cycle Super Highways, contraflow cycling, a route planner app, and, last but not least, bicycle bridges. [*www.kk.dk/cyklernesby*]

Malene Freudendal-Pedersen, [2015] argues that this is in fact not the case. Rather the specific project identities that are nurtured by Copenhagen's cycling community inhibit it from advocating publicly or aggressively for a vision of the common good that gives cyclists greater and more protected access to the city's mobility spaces. The question of how to get more people to cycle has spread too many cities around the world. Danish people's taken-for-granted familiarity and comfort with common good arguments as a way to bridge the relationship between abstract societal considerations and everyday practical matters is evident in the interviews with cyclists. Copenhagen is often identified as having achieved considerable success in this regard, but there is a danger that the

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positive cycling narrative that prevails in Copenhagen may block critical discussion regarding the right to city space. Drawing from qualitative research conducted in Copenhagen as part of an "Urban Cycle Mobilities" project, this article demonstrates that people who cycle in Copenhagen constitute a community of cyclists, and asks whether such a cycling community creates the condition for cyclists and cycling to be given greater consideration in broader societal understandings of the common good.
In order to increase the effectiveness of active transportation in Bhubaneswar, Odisha, a study has been conducted with an intention to evaluate the effects of the Public Bicycle Sharing System (PBSS) by integrating it with the existing modes of transportation. The inadequate PBS supporting infrastructure, cycle tracks specifically designed for that purpose, inaccessible station locations, and lack of first and last-mile connectivity for public transportation and the like aspects those needed for an effective PBS network and will aid in the creation of an effective transportation system. The research study was carried with an optimistic approach for the development of an efficient and successful public bicycle sharing (PBS) network. But the rapid urbanization and the existing planned urban mobility infrastructure and the share of dedicated land for the societies need and the additional space that necessitate for accommodating the required ancillary spaces for integrating different modes of transportation for adapting to the passenger behavior was not possible. The study stresses the importance of PBS aspects improvement in the quality of life through better accessibility and last mile connectivity in the urban areas. But it expresses that 'in order to maintain the positive effects of PBS and prevent its negative effects, it is requires the involvement of the public, private sector, and government in multi-party cooperation and the development of collaborative governance networks. Other initiatives include enhancing bicycle infrastructure, building a dense network of docking stations, bolstering law enforcement and supervision of unlawful activity, and enacting new rules and regulations to make this plan a fantastic one. [Subha Swostik et al, 2024]

Because the task of implementing PBS has two components. The planning and design components. The planning component majorly has preparing the town or city spaces to accommodate what the town or city and their people wants. And also spaces for accommodating the design components of PBS.

The bicycle sharing systems design of bicycle sharing systems raises several optimization problems as it involves the determination of the number, capacity and location of bicycle station facilities as well as the bicycle fleet size along with the allocation of bicycles among stations. These design decisions are subject to several variables, restrictions and dependencies, such as the predicted user demand patterns, the synergies among the bicycle sharing system and the public transportation network, the budget available for setting up the system, etc. Alexandros Angelopoulos et al, 2016].

A study by Aman Joshi and Deepak Dalal in 2018, aims to find the potential impacts of some of the bicycle friendly infrastructures and policies on urban Indian bicycling from the user perspective. A questionnaire survey was conducted in Delhi-National Capital Region [NCR]. The study has two components, one is on bicycle friendly infrastructures and other is on policies based on public opinion. Bicycle Sharing Service and Dedicated bicycle lane was found to be the most preferred bicycle friendly infrastructures based on the public opinion and whereas facility to carry bicycle on public transportation was found to be the least preferred one. The findings from this study could be used by various policy makers and stakeholders to improve bicycling in their region. According to their study the Bicycling is considered as one of the most efficient mode of sustainable transportation for shorter commutes. On the contrary, in India, modal share of bicycling is declining year by year. Although it is expected to be attractive option for short commute trips in India due to its extremely low cost of operation, studies have shown that it is not an attractive mode among commuter belonging to high and middle income group. Bicycle users in India are predominantly captive users such as lower income group people and students. In order to promote bicycling, development improvement of bicycle friendly infrastructure is highly essential. For a developing country like India, which depends heavily on imported fossil fuels for transportation, promoting bicycling for shorter commutes will have long term influence on its economy as well.

India with its large population and millions of bicycle users has a huge potential for becoming one of the top countries in terms of level of bicycling in the global context. Even without presence of any bicycle friendly infrastructures and policies as such, India has a considerable share of bicycle trips even more than some of the developed countries. However, it is declining at a faster rate year after year due to the affordability of motorized vehicles and is becoming restricted only to captive riders such as lower income group people and students. This study also shows that age and perception about effect of Bicycle on social status is not a factor for them as they do not have any choice to use other transportation modes. The safety ***concern regarding bicycling*** is very impartment in India.

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As safety concern regarding bicycling is very high in India, there is high chance that these people have will shift to other modes as soon as they could afford such change, if a safety is not achieved while introducing Non Motorized Transport [NMT] system by introducing bicycle mode. This study also shows that the house hold income has statistically significant impact on bicycle ridership. High income group people are less probable to use bicycle than low income group people. Similarly, probability of choosing bicycling as a mode of transport decreases with increasing travel distance and increase in the house hold income. However, limitation of the ridership model of this study lies in the fact that age, income and travel distance were not considered as continuous variable. Female participation in bicycling is also found to be far less than that of males. This type of situation is not at all sustainable. If steps are not taken immediately, situation could get worse and experience around the world shows the reverse transition is not that easy to attain. Attention must be given to maintain lower income group, kids and student ridership. ***Therefore, policy makers in India need take some urgent initiatives to promote bicycle in urban India across the country.*** Since policy makers are often bound by time and money constraints, this study may work as a guide for them to choose among their alternatives and prioritize them. *Based on the results of this study, it can be concluded that* ***dedicated bicycle lanes*** *must be the given more importance than another infrastructure or policy to promote bicycling.* In case when it is not possible to make all the roads favorable for bicycling, safety and congestion freeness should be compromised over travel time to some extent. Bicycle sharing service and policies like incentive for employers for using bicycle can act as a supportive measures to the before mentioned infrastructures. Intersection modification must be done judiciously as public opinion in this regard is very much skeptical. Facility to carry bicycle on public transportation is hard to implement in a country like in India where amount of crowd in public transportation is very high and retrofitting the idea of Bicycle sharing service and making policies like incentive for bicycle riders never work and cannot act as a supportive measure [Aman Joshi and Deepak Dalal in 2018]. However, in many cities of western country the planning and design interventions of bicycle and other NMTs are performing satisfactorily.

Most Indian cities are still compact in their design with high population densities and mixed land use ideal preconditions for NMT as a substantial form of mobility for shorter trips and as a feeder to mass transportation services. Many studies have estimated that Indian cities are expected to exceed 800 million inhabitants by 2050. The growing demand for mobility and the increasing motorization rates are putting strain on the existing resources and are resulting in highly polluted and congested cites. In addition, the Indian real estate market is witnessing acceleration in many green field housing development projects to cater for the growing upper middle class which tends to follow the model of low-density development and suburban sprawl. It has thus become imperative to address the growing challenges in urban transportation and to maintain and further develop NMT as a key element in the transport system.

A study on 'Non-Motorised Transport Policy In India', [Kartik Kumar, 2013], by Federal Ministry for Economic, Cooperation and Development (BMZ), On behalf of Division Water; Urban development; Transport, Germany and Sustainable Urban Transport Project – Policy Briefing INDIA discussed on NMT for Indian cities. This document is intended to assess the current NMT policy situation in India and to outline a broad policy reform agenda to support the development of NMT in India. Non-Motorised Transport (NMT) includes mainly walking, cycling and cycle rickshaws. All of them are green modes of transport: their carbon footprint is low, energy consumption is minimal and their local emissions are zero. In addition they are not dependent on fossil fuels and therefore inexpensive compared to motorised transport. Low-income households in India largely depend on NMT in their daily life. Also, active transportation in the form of walking and cycling has immense health benefits. Still, NMT is all too often neglected as a substantial mobility option as it is capital intensive and infrastructure intensive modes of transport to integrate to other modes of transport in case of green field area planning and the invites complex situation to retrofit to developed cities as well as in case of brown field planning.

This literature has documentation of recent trends in the modal share of NMT in Chennai or Patna. The share of NMT (walking and cycling combined) in Indian cities in the early 1980's was in the range of 40–60 % of the total trips. A recent study for seven Indian cities has shown that the share of NMT has been declining in recent years (with few exceptions such as Chennai or Patna. Rickshaws a unique type of NMT used for both passenger and freight traffic holds a substantial modal share in most Indian cities. However, rickshaws are often blamed for creating congestion and hampering the flow of traffic. But by providing segregated lanes for NMT, in fact, considerably increases road capacity. Rickshaws are an important feeder service for public transport as 24 % of the Delhi metro trips are dependent on Rickshaws as feeder mode. Even then most of the master plans of these cities unable to solve the safety issue and needs of NMT, though the Indian cities are required to plan to mitigate the impacts of climate change as pressing issue concerning NMT for users. Cyclist and pedestrians have the highest share of traffic accidents in many cities. The study documents; the number of road users killed in the cities of Mumbai, Delhi, Kota and Vadodara on selected highway locations shows that car

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occupants were a small proportion of the total fatalities whereas pedestrians, bicyclists, and motorized two wheeler riders accounted for 60–90 % of all traffic fatalities. And the study says that this is a result of increased urbanization and infrastructure development that has given priority to motor vehicle movement over the past decades. According to a study by Mohan and Tiwari (2000); hope its not true, because the problem may be in the existing Indian urban planning, as it was not capable to adopt NMT as urban pre requisite.

On one hand, cities are a significant contributor of carbon emissions aggravating climate change and on the other, cities are considerably impacted by climate disasters. The recently released Global Climate Risk Index 2021 ranks India as the 7th most-affected country from climate-related extreme weather events (storms, floods, heat waves etc.). Further, studies indicate that poor planning and urban management are expected to cost Indian cities somewhere between $2.6 and $13 billion annually. *Mani, M. et al.,* [2018]. *South Asia's Hotspots: The Impact of Temperature and Precipitation Changes on Living Standards, Washington D.C.: World Bank Group acknowledges that Cities* are increasingly at the forefront of addressing both urbanization and climate change and to strengthen climate-sensitive urban development, a holistic understanding of the urban development from a climate lens is crucial. The Climate Smart Cities Assessment Framework (CSCAF) launched in 2019 by the Ministry of Housing and Urban Affairs (MoHUA), Government of India aimed to address this gap. This first-of-its-kind assessment with 28 progressive indicators across 5 thematic areas helps cities to benchmark their development, understand the gaps and further prioritize climate relevant development.

With a focus on building local capacities to develop and adopt climate measures, the Climate Centre for Cities (C-Cube) at the National Institute of Urban Affairs (NIUA) initiated a series of training aligned to the thematic areas of CSCAF - Energy and Green Buildings, Urban Planning, Green Cover & Biodiversity, Mobility and Air Quality, Water Management, Waste Management. The focus of the training is to provide a step-by-step approach of conducting studies, assessments and stakeholder consultations, establishing committees, developing action plans and implementing relevant measures that not only makes the cities climate resilient but also helps them progress across the assessment of CSCAF. Likewise there are many guidelines policies, guide lines, standards to adopt the same; but fails to achieve satisfactory result. Thus a study ha been carried in the urban context of Mysuru.

STUDY AREA:

Mysuru the second largest city located at closer proximity to Bengaluru; a state capital of Karnataka state in India. Mysuru has a salubrious climate with an average temperature varying from 12° C to 35° C. Mysuru located at 12.30°N 76.65°E and with average altitude of 770 meters (2,526 Ft.). It spreads over an area of 128.42 Km^2 with a fairly flat topography of urban area except a holy hill called Chamundi Hill located towards south eastern part of Mysuru city without spreading its hilly terrain character in the city area. The city has many major surface water bodies in the form of lakes like the Kukkarahalli, Karanji and the Lingambudhi lakes with many minor water tanks are inter connected with many natural water courses with greeneries and made the whole city's local climate cooler. The summer season starts from March to June, followed by the monsoon season from July to November and the winter season from December to February. The annual rainfall of Mysuru city is varying from 750mm to 800mm. the city is neither affected by the greater variations in the temperature nor the dynamics of rainfall in relation to the requirements of NMT for its best integration as urban requisite in the urban climate of Mysuru city. As the city has a semi-arid climate character thus to create a comfortable ambience for NMT more provisions of green spaces through the city planning is necessary.

The political history of Mysore was very significant between 1761–1799 and is the political history during the rise of Haidar Ali in 1761 to that of the death of his son Tippu Sultan in 1799. During this period the contiguous historical regions of Mysore State and Coorg province on the Deccan Plateau in west-central peninsular India, the Mysuru city and its region started developing from the time of Wodeyar dynasty throughout their genealogy. The ruling dynasty's especially as expounded in later period with the British on the Mysore by

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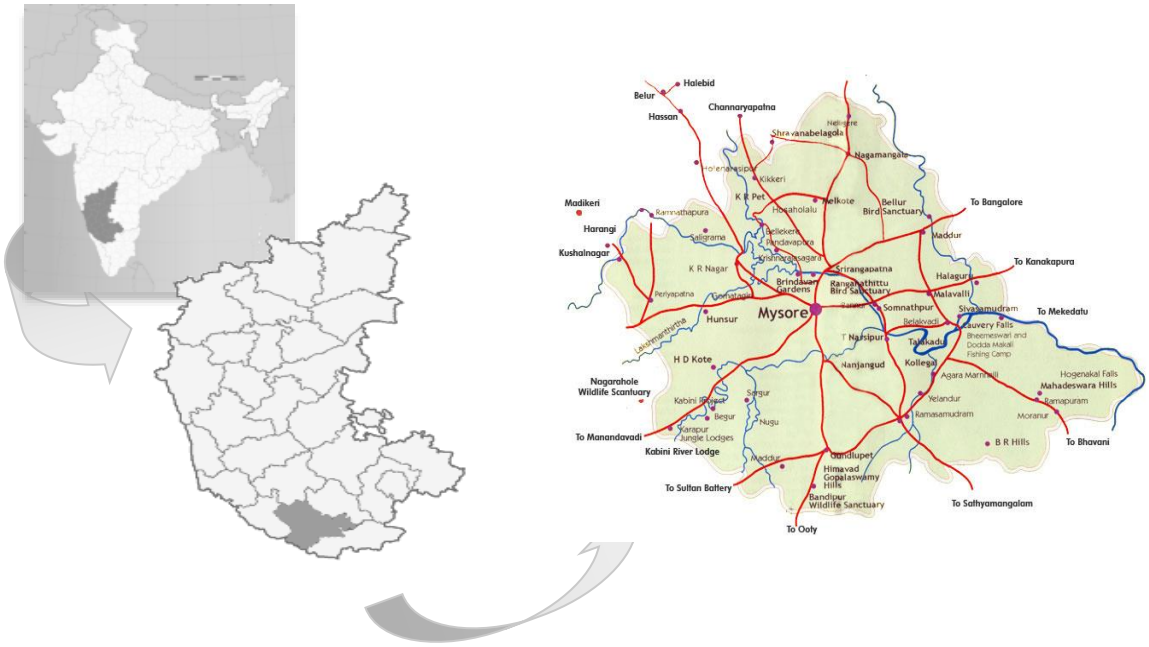

Fig 1.0 Study Area Location Map. **Source:** Compiled by author from master plan 2031).

demonstrating their "unbroken" royal lineage, has made the Mysore city as capital of the former princely state of Mysore. But during the reconstitution on the linguistic reorganization of the state in 1956 formed its new headquarters at Bangalore and has made Mysore as district. Later, on the first of November 1973 the state was renamed as Karnataka. The then Mysore district comprised of 3 sub-division viz. Mysore [now the Mysore is called Mysuru], Hunsur and Nanjangud sub divided into 11 taluks with a total area of 11954 sq.km. The district was bifurcated with the creation of a new district viz. Chamarajanagar, with its headquarters at Chamarajanagar by taking out the taluks of Chamarajanagar, Gundlupet, Kollegal, and Yelandur. Thus, the district at present consists of 7 taluks with a total area of 6269 Sq.km. The city was subjected to a rapid development and spread across an area at the base of the Chamundi Hills as the city is well connected to Bangalore, Mangalore, Hassan cities by road way, railway and also connected to major cities of adjacent states; Tamil Nadu, Maharashtra, Goa and Kerala by national and State highways, railways and also by air way.

The size of population also started growing. According to 2001 census Mysuru city has a population of 7,62,408 it is increased to 8,87,446 population size in 2011 with 4,43,813 males and 4,43,633 females. The gender ratio is 967 females to every 1000 males and the population density is 6223.55 per Sq. Kms. The literacy rate is 82.8%, which is higher than the states average. The city has good potential for post modern development, thus it has much faster developing urban areas along its major arterial roads. The city growth and developments are governed by the Mysore Development Authority [MUDA] and the Mysore City Corporation.

The present growth and development dynamics and its trend in Mysuru city is started reflecting the symptom of further growth and development. The future growth of Mysuru will accommodate many major industries, high end residential urban extensions, and commercial centers due to the Bengaluru - Mysuru infrastructure Corridor and double lane railway and ten lane expressway to Bengaluru have made the city have lesser travel time and establishes more interaction between the state capital. The Master Plan for the Mysuru city has a good proposal for its prosperous future growth and development and making the city denser and making the city more congested. , there is a need for preparing the city for its future urban growth and development prosperity by strengthening its physical infrastructure. Because the imbalances of the past and present growth and developments and the current dynamics of climate change and their impact demands many initiatives as urban prerequisites to promote sustainable planning and developments, but it is observed that the practicing planning approaches, policies regulations are facing many challenges as the most of the planning initiatives as urban prerequisites to promote sustainable planning and developments are not effective enough to reach or fulfill the objectives of any sustainable planning and developments initiatives, Thus, following study has been carried in the urban context of Mysuru to explore how effective the NMT is functioning which was introduced in the city in the recent past and also to find what are the planning needs are required to be improved to make the NMT to satisfy the urban mobility needs efficiently.

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Population growth dynamics of the city:

A study carried for understanding the how the city has been prepared through master plan for accommodating the present and its scope of accommodating future population growth. It shows that the increasing trend in its population growth but shows a little decreasing rate of growth [table & fig 1.0].

Table No. 1.0 Decadal population growth of Mysuru [1901-2011].

Year	Population	Growth rate %
1901	68,111	-8.00
1911	71,306	4.69.
1921	83,951	17.73
1931	1,07,142	27.62
1941	1,50,540	40.51
1951	2,44,323	62.33
1961	2,53,865	3.91
1971	3,55,865	40.11
1981	4,76,442	34.69
1991	6,52,246	36.37
2001	7,85,800	20.27
2011	9,19,414	23.41
2021	16,50,000	79.50
2031	21,00,000	27.30

Source: Census of India and Mysore Master Plan 2031

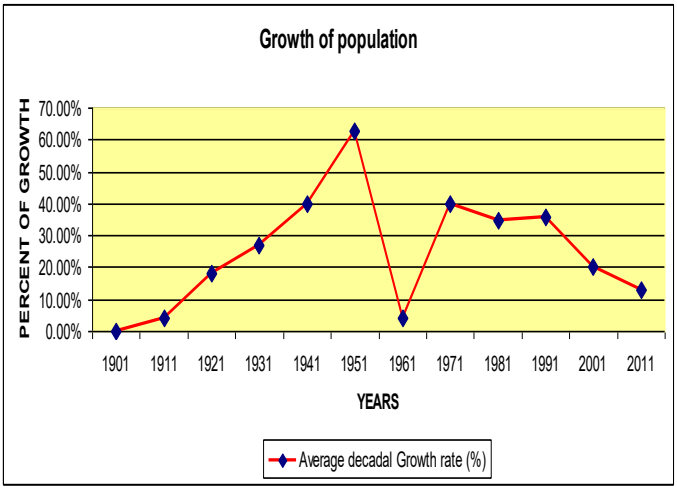

Figure 1.0 Decadal population growth of Mysuru [1901-2011].

The Mysuru City was started developing as single nucleolus but now due to the growth and development demand the urban context of Mysuru is integrated with its adjacent town called Nanjungud within its planning jurisdiction called Local Planning Aarea [LPA]. The population growth trends have been studied based on the census of India data for the entire LPA. The master plan for 2031 has reserved about area of 509.03 sq.km. for accommodating future growth and development of the city as the city has very good potential and capeble to invite huge investment on industrial developments, trade and commerce tourism and recreation etc. Because of these developmental activities the migration of population into the city has been increased from 68,111 in the year 1901 to 16,50,000 in the year 2021 and it is forecasted that the population will increase to 21,00,000 in the year 2031.

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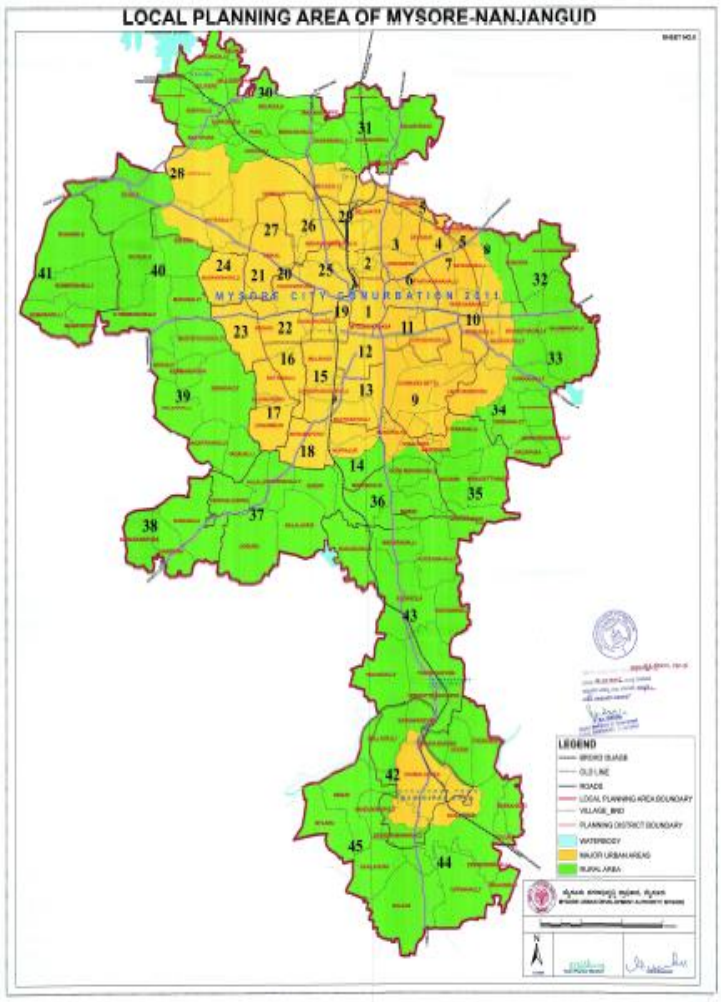

Figure 1.2 proposed Local Planning Area [LPA] for the planning period 2031. Source: Mysore Master Plan 2031.

Spatial growth dynamics and land use planning of the city:

A study on spatial growth trend and land use planning for accommodating the growth and development of present and future of the Mysuru city has been carried. The study shows that the provisions of city supporting space and infrastructure through the master planning processes from the period of the inception of planning authority called ***City Improvement Trust Board*** (C.I.T.B.) was good. The CITB was founded by His Highness Sri Nalwadi Krishna Raja Wodeyar - IV and it holds the proud distinction of being the oldest planning institution in Asia. Innovative planning combined with a humanitarian approach has achieved to allocate spaces for the city needs effectively, as the population size in turn the city size was less, there was no scarcity of urban spaces till to the formation of planning and development authority called the Mysore Urban Development Authority [MUDA]. The problem of scarcity of urban spaces have started after the planning intervention through MUDA as the land use planning were focused much on major requirements of the city needs other than the urban prerequisites like a dedicated lane for NMT. The table 1.2 shows land uses of the master plan carried till to the year 2009. The land allocated for traffic and transportation uses was only 3413.73 hectare [11.67% of the total developed area] in the year 2009 and master plan for the year 2031 has allocated 4568.26 hectare [15.62 % of the total developed area]. The total land allocated for the traffic and transportation uses from the year 2009 to 2031 is increased by 1.5 times, where as the population size from the year 2009 to 2031 increased by 30 times in turn the traffic on the road can also be presumed to be increased in the same magnitude over the road width which designed in the master plan of the year 2009. The field surveys have been conducted to study the issues related to NMT, beside it is observed that the roads formed during the period of king are much wider than the roads formed after forming the planning authority and after the master plan [earlier the master plan use called Comprehensive Development Plan]. [MUDA, Master plan 2031 report for Mysore].

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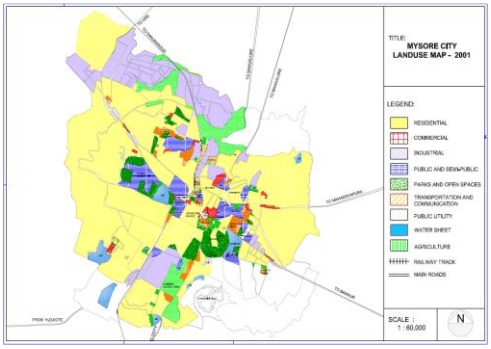
Table 1.2: Land use of Mysuru city for the year 2009.



Existing Land Use-2009 - Mysore City Conurbation		
Land use Category	**Area in ha**	**Percentage to Total Area**
RESIDENTIAL	7049.81	24.11
COMMERCIAL	467.52	1.60
INDUSTRIAL	1320.49	4.52
PUBLIC/SEMI-PUBLIC	1551.69	5.31
PUBLIC UTILITY	107.20	0.37
OPEN SPACE	772.87	2.64
TRAFFIC & TRANSPORTATION	3413.73	11.67
AGRICULTURE	13455.56	46.02
WATERBODY	336.10	1.15
FOREST	766.50	2.62
Total	**29241.48**	100.00

Figure 1.3 Mysore City urban spread in 2001. Source: Mysore Revised Comprehensive Development Plan 2009,

The urban growth and development from the year 1995 to 2011 shows a considerable increase in the area under different civic use land uses excluding the area under water body, agriculture and area under Nehru loka; an area reserved for one specific use. Now the proposed master plan 2031 has a conurbation area of 29242.5 hectares comparing to an area of 29241.48 hectare reserved in the year 2009; this indicates there is no additional place for accommodating any kind of new planning interventions like NMT.

The total area for Mysore city as per MUDA has shown an increase in its urban area to 9221 hectares in 2001 from 7569 hectares in 1995, representing a growth of 22%. As per MUDA, the total area is further expected to increase to 15669 hectares by 2011, representing a significant increase of around 70 % over the total area in 2001. The city area has become double to its previous decades.

The city's growth in the recent years becoming very fast and dynamic, towards southern of Mysuru the industrial areas located closer to Nanjangu. The MUDA as well as private developers have developed many new layouts in the areas adjacent to Vijayanagar and J.P.nagar residential urban extensions including the area in the north eastern part of Mysore and still many residential layouts of private developers have lined up an array of proposals and ther are many proposals to develop malls, convention centres and golf courses film city and the like. The Future growth of Mysore will be determined by the Major development happening in the city. The figure 1.4 shows the major areas of development in Mysore that has almost filled with recent development over the proposed Land Use of Revised Comprehensive Development Plan of the year 2009 and 2011.

Table 1.3 Proposed Land use for planning period 2031

Proposed Land Use 2031 - Mysore City Conurbation		
Land use Category	**Area in Ha**	**Percentage to Total Area**
RESIDENTIAL	15735.06	53.81
COMMERCIAL	800.88	2.74
INDUSTRIAL	1812.70	6.20
PUBLIC/SEMI-PUBLIC	1981.33	6.78
PUBLIC UTILITY	192.48	0.66
OPEN SPACE	1611.62	5.51
TRAFFIC & TRANSPORT	4568.26	15.62
AGRICULTURE	1098.16	3.76
WATERBODY	372.68	1.27
FOREST	763.92	2.61
SPECIAL AGRICULTURAL ZONE	305.41	1.04
Total Area of Mysore Urban	**29242.51**	100.00

Source: Mysore Master Plan 2031

The land requirement for the proposed development in the master plan period was assessed by adopting an optimum town level density between 100 pph to 150 pph and by adopting a density of 100 pph; a total area of 21,000 ha of land has been considered to

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accommodate the growth and development to the year 2031 it is almost occupied with about 90% of development.
The data reveals that the registration of two wheelers increased by 67.34%, during the period 2001-2008, where as the three wheelers, which include Autos and three wheel luggage carriers increased by 49.62%. Light motor vehicles (LMV) grew by 93.955% and heavy duty motor vehicles increased by 215.9%. It is evident that almost all types of vehicles have been growing steadily. It may be observed that LMV and Heavy Motor Vehicles [HMV] type of vehicle have been growing at relatively faster rate. The two wheelers and three wheelers have also not lagged behind. The number of vehicles has 1,45,000 in the year 1996 has increased by almost 25 times with respect to the year 1970 that has about 6000 vehicles. According to Regional Transport Office [RTO] Every year about 7000 vehicles added to the Mysuru city in which 80% two wheelers. Mysuru has more than 7 lacks registered vehicles. The city has maximum of 25000 to 30000 visitors per day during peak period of tourism and about 10000 to 15000 visitors per day in normal day with added vehicles to city 3000 to 5000 per day. The road capacity during peak hours almost crossing two times to their designed carrying capacity.

The existing road network of Mysore City is observed that some of the important roads itself identified that they are not uniform in their width and some stretches crating congestion. This aspect has already been identified in the approved master plan and the proposed widths are suggested still not done. The small access road of 6m and 9m widths with other roads connected to the existing road major roads of the city having 22m to proposed to be widened to 30m right of way not carriage way roads as per the approved plan with no service roads except the existing Outer Ring Road of the city. As per study carried the vehicular urban mobility in the major urban roads reduces by 50% to designed speed during peak hours.

There are about 97 major junctions in core developed part of Mysuru city, out of which 70% are signalized where as the rest are non signalized. Out of above 97 Junctions 10 are T. Junctions, three of which are signalized. It is observed that some intersections have more than

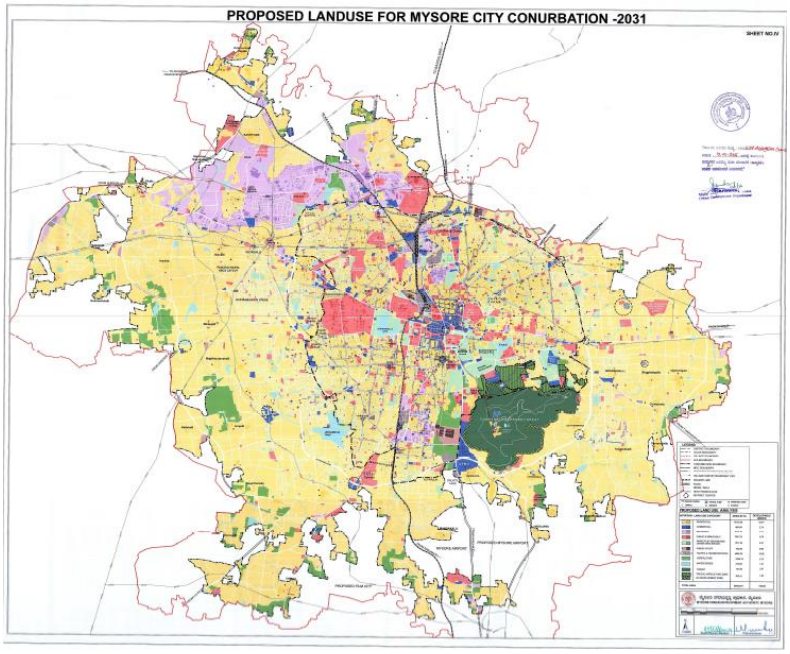

Figure 1.4 proposed land use of Mysuru for the planning period 2031.
Source: Mysore Master Plan 2031

four roads and there is scope for constructing a rotary with large island in the centre and road medians along all the arms of the various roads which approach the intersection for segregation of traffic at the intersection due to traffic congestion.

Share of cars have increased from 8.7% to 9.2 %. There is marginal increase of 0.1% in share of buses over the period. Various modes of vehicles have grown from 4 times to 25 times with the highest growth seen in two wheelers and cars. The growth of private vehicle suggests the lack of public transport which is not able to suffice the needs of the citizens combined with increased average per capita income of the residents. The total road network in the city was 335 kilometres in 1972. It increased to 432 kilometres in 1981, which accounts for 29% of increase over a decade. There are 48 main roads in the city covering a total length of around 58

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kms. The share of concrete/bitumen roads in the city is approximately 90% of the total road length. As a number of layouts have been developed during the period 1981-91 the total road network exceeds 600 kilometres. The road capacity in older part of the city has remained same while the quantum of traffic has increased significantly. The city has a road density of 8.58 km per sq. km and 1.45 km road length per 1000 persons. City's main road network are supported with signals, road dividers, pavements and street lights on the main road and these are present on almost the entire length of the road, but no service roads and additional dedicated road space for NMT in any of the master plan. Roads form an important component of physical infrastructure to promote social and economic development of the city without affecting the environment. The city governance thought of introducing Public Bicycle Sharing [PBS] system to Mysuru city from the year 2000 and introduced the PBS by naming it as ***Trin Trin***

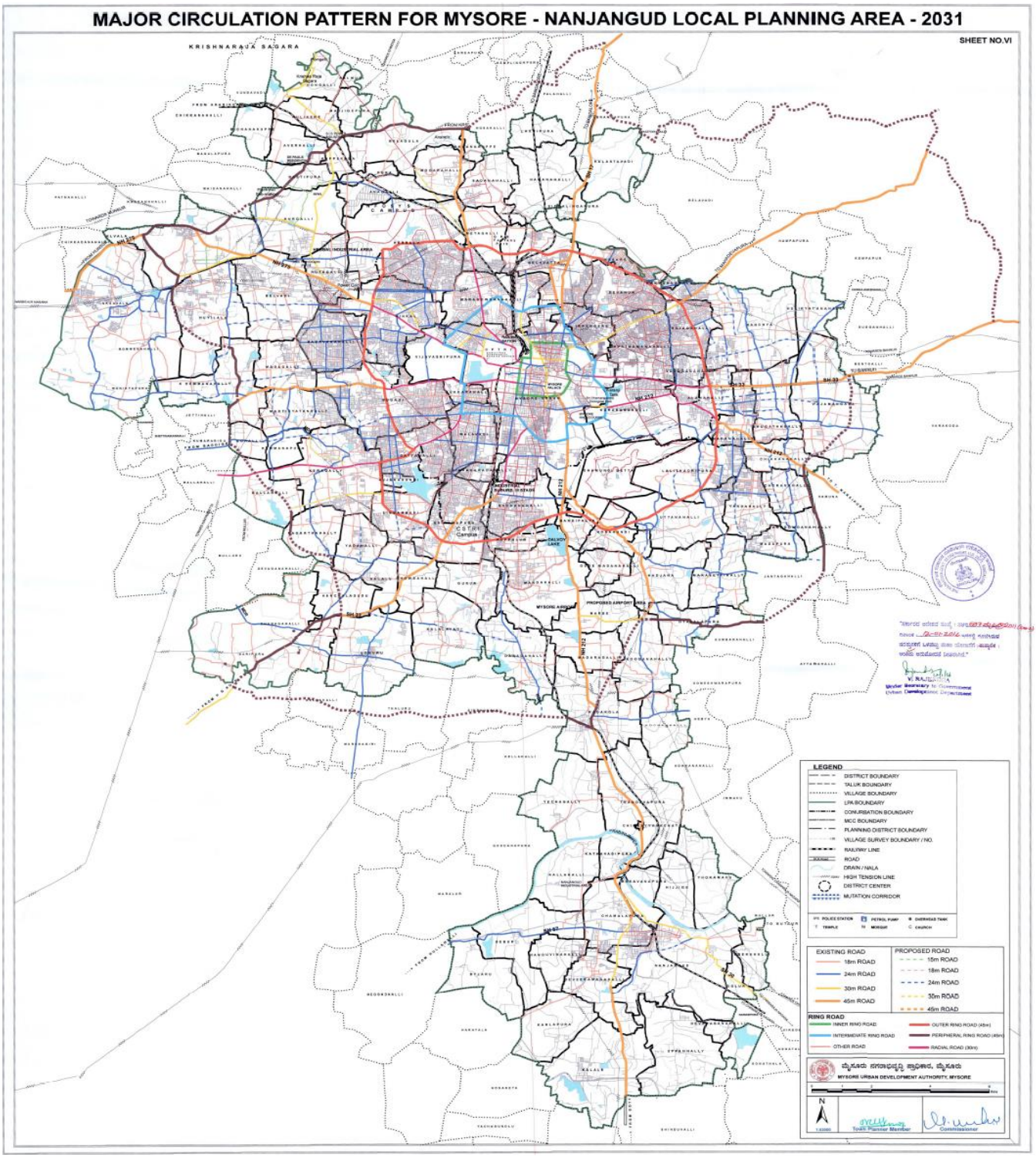

Figure 1.5 Major urban roar way network of Mysuru LPA as in Master Plan 2031.

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Source: *Mysore Master Plan 2031*

STUDY ON PUBLIC BICYCLE SHARING SYSTEM IN MYSURU CITY:

Mysuru City Corporation has implemented a Public Bicycle Sharing System [PBS] from the year 2016. The PBS has been implemented to the whole city by selecting a convenient location of bicycle docks with an intention of introducing citywide Bicycle-based transportation system to provide a low-cost, Environment friendly mobility option for city residents as well as for tourists. Bicycles are made available through a smart networking system by integrating the monitoring and management system with cycle of all docking stations. Users can avail and check out cycles at one station and return them to any other station in the network, the managing authority also has mechanism to redistribute the bicycles to balance the demand among the docks accordingly through the centralised governing system.

Directorate of Urban Land Transport [DULT] is the state level monitoring organisation through agencies for the implementation of Public Bicycle Sharing System (PBS) in Mysuru. The project was funded by World Bank Global Environment Facility [GEF] grant, to execute through DULT & Mysuru City Corporation. The PBS is branded as with a tagline of TRIN TRIN with in English & in Kannada. On 17th July 2016, the brand name, logo, website, brochure and cycle models of Mysuru PBS were launched at a public event held in Mysuru.

A Government order has been issued to set up a Project Monitoring Committee for periodic monitoring and supervision of PBS Project under the chairpersonship of Deputy Commissioner, Mysuru District with the group of members: Deputy Commissioner Mysuru District, Mysuru, as Chairperson, and members are Commissioner of Mysuru City Corporation, Commissioner of Police, Mysuru;, Commissioner of Musuru Urban Development Authority [MUDA], Representative of Commissioner, DULT.

DC, Mysuru along with MCC Commissioner on ride before system implementation.

The World Bank team reviewing the PBS system in Mysuru

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In the beginning the PBS consists of 450 cycles at 52 docking stations and was made operational from the year 2016.The initial coverage area was on some selected major road ways to connect different destinations. The key destinations across Mysuru city like Race Course, Kukkarahalli Lake, Mysuru Palace, Chamundi Hill, Lashkar Mohalla, Bus Stand etc.

The PBS system was inaugurated by the Hon'ble Chief Minister of Government of Karnataka on 04.06.2017. Publics of Mysuru of more than 7000 members has been registered in the system as on 01.11.2017 along with a public awareness programmes.

TIMES CITY

India's first cycle-sharing scheme pedals on in Mysuru

'Trin Trin' Aims At Reducing Carbon Footprint

Automated system to reduce hassles

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The system components of Mysuru PBS systems are well equipped with 45 Docking stations are operational out of 48 docking stations. Total 700 ports were made operational out of 750 ports. In total 425 no. of cycles were put to use in the system out of 450 cycles. It was managed by a central control centre with set-up of a website and Mobile phone app (Android and iOS) have been developed. The city has 6 Registration centres along with 6 Mysuru one centres separate hub for performing Registration activities and for controlling and monitoring CCTV streaming was made available for 44 locations with 6 number of crew units for redistribution of bicycles was developed with a complete operational mode. But the initial glory of success started dampening due to following reasons as explored from the field studies and enquires of the PBS users.

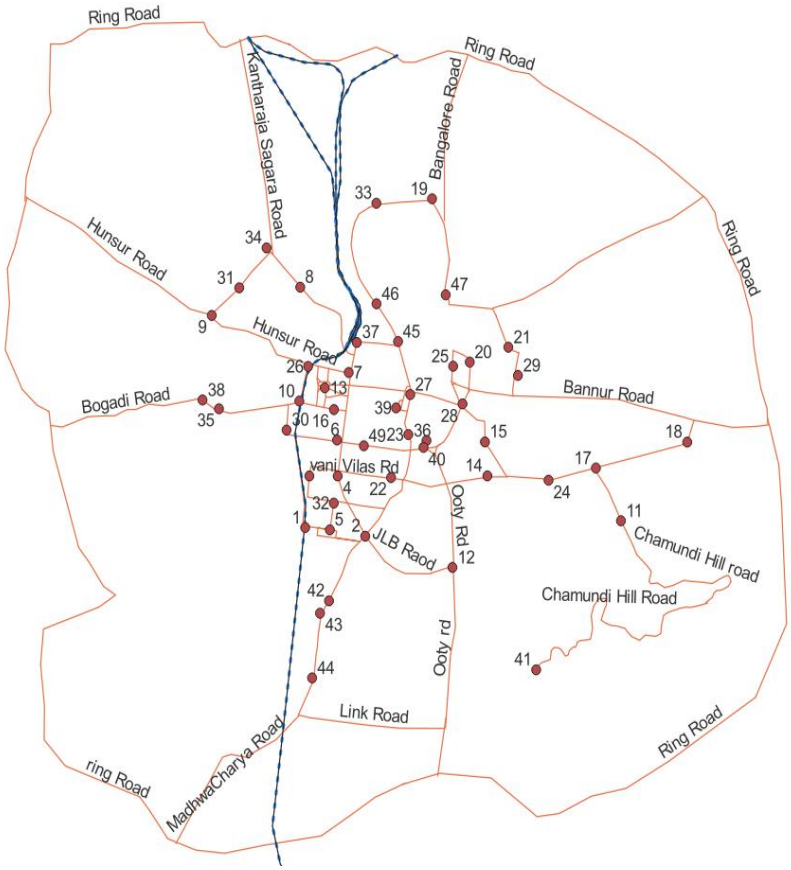

Fig. Docking Stations in Mysuru city with vehicle carrier for redistribution of bicycles

Station locations for PBS:

Location and station design for PBS is a function of the level of demand, the amount of space available, and the nature of the roadside environment. As the master plans of Mysuru city does not allocate dedicated space for PBS stations, the authorities

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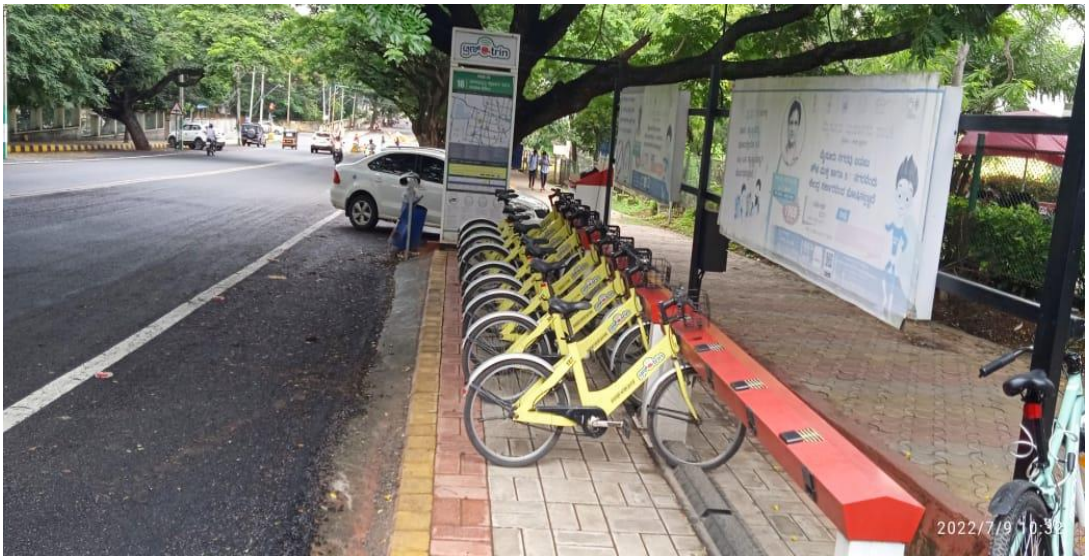
attempted to provide over foot paths and other areas conveniently by compromising all the planning and design principles of NMT. But all stations were accommodated with supporting infrastructure such as automated check-in and check-out with smart cards or other electronic payment mechanisms. Automated systems reduce operating expenses, improve efficiency, and provide a better user experience.

Other implementation challenges are about Site Clearance. Although most of the sites belong to the Mysore City Corporation, getting site clearance taking much longer time than expected. And alternate site locations: Getting the alternate site locations with a provision of 1.5m clear footpath space was time consuming. The docs are located for NMT has Network Connectivity and also Clear line of sight was not available from many docking station to the Control center.

The implemented NMT has Operational Challenges also. The Redistribution of cycles at every week becoming a problem as about 300-500 new users are getting added and Identifying a redistribution pattern is becoming real challenge to the operator along with mobility of NMT with mixed urban traffic. The data Traffic becoming unmanageable, because of more no of check-in and check-out, the data traffic flow between the docking stations and control center is becoming too high.



Some of the key problems of PBS in Mysore city are

1. Encroachment of Hubs, Parking by motor vehicles on hubs
2. Poor surface quality and maintenance of tracks,
3. Lack of continuity of cycle tracks,
4. Low levels of security due to inadequate street lighting
5. Low software connectivity during to access the cycle from Hubs
6. Some of the Hubs are not access to the public Transport like Bus stand Auto station.
7. Lack of poor Infrastructure in the Hubs, like Don't provide the Roof systems on the Hubs
8. Some of the Hub's are don't have access to the institution centers
9. Using the poor System to access the cycle during pick hours
10. improper road width casus accident, Lack of safe cycling conditions in the cities

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11. Lack of innovative cycle promoting spatial planning for bicycle sharing for discouraging personal transport

RECOMMENDATION OF PROPOSALS:

The PBS has the potential to serve both as a last-mile mode and as an independent mode. The role is dependent on how cities master plan and mobility plan on city-wide integration of PBS with public transport prepared before the city develops.

Cities must have a clear objective for implementing a PBS system. The objective should drive the decision for selection of business model, system planning, and allowable form factors (pedal bicycle, pedal assist, electric powered bicycle etc.) within the PBS framework.

Indian PBS systems observe benefits like congestion reduction and emission reduction due to unique mode shift from two-wheeler to bicycle. Along with Financial support from the public sector in the form of subsidy or Viability Gap Funding (VGF)is critical, the cities have introduced e-bikes without pedal within the regulatory framework of bicycles. While these modes do serve as an innovative mobility solution for last-mile connectivity, cities need to align their choices with their intent to implement PBS.

The city road networking, road hierarchy system, neighborhood block and zoning should be planned and designed to accommodate threshold scale of PBS systems mostly cater to short trips of 2 – 4 km with a dense network of stations across the coverage area, with a spacing of approximately 300 m to 500 m between stations.

Cycles must be upgraded with specially designed parts and sizes to discourage theft, with a fully automated locking system at stations that allows users to check cycles in or out without the need for staffing at the station.

Electronic tags to track where a cycle is picked up, the identity of the user, and the station where it is returned. The identity of the user is associated with that of the cycle to ensure security. Redistribution of cycles to ensure availability of cycles and empty docking points and Real-time monitoring of station occupancy rates through information technology (IT) systems, used to guide the redistribution and provide user information through the web, mobile phones, on-site terminals, and other platforms.

Pricing structures must be lowdown to incentivize short trips, helping to maximize the number of trips per cycle per day. So the Cycle sharing goals can be extended to reach the city's public to integrate other transport system by solving the "last mile" problem. It enhance the image of cycling to facilitate modal shift in turn reduce congestion and improve air quality by attracting private vehicle users thus improves the environmental quality.

An assessment of the current state cycle infrastructure in the city should be updated with land use in turn urban planning system, as the Cycle sharing can be implemented even if there is little existing cycling infrastructure, but pairing the construction of new cycle tracks with the opening of a cycle sharing system can add to public acceptance and enhance safety for users of the new system. To have updated combined cycle sharing with street design improvements for more and continuity in improvements. The stations should be placed near important origins and destinations, including public transport hubs, points of interest, libraries, colleges, markets, shopping malls, and at strategic positions in residential areas. In the absence of a single important building, stations should be placed nearer to intersections to serve origins and destinations in multiple directions. These planning should synchronizes the character of urban mobility pattern, city functional and physical character.

Initiate a process for enactment of a legislation that will comprehensively address pedestrianization, the mandatory implementation of important guidelines for walkways, traffic volume reduction measures, and strongly enforcing penalties on motorists for encroaching into pedestrian space or NMT otherwise violating pedestrian rights. A dedicated NMT cell should be created within the planning authority at city level. This cell should be responsible for handling of dedicated NMT funds for planning, implementation and maintenance of NMT infrastructure. The Master planning of cities should be done in line with the objectives defined under the National Urban Transport Policy and should be enforced according to the conditions specified under the central funding scheme.

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CONCLUSIONS:

There are various guidelines and documents available for Planning, and design implementation of PBS systems, both in global and Indian contexts. Integrated Transport Development Plan has published a guidelinefor planning bike-sharing systems. The Sustainable Urban Transport Project (SUTP) under MoHUA has published development guidelines for Transit Oriented Development, NMT, and PBS. MoHUA also published a toolkit for PBS systems for Indian cities. Though these exists there is a need of updating the land use planning principles, standards, policies and regulations in existing urban planning practicing systems to take forward the PBS systems in cities of Indian context by treating this as urban prerequisites.

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