

Upgradation of the Existing Urban Infrastructure to Achieve Standards of Comprehensively Developed Smart City

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Abstract— A smart city is that city which uses technology to make most favorable utilization of resources to build cities more efficient, people-centric and sustainable. If we observe, in the two last decades, urban infrastructure in most of the Indian cities has been in many aspects upgraded. Current expressways, flyovers, bridges and airports can be traced at most of the big cities in the country. But, the urban services quality has not kept rate of knots with the population explosion into our major urban centers. Overcrowding led to space crunch, which is resulted due to lack of scientific and effective utilization of spaces. A smart city is accredited by smartness all along multiple parameters, with smart governance executing a master role in assisting each of them. Government of India has taken an initiative to build up 100 cities as smart cities. Main gears of development based on area within the Smart Cities Mission includes city enhancement (retrofitting), replenishment of city (redevelopment) and city extensions (Greenfield development/growth) along with an initiative of Pan-city development which confirms covering larger parts of the city, Smart Solutions are applied. In this paper, research is carried out in Orange city- Nagpur. In the year 1818 fort built on the twin hills of Sitabuldi, the town is dominated by the British, located at centre of the city. Zone 2 Dharampeth, is studied for this research among 10 main zones of the city. Research design, adopted is Maxwell's Interactive model which both had order, nor directionality and would facilitate us to not only expand an understanding of the definite structure of our study, but also to graph our study and carry it out (Maxwell 2005). To craft a smart city, this paper studies the strategic outline identified four broad escalation direct solutions: building a new sustainable city, movement people and not of vehicles, achieving accomplishment in providing citizen services, and reformation economy.

Key words: Smart City, India, Nagpur, Smart City Model, Maxwell's Interactive Research Model, Vayusena Nagar, Rejuvenation of Lake, Capacity Loss, Usable Capacity

I. INTRODUCTION

Climate change, increase in population, urbanization and resource depletion demographic change, has created a big problem which denote that it is essential for world's great cities to get used to survive and thrive over the approaching decades. Cities are considered as engines of intensification for every nation's economy, as one with India. As per 2011 Census about 31% of the total India's present population lives in metropolitan areas contributing 63% of the total India's GDP. With increase in urbanization, urban areas are supposed to contribute 40% for housing of the India's population and fling in to 75% GDP of India at the ending of 2030. But it needs comprehensive growth of physical, institutional, economic plus social infrastructure. All these things are very important in nourishing the life standards

and attracting people and to create investments to big City, moving a righteous cycle of development and growth. Smart City development is a walk in that direction. With rapid growth of India's population, citizens are bound to shift to cities.

After Initiation of Industrial Revolution, Human development has had severe repercussions onto the environment, destructive actions as well as growth of human society leads to harmful impacts on the Earth's sub-systems.

The government targets on developing new satellite towns by making the pre-existing cities smarter. The purpose of smart city development is to encourage cities that make available core infrastructure and to provide a decent eminence of life to citizens as well as an uncontaminated and sustainable environment with means of 'Smart Solutions'.

Maxwell's Interactive model for research is adapted for this compound study of the area. Less restrictive concept for qualitative research with blueprint than supplementary usual linear approach, this research interactive model allows ensuring that every phase can merge together for functioning as a whole.

The basic elements of infrastructure in a Smart City would involvement of:

1) Smart Transportation with Urban Planning

- Intelligent Traffic Management
- Smart parking
- Advance Safety control
- Sustainable and efficient public transportation

2) Clean Energy and Environment

- Renewal energy sources and system
- Green building infrastructure
- Energy efficient facility
- Smart grid system and metering

3) Project Governance Requirements

- Citizen interaction and engagement
- Public information facilities
- Monitoring system for execution of projects
- Financial framework for development of the tiny cities

4) Water Distribution and Waste Management

- Sustainable water management facilities
- System for Water quality monitoring
- Waste disposal
- Sewage treatment system
- System for recycling e-waste
- Advance waste collection

5) Smart Communication Techniques

- Citywide wireless networks
- Wide Wireless connectivity in city
- Smart monitoring
- Smart cards and other applications
- Sensors, smart devices like routers, modem and other

- GIS system
- Mobile apps and other relevant devices

A. Smart City

At present, there is no such unanimously established clarification of a 'Smart City'. Hence there are diverse presumptions towards different people. Therefore the thought of Smart City, hence, varies from a city to other as well as a country to another, solely lying on the level of development, apprehension towards transformation and to get reformed, required resources, aspirations and vision of the city residents.

A smarter city (i.e. smart city) utilizes digital or information and different technologies of communication to enhance quality and efficiency of metropolitan services, to lower costs as well as consumption of the resources and to pamper more actively and effectively with citizens. In smart city present-day system is so utilized that the arrangements and seams of the various inner-city systems are made simple, responsive, clear, and even flexible. Citizens are engaged also informed in the connection among their activities, with their neighborhoods, and the urban ecosystems sprinkled widely, but they are encouraged to witness the city itself as incredible they can tune collectively, so that it becomes efficient, adaptive, interactive, engaging as opposed to the mono-functional, inflexible, as well as monolithic structures of lots of 20th century cities.

B. An Initiative taken by India's Central Government – 'Smart Cities in India'

Experts envision that about 25-30 natives would move about an every minute from rural areas in an Indian city in look for of relatively better employment and better lifestyle. It is predictable that by the ending of year 2050, 843 million inhabitants will be living in cities of India.

To make possible this huge urbanization, India need some smarter ways to handle the complexities, augment efficiency, lower expenses and make up on the qualities of living. India is scheduling 100 new smart cities development and it will build up modern and advanced satellite towns in the region of the pre-existing cities included in this programme. Government of the India has put aside 70.6 Billion Rs (near about USD 1.2 Billion) for project of Smart City development in current Budget 2014-15. Smart Cities in the direction of creating 10-15% boost in employment. Department of Urban Development Ministry planning for strategic development of any two smart cities in every state. The AMRUT i.e. Atal Mission for Rejuvenation with Urban Transformation planning for spending INR 50,000 Crore Rupees (USD\$ 8 billion) in subsequently five years for 500 cities in such towns having minimum population of 1 Lakh. As per the administrator, smart cities are going to built in three phases, the first phase is started in year 2015 would intend to construct 20 smart cities and on other side the rest would be completed in two phases including 40 of each. While making an allowance for population, these selected 20 cities should have 3.54 crore inhabitants. Bhubaneshwar is at top of this list. List includes, Bhubaneshwar, Jaipur, Ahmedabad, Kochi, Pune, , Indore, Vizag, Surat, Shilapur, Jabal, NDMC, Coimbatore,

Dhavangiri, Kakinada, Udaipur, Guwahati, Chennai, Belgaum, Ludhiana and Bhopal.

In month of April The Cabinet had agreed about 1 Lakh Crore Rs investment in urban expansion under Project of Smart Cities mission and for 500 AMRUT cities with the purpose of is outlaying Rs 48,000 Crore Rs for Smart City Mission and Rs 50,000 Crore Rs, for AMRUT city development.

C. Need of Cities Development as Smart

Objective of mission for developing Smart Cities includes promoting cities with predefined aim including provision of core infrastructure and give a decent living to its citizens, a spotless and sustainable environment and other application of 'Smart Solutions'. The core of this undertaking is to develop sustainable and inclusive environment and the theme is to look at compact and undeveloped areas, to create a model which will operate like a light house to some other aspirant cities.

If we observe in last two of the decades, metropolitan infrastructure in most of Indian cities has upgraded. Modern bridges, flyovers and airports, expressways can be found in most of the cities in the country. But, the superiority of urban services is not found developing by a rate with the population explosion in most of the major metropolitan centers. Overcrowding is resulting in space crunch, which is now intensified due to lack of well-organized and scientific consumption of urban land. The rising urban population exerting unbearable high stresses on the environment which contributing to decline in qualities of lives of most of the people. To get by up with demands of society urban planners have approached with idea of development of the complete inner-city eco-system, represented via the four aspects of the comprehensive improvement i.e. social, institutional, physical infra in addition to economic. This be able to ascribed as a long term goal as well as cities can be understood to work towards mounting such comprehensive infrastructure development adding together 'smartness' layers.

D. Smart City as a System

Present-day idea about the incorporated sustainable city of the metropolitan as a system-can only beamed reality with a elegance, integrated approach to both stratagem and delivery.

In a mutually interconnected metropolitan system, trees and green fortifications are used for naturally cold streets as well as buildings; along this green waste be able to convert into energy by means of anaerobic digestion or similar kind of organic treatment;

E. Profile of Nagpur City

Nagpur region dwells the north-eastern division of the Maharashtra. The region has approximately triangular shape. The region is rich in geographical with mineral wealth. As that of natural resources, fossils of flora as well as fauna both have been reported from this region in large numbers. Its quiet fascinating to note that, semi-valuable stones, rock crystal with agate forms to make beads were utilized in pre-historic period. Readily accessible natural resources with climate may have occupied human settlement from the time of pre-historic era.

F. Need of Development in Nagpur

It would be imperative to scientifically revamp the present infrastructure like transport, roads, civic facilities, water supply, sewerage system and other such allied elementary services that make a city enjoy living. To achieve this objective, it is imperative that sustainable use of natural resources, designing customized city development models, securing funds for the projects and ensuring optimal use of technology. Due to lack of phased planning, the essential infrastructure to achieve the desired development has not taken place. The cities need ought to be developed as to function engines of economic development.

Availability of requisite funds and revenue model are very important for implementing any infrastructure development of projects. Unfortunately, the projects are conceived without making clear as to how far such projects are viable for implementation. Funds are sanctioned but sometimes later such projects are found to be non-viable. Due to lack of regulatory and monitory mechanism to access the viability of the projects, assigned funds are either misused or diverted for some other purposes. Hence, there is the absolute requirement for making detailed guidelines to work out proper control on utilizing funds and the implementing only such projects that are sanctioned by the Central Government. The facilities and requirements of modern era are very imperative for important cities like Nagpur. This city which is the fastest growing city in terms of industry, education, agriculture, health services and population wise basically faces lack of modern and improved infrastructure. Nagpur has experienced extraordinary growth in population which has already increased to nearly 32 lakhs. Government is planning create 10 crore houses which could be made possible only if 500 another towns are created with the funding from Centre and State.

The present state of infrastructure facilities and service delivery is not adequate in Nagpur and there is an pressing need to formulate a strategy to get all the essential requirements accomplished like healthy mass transport system like mono-metro rail then creation of satellite towns etc. Being a centrally located place Nagpur has come to be recognized as a strategically important and is the geographical centre of India.

II. METHODOLOGY ADAPTED

A. Research Design: Maxwell's Interactive Research Design

Realizing the knowledge of smart city needs complete perceptive of the complexity of city with interconnections among the societal gears as well as services with the material environment. The pathway towards fetching a sustainable satellite city needs strategic proceedings with gears, which take in hand the complexity for organization in a holistic mode. All the way through a SSD i.e. Strategic Sustainable Development come up to actors inside an organism can work simultaneously with aggressively evolution from beginning, untenable state of civilization to an ecologically and generally sustainable society.

By applying sustainable improvement in a calculated approach achieved from end to end by a method of systems thinking, acceptance of sustainability in the

course of meaning that is based on methodically agreed on main beliefs, with a rear casting by an ideological strategy. SSD can be applied all the way through a structure, which is now stated as the Framework for the Strategic Sustainable Development i.e. FSSD. Respective structure allowing a multiplicity of stakeholders divided up a mental replica, aiding in acceptance of the complex dilemma recognized in smart city idea.

This research was planned around the five component parts as shown in outline below,

1) Goal

The objective set as, all the way through a Development in Strategic Sustainable social approach, to build up recommendation for the practitioners of smart city to shift their respective cities towards sustainability resourcefully and successfully.

2) Intangible framework of research study

The framework of study gives a primary knowledge about the study region and a Smart City Model representation including all other aspects that are desirable in development of a region as smart.

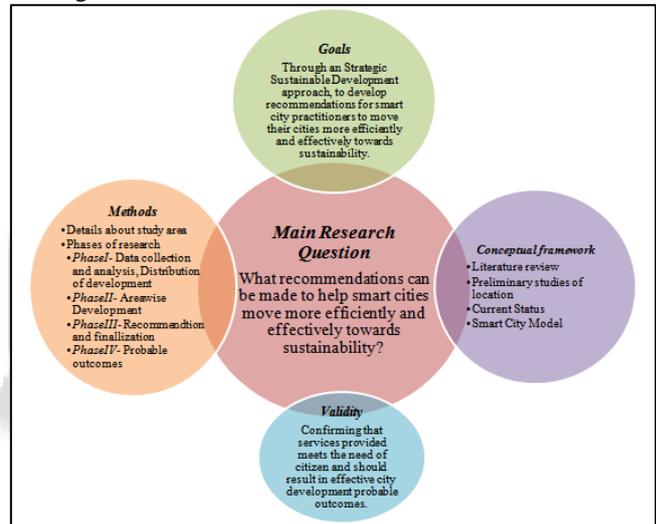


Fig. 1: Research design (adapted from Maxwell 2005)

3) Main Research question

The investigation questions formulate following the goals with intangible outline of blueprint is determined to assist in clarifying what we exclusively required to comprehend through this learning. The most important study question comes as, "What commendations can prepare for supporting smart cities shift in more efficient with effective way towards achieving sustainability?"

4) Methods

Data was gathered first, then simplified to the investigate structure which is passed out by dividing study into 4 phases as shown in figure.

5) Validity

Confirming about services provided meet the call for citizen and should end result in effective urban development with probable outcomes.

III. THE MODEL FOR SMART CITY

Giffinger et al. 2007 presented 6 different depicting characteristics in which smart city development should planned. Each feature comes by way of position of factors which appraise success. These models provide simplified

view throughout which anyone can assess comparative strengths with weakness of smart cities. This model was completed chiefly used for mid-sized city, however has been applied in diverse contexts.

<p>Smartness in Economy (Competitiveness) Innovative Spirit, Productivity, Flexibility of labour</p>	<p>Smart Natives (Social/Human Capital) Affinity for life-long learning, Participation in public life, Creativity and flexibility.</p>
<p>Smart Governance (Participation) Participation in Decision making, Transparent Governance.</p>	<p>Smart Mobility (Transportation and ICT) Local Accessibility, ICT infrastructure, Sustainable, innovative and safe transport systems.</p>
<p>Smart Environment (Natural Resources) Attractiveness of natural Conditions, Environmental protection, Sustainable resource mgmt.</p>	<p>Smart Living (Quality of Life) Cultural Facilities, Health Conditions, Housing Quality, Social Cohesion.</p>

Fig. 2: Six Different Characteristics of Smart City Model by Giffinger et al. 2007

A. Smartness in Wealth

Smartness in Wealth referred for a city's on the whole competitiveness which is based on its inventive approach towards commerce, research and development i.e. R&D spending, productivity, opportunities for entrepreneurship and liveness of labour markets, with the cost-effective role of the metropolitan at national as well as international marketplace.

B. Smart Natives

Smart Natives means a towering and reliable point of education delivering towards people, as well describes excellence of the social communications with artistic consciousness, permissiveness at stage of involvement that citizens clutch in their communications among the public living.

C. Smart Supremacy

Smart Supremacy more exclusively addresses contribution at municipal level. The ascendancy organization should be transparent as well as allows citizens to play a part in administrative. It proved easy for citizens to way in information as well as data relating to the administration of their capital by means of ICT infrastructure. By means of creating new efficient as well as interconnected authority system with barriers linked towards collaboration and communication can be removed.

D. Smart Mobility

Smart Mobility administrates additional proficient transportation systems (for e.g. non-motorized ways) as well as promotes innovative societal attitudes for automobile usage which ensures aim of citizens having right to use local as well as civic transportation, and that of ICT yet again it is incorporated to boost efficiency. Smart city seeks out to boost how proficiently citizens, vehicles with goods are elated in an metropolitan atmosphere.

E. Smart surroundings

Smart surroundings emphasizes necessitate liable resource administration as well as inner-city planning with sustainability. In the course of emission and pollution reductions and hard work towards the environmental security with natural splendor of the city can be able to enhance. Smart city encourages diminution of energy expenditure, with the incorporation of new-fangled hi-tech innovations with the intention of resulting in efficiency gains.

F. Smart Livelihood

Smart livelihood seeks to augment the quality of living of citizens, in addition to provision of healthy and safe living wage conditions. Citizens in elegant cities have easy admission to health care amenities, electronic health administration, and to assorted social services provided.

IV. PHASES OF DEVELOPMENT

As per the research model implemented to this study, project work is distributed in four phases which simplifies the project structure. Entire area is analyzed in phases and suitable recommendations are made as,

- Phase I- Data Collection and analysis
- Phase II- Area wise Development (area studied are, Futala Lake, Telankhadi Hanuman Temple, Western Coalfields, civil lines, WCL road, Seminary Hills Road)
- Phase III- Finalization and Recommendation
- Phase IV- Probable outcomes

A. Phase I Data Collection

1) Preliminary study of locality (Nagpur City Profile)

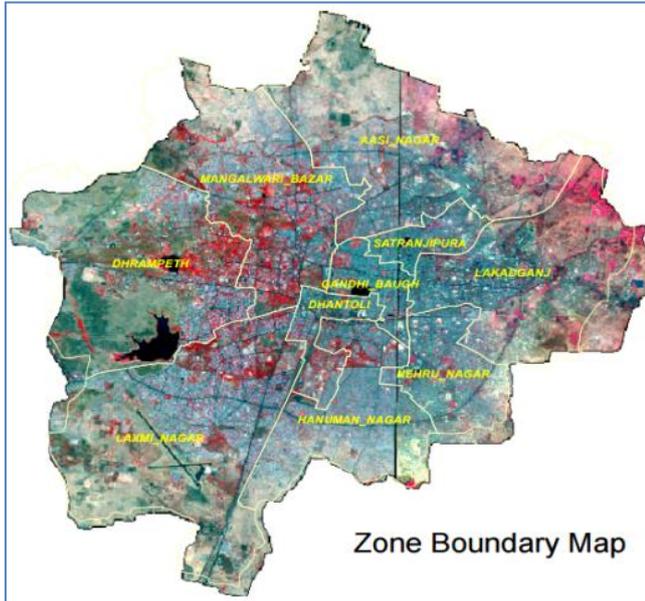
Nagpur city is 300 Years old city. It is awarded as second greenest city & Geographical midpoint of India. A heritage monument called as, Zero Milestone of India located within the city. Nagpur is well-known as, Orange City, is the largest capital in Central part of India. It is a winter capital of Maharashtra. City is connected to all main cities in the country by Air, Rail and Road resulting in Global Connectivity. City is emerging as Cargo Hub as well as Health and Educational hub.

Discription	
Actual Population/ District population	4,653,570
Nagpur city population	20.52 lakhs
Total Nagpur District area	9897 sq. km
Nagpur city area	217.65 sq. km. (2.2%).
Municipalities/zones	10
Population in the city of Nagpur lives in slums	36%
situated at	21° 06' N latitude
	79° 03' E longitude
Water supply	645 MLD
Sewerage length	1670 Kms.
Water pipeline length	3200 Kms.
Road length	3947 Kms.
Lakes	11 Nos
Rivers	3 Nos.

Table 1: Nagpur City Profile

2) Distribution of Nagpur Zones

Different departments of Nagpur Municipal Corporation (NMC) like public relations, health, roads, finance, public works, local audit, octroi, library, slums, establishment, buildings, street lighting, traffic, water works, education and gardens, legal services, fire services manage their detailed activities. The NMC actions are administered by its zonal office.



Prepared By: Maharashtra Remote Sensing Applications Centre, Nagpur

Fig. 3: Nagpur Zone Boundary map
NMC divided city in 10 different zones which are operated by individual respective zonal offices,

Sr No.	Zone	Area in Ha.
1	Dharampeth	4084.63
2	Laxmi Nagar	3516.31
3	Hanuman Nagar	2181.52
4	Dhantoli	815.37
5	Neharu Nagar	1423.69
6	Sokta Bhawan	556.07
7	Satranjipura	744.48
8	Lakhadganj	2406.16
9	Ashi Nagar	3225.02
10	Mangalwari	2109.06
Total		21062

SN	ZONE	wards	Population	Slums	Slum Population	Garden	108 service	referral hospital	Drinking water spots
1	Laxmi nagar	13	239171	48	60672	19	4	3	27
2	Darampeth	11	159458	37	64248	14	3	2	31
3	Hanuman nagar	13	232247	35	62627	15	3	2	18
4	Dhantoli	14	208426	27	49642	14	1	5	35
5	Neharu nagar	13	243953	22	52205	11	2	1	26
6	Gandhibag	15	216866	30	95869	10	3	3	17
7	Satrnjipura	12	187044	45	110395	12	1	1	17
8	Lakadganj	15	333859	54	132601	12	2	2	24
9	Ashinagar	16	317321	73	103422	13	2	1	22
10	Manglwari	14	297320	53	75826	16	4	2	23
Total		136	2435665	424	807507	136	25	22	240

Fig. 4: NMC divided city in 10 different zones

3) Study Area- Zone-2 Dharampeth

Entire Dharampeth zone is distributed in six divisions (prabhag) and 11 wards. Each ward in zone2 represented by a designated cooperator and zone divided in 6 Divisions listed as, VNIT, Ambazari, Vayusena Nagar, Shankar Nagar, Civil Lines and Ravi Nagar. Latitude with longitude at Dharampeth zone are, 21.014179.0396 and 79.0396 respectively. Area of the zone found as, 40sqkm and population in 2004 is, 2,61,666 and the Total water demand in MLD in 2015is, 103MLD.

Division wise population	
Division	Population
Division 24- Vayusena Nagar	45,000
Division 21- Civil Lines	31,500
Division 25- Ravi Nagar	56,000
Division 52- Shankar Nagar	54,000
Division 53- Ambazari	57,000
Division 54- VNIT	19,500
Total Population in Zone 2	2,62,500

Fig. 5: Division Wise Population

4) Present Water Supply Distribution System at research location

Details about the water resources in entire city are given in chapter 02. Existing system of water circulation in of Nagpur display appx. 2100 km long pipe network which is separated into three different regions,

- At North-East-South parts of city - water supplied by means of Kanhan Head Works & Water Treatment Plant.
- At North-West-South-Central division of city -water supplied through pench project as well as by WTP Gorewada.
- North-Central region of city -water supplied from both sources, Pench & Kanhan

Water supplied at zone 2 is with means of 10 ESR/GSR with major resource of supply as WTP at Gorewada.

ESR/GSR	AMT OF WATER SUPPLIED (MLD)
Ram Nagar ESR	22
Ram Nagar GSR	10
Futala line	17
Riggle Line	5.5
Seminary Hills ESR	13
Seminary Hills GSR	3.5
Dabha ESR	7
Wadi Tekadi ESR	1
G H (Government House)Buldi	14
Dhantoli ESR	10
TOTAL	103

Fig. 6: ESR/GSR

5) Current Status of Dharampeth zone2

The existing state of infrastructure services and service liberation is inadequate in chosen area and there are critical needs to formulate a policy to meet all the vital requirements like capable mass transport system such as mono-metro rail, formation of satellite towns etc. Some of the major troubles in urbanization are,

- 1) Urban slump
- 2) Overcrowding accommodation
- 3) Unemployment

$$\% \text{ Reduction of Road Width} = \frac{\text{Width of obstruction (ft)}}{\text{Width of road (ft)}} \times 100\%$$

- Calculation of % of Loss in Capacity

Subsequently the percentage of capacity loss of the total road needs to be found. To discover the percentage of loss in capacity of the existing road by a definite factor, the equation used is,

$$\text{Capacity Loss} = \frac{\text{Length of obstruction (ft)} \times \% \text{ Reduction}}{\text{Length of road (ft)}} \times 100\%$$

- Calculation of % Usable Capacity of roadway

After computing the total percentage of the capacity loss, the percentage of serviceable capacity of the road is determined by plainly deducting the value obtained as capacity loss from 100,

$$\text{Usable Capacity (\%)} = 100 - \text{Capacity Loss}$$

b) Effects on Capacity/ Capacity Loss at Road Segment is Computed by,

Due to on street parking,

- Width of Road=9.5m
- Length of road=500m
- Width of obstruction= 2.8m
- Length of obstruction=1.3m+1.3m+1.3m=3.9m
- Capacity Loss=29.98%

Due to on/off street construction,



Fig. 10: Street construction

- Width of obstruction=2.4m
- Length of obstruction=15m
- Capacity Loss=75.78%

Usable Capacity at road segment = 50.617%

Development Strategies at respective road segment

- To increase literacy of people using Safety signs at Intersections.
- Waste bins at every 150m and GPS tracked collection vehicles.
- Solar Street Lights.
- Road markings for traffic guidance and to increase safety.
- Curb extension of 1m beyond shoulder/footpath should be provided at intersections.



Fig. 11: Analogs figures for present situation

- Local Street Design- "Yield" as well as "slow" conditions are outdated ways of calming traffic on native streets. This can lead congestion as well as did not provide sufficient safety to users. This can be overcome by proper road markings which divides the traffic can manage traffic in more sophisticated way as shown in figure, This concept can be implemented in most of the regions selected for study.

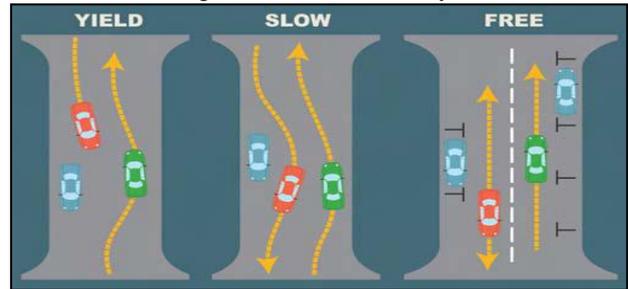


Fig. 12: Screenshot

- Shoulder of 1m width on either side of road should be allotted with carriageway= 9.5-1-1=7.5m



Fig. 13: Screenshot

A probable estimate is made prior to suggested development giving the idea about the total cost of the project including some of the development strategies.

Sr. No.	Item	No. of units req.	Cost per unit	Total Cost
1.	Truck with capacity 7.5 Tonnes with manpower and maintenance	1	*57 Rs./ km	57 Rs/ km
2.	Waste collecting bins at every 150m	3	5,200 Rs.	15,600 Rs.
3.	GPS Tracking devices on vehicle with server set up	1	18,000 per device	18,000
4.	Solar Street Lamps at every 10m (SL7 15 Watts Street Light) with panel stand	50	21,000 + 3000	12,00,000
5.	Retro reflectorised traffic signs size more than 0.9sqm	2	7562.00+362.00 (Labour charges)	15,848
6.	Providing line, dashes, arrows etc. on roads in two coats, a) over 10 cm. in width (white and yellow) b) upto 10 cm. in width	-	112+61Rs/sqm 118+62 Rs/sqm	a)8,21,750 b)8,55,000
Total				29,26,198 Rs.

*Ref. by DSR 2015-16-WRE Mech. Department Maharashtra and CSR 2015-16 PWD Nagpur

Fig. 14: Probable Estimate

2) Road segment from Chowpati road to Futala road, Vayusena nagar



Fig. 15: Road segment from Chowpati road to Futala road, Vayusena nagar

Some of the Problems faced, at this segment are, Polluted Water resources, Lack of parking spaces, Anti-environmental activities causing unhealthy lake conditions, helping in spreading water born diseases and at roadway, lack of parking area and no provision is provided concerning pedestrian safety.

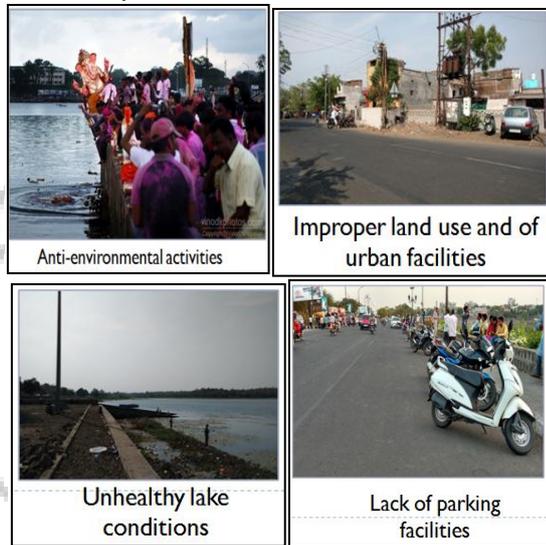


Fig. 16: Screenshot

a) Effects on capacity/ Capacity Loss at selected area Due to on street parking,



Fig. 17: Due to on street parking,

- Width of Road=14.60m
- Length of road=700m
- Width of obstruction 1= 2.16m
- Length of obstruction 1 =200m
- Width of obstruction 2 = 4.6m
- Length of obstruction2=100m
- Total Capacity Loss= 12.66%+13.50% =26.16%

Due to on street shops,



Fig. 18: Due to on street parking, No.s= 10 (approx.)

- Width of obstruction=2m
- Length of obstruction=3.2m
- Capacity Loss=6.26%

Usable Capacity=100-26.16-6.26=67.58%

b) Rejuvenation Futala Lake

The Futala Lake along with its environs near Telankhedi Garden at Amravati road, Nagpur is a popular picnic spot. It is a precipitation impoundment with a region of 26.3 Ha and 4-5 meters deep throughout monsoon. Lake is subjected to contamination due to human activities as well as cattle washing. Excessive nutrient weight (P, C and N) in Futala Lake have caused heavy spreading out of water hyacinth, wolfia, potamogeton, water lily, hydrilla, and mostly algae. Anaerobic conditions developed within the lake. Anaerobic bacteria release toxic gases into the lake water together with Hydrogen sulphide(H_2S), methane (CH_4) and ammonia (NH_3). These compounds are deadly to fish thus dropping the food chain competence.



Fig. 19: Futala Lake

(1) Lake Restoration- Treatment options

Following treatment options are suggested for lake restoration,

(a) Alum Treatment (Aluminium sulfate)

Benefits and other specifications of use of alum are,

- 1) Non-toxic material
- 2) Used for coagulation and flocculation of cloudy water.
- 3) Reduces quantity of nutrient phosphorous within water.
- 4) Controls algae
- 5) Depth of lake=4m
- 6) Area=26.3 Ha
- 7) Volume of lake=10,52,000 cu.m.
- 8) Alum dose required=10520kg (10mg/ltr)
- 9) A motorboat can be there used to create turbulence for mixing of alum in water.

(b) Biological treatment

This can be more effective due to following qualities of such treatment,

- 1) Without charge of pollution hazards
- 2) More everlasting
- 3) Carps be feeder of weeds- Common carp, Chinese gram carp, tilapia, and silver carp
- 4) Carps consume weeds the same as their body weight.



Alum



Siamese Carp

Fig. 20: Biological treatment

(c) *Prevention of silt entry to lake*

For maintaining the surrounding of the lake to enhance aesthetics of the lake the following option can be suggested,

- 1) Vegetation at bank sideways can effectively avoid soil wearing away as well as beautify the lake surroundings.
- 2) Gabion structure Size 1.0mX1.0mX2.0m with mesh of 4.4mm can be provided at the surrounding area to prevent erosion.



Vegetation along lake boundary



Gabion Structure

Fig. 21: Prevention of silt entry to lake

c) *Sediment basins*

During rainy season, run-off can cause major silt entry to the lake. To prevent this, sediment basins can be provided having specifications as follows,



Fig. 22: Sediment basin at site

- 1) Temporary structure of 3-4 year life duration.
 - 2) Max. size of particle settled = 0.005mm
 - 3) Basin shape- length to width quotient= 2:1 or more
 - 4) Embankment Side slope of 2:1 or flatter
 - 5) Top width 2.5m and height 3m.
- d) At road segment, the improvements made can be,
- 1) Dust bin provision at lake side and along road stretch.
 - 2) Road markings
 - 3) Shoulders of 1.5m on either side

- 4) Footpath= 1.5m
- 5) Carriage width= 14.6-1.5-1.5=11.6m
- 6) Parking area along restaurants and a special parking area of 24.1mX108.40m.
- 7) In front of restaurants, space available=5.87m

A probable estimate can be made as per the suggested recommendations as,

Sr. No.	Item	Units	Rate	Total cost
1.	Alum	10520 kg	6 Rs./kg	63,120
2.	Dust bins at roadside at 150m; 500ltr	5	5,200 Rs	26,000
3.	Truck with capacity 7.5 Tonnes with manpower and maintenance	1	57 Rs./km	-
4.	GPS tracking devices on vehicle with server set up	1	18,000 per device	-
3.	Dust bins twin at lake side 55ltr (550m)	5	3,000 Rs	15,000
4.	Providing line, dashes, arrows etc. on roads in two coats, over 10 cm. in width (white and yellow)	-	112+61Rs/sqm	17,68,060
5.	Gabion structures 1m*1m*2m	No.	3603.00+950	-
6.	Solar Street lights with panel stand	70	21,000+3000	16,80,000
TOTAL				

*Ref. by DSR 2015-16-WRE Mech. Department Maharashtra and CSR 2015-16 PWD Nagpur

Fig. 23: Probable estimate

e) *Parking facility at Chowpati road square*

Due to lack of parking space, there is increase in roadside parking by users which results into lack of safety to users as well as leads to traffic congestion. Specifications of selected area are,

- Length=108.40
- Width=24.10m
- Two entries on west face
- Protected with concrete walls



Fig. 24: Screenshot

Capacity of area 35 Cars and 48 Two-wheelers can be made available along with minimum 15% green area should be maintained. This can reduce 90% of the traffic problem near Futala Lake. This can lead to the proper land use as well as improvises the surrounding area.



Fig. 24: Futala Lake

3) Effect on capacity due to lack of Parking provisions at different locations

a) Capacity Loss at Hanuman Mandir, Futalalake

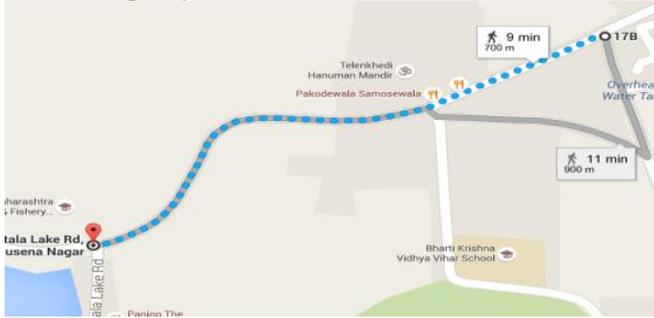


Fig. 25: Map

Due to on street parking,

- 1) Width of Road=13.2m
- 2) Length of road=700m
- 3) Width of obstruction 1= 2.16m
- 4) Length of obstruction 1 =50m
- 5) Width of obstruction 2 = 4.6m
- 6) Length of obstruction2 =70m
- 7) Total Capacity Loss= 11.68%+34.84% =46.52%

Due to on street shops,

- 1) No.s= 12 (approx.)
- 2) Width of obstruction=2m
- 3) Length of obstruction=3.2m
- 4) Capacity Loss=9.97%

Usable Capacity=43.51%

b) Capacity loss at Western Coalfields, Seminary Hills



Fig. 25: Map

Due to on street shops,

- 1) No.s= 3 (approx.)
- 2) Width of obstruction=2.3m
- 3) Length of obstruction=3.5m
- 4) Capacity Loss=15.25%

Due to on street parking,



Fig. 26: Parking

- 1) Width of Road=9.5m
- 2) Length of road=500m
- 3) Width of obstruction 1= 2.16m

- 4) Length of obstruction 1 =10m
- 5) Width of obstruction 2 = 4.6m
- 6) Length of obstruction2 =30m

Total Capacity Loss= 4.547%+29.05% =33.59%

Usable Capacity=51.16%

To rectify these losses,

- 1) For the area in front of restaurants, at Futala lake road, segments of parking area are marked, two Stretches can be marked of length 25m and 37m and of width 5.9m and 6.2m respectively.
- 2) At Hanuman Temple, Vehicles are parked on road in front of temple and food stops nearby. Parking stretch can be provided of 40.40mX7.10m.



Fig. 27: Vehicles parked on road

- 3) At Western Coalfields, traffic facing lack of parking spaces.

At stretch of 9.50mX8.40m and 8mX 4.40m at right and left side can be provided respectively.



Fig. 28: Parking spaces

- c) Probable estimate is made for the parking provisions including the proper safety markings,

Sr. No	Area	Specific ations	Pavement	Markings	Cost of Pavement+ marking (Rs.)	Total Cost (Rs.)
1.	Parking near Sharada Mandir	108.40mX 24.10m	Providing and laying Bituminous Concrete of thickness 30 to 40 mm on prepared surface with specified graded crushed stone aggregates premixed with Bitumen of VG 30 Grade	Providing line, dashes, arrows etc. on roads in two coats, over 10 cm. in width (white and yellow)	8,80,914+ 4,51,952	13,32,866
2.	Parking at Futala	a)25mX5.90m b)37mX6.20m		112+61Rs/sq m	a)62,820.25 b)97,701.46	1,60,522
3.	Parking at Hanuman Mandir	40.40mX7.10m			72,541.84+ 49,623.32	1,22,165
4.	Parking at Western Coalfields	a)9.50mX 8.40m b)8mX 4.40m	8378.00 +52.00 Rs./cu.m. (Job Mix, including diversion of traffic, heating bitumen and chips, mixing bitumen, chips and filler, transporting the mix)		a)33,986.82 b)14,991.68	48,979

Fig. 29: Probable estimate is made for the parking provisions including the proper safety markings,

C. Phase III- Recommendation and finalization

- 1) After analyzing some of the area of Vayusena nagar, there are some techniques that we can adapt for entire area in water supply and light sector.
- 2) Total road stretch=3.2km(southwest) + 6.1km(east) +3.2km(west)

- 3) 30% area of Vayusena nagar are having road network of width less than 4.5m.
- 4) Open spaces are used as dumping grounds instead of developing them as green belts.

	Development Strategy	No. of units	Rate per unit	Total cost (Rs.)
1	Solar street lamps for entire road stretch= 12.5km	1250	21,000 +3000	3,00,00,000
2	Water meters (Kranti 40 mm Bulk Enclosed Flow Meter)	50,000	5,189	25,94,50,000

Fig. 30: Phase 3

D. Phase-IV Probable Outcomes

- We can diminish impact on capability of roadway by providing parking spaces and proper road marking.
- Provision of water meters instead of traditional way of charging, can generate more revenue as well as water consumption will be less.
- By rejuvenation of Futala lake, it can enhance aesthetic look of city as well as reduces unhealthy lake conditions.

Parking provision can save upto 2,20,000 gallons of fuel till year 2030. By means of parking and shoulder provision we can utilize 100% capacity of the road.

- Solar street lamps are proved as cheaper than the regular lamps can reduce 20% electricity consumption. (Pacific missile range facility).
- The graph showing the effect on the road capacity of on-street parking, food stalls, on street construction work as,

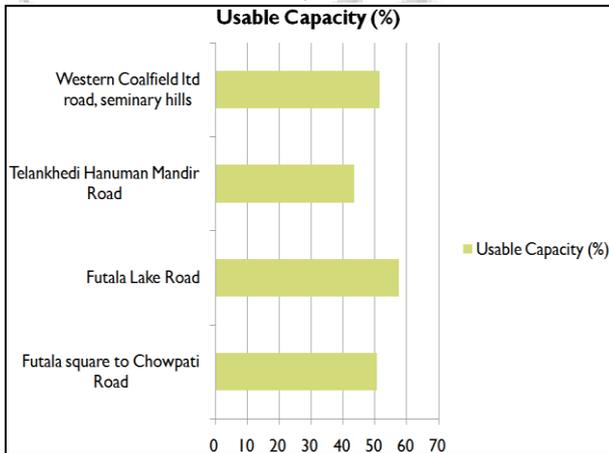


Fig. 31: Graph

Digital mobile apps are mean of linking people. Digitalization is avital aspect of the smart city. This can be efficiently used for mounting city as smart city.

1) Mobile -Digi-Tel App

Municipality is for all time by your side, everywhere at all times. Make contact with municipal departments, photograph and report about hazards, and keep up to date about how they are handled by authorities.

Telemedicine app meant for mobile devices, developed via Council of Associate Partner UST Global into

collaboration with Dr. Balabhai Nanavati Hospital based in Mumbai and Blackberry based mobile phone function that uses telecommunication to facilitate delivery of medical health care to inaccessible locations.

V. CONCLUSION

A huge number of residents of the city look as if to have no civic intellect. People throw garbage and other junk by the roadside and also in the parks at the night time. Even where dustbins provided by the city’s Municipal Corporation (MC), residents are seen as throwing garbage packed polythene bags outside the waste bins and trash at the space around. This pollutes air and causes problems for inhabitants who live in the locality of such dustbins. Maids wash courtyards and throw the unclean water on the roads in face of the houses instead of throwing that into the gullies. And so far the house owners don't utter anything.

Additionally, people are seen taking walk on the left face of the road while they should walk along the right side. Because you are able to have an eye on the approaching traffic and put away yourself by stepping out-of-the-way. At the same time of walking on left side, one have to constantly turn as well as look back to put away oneself from the traffic upcoming from behind. Such lessons should be taught in school days. But no one cares on the subject of such things. People here are habitually seen littering on the roads by throwing junk from their running cars. Where in the US, citizens are fined for such non-civic behavior. The trouble at this point is that, the offenders are neither punished nor caught by the uncaring staff - whether it is the Municipal Corps or police force. Minting money along with fattening pockets by means of catching the wrongdoers has turn out to be the order of the lawmen here. In the US, car drivers bring to a halt their vehicles if a person is crossing the road. But here, the person on foot crossing the road is showered by high-grade of abuses.

The smart strategy means any provision in development that can lead the present situation to change into the more efficient and lively for the people in the system. Small changes can create the big differences. The developments suggested in this paper, can enhance the aesthetics as well as can beautify the city only if implemented all over the city effectively likewise suggested for the selected area. Nagpur city can soon become smart city if every part of the city takes involvement in the development and play their respective roll with due respect and responsibility.

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