International Journal of Research in Engineering, Science and Management
Volume-3, Issue-8, August-2020
journals.resaim.com/ijresm | RESAIM Publishers


# Evaluating Urban Sprawl Requirements for Local Infrastructure Facilities of Kolhapur City

Rohit R. Chimanna[1*], Sushma S. Kulkarni[2]
[1]*M.Tech. Student, Department of Civil Engineering, KES' s Rajarambapu Institute of Technology, Rajaramnagar, India*
[2]*Director, Department of Civil Engineering, KES' s Rajarambapu Institute of Technology, Rajaramnagar, India*
*Corresponding author: rohitchimanna010203@gmail.com

***Abstract*: Urban sprawl is one of the major threats for any city. It acts as a barrier for the city's development. When the population of the city increases then the city's need also increases. Therefore, the responsibility of the corporation is increased to provide them all the basic infrastructure facilities like Water, Sewage, Road and Transportation etc. The population of Kolhapur city is increasing from past few decades as Kolhapur city is famous for Tourism, IT, Industries & Education. The population of Kolhapur city in 2001 was 4, 93,167, in year 2011 was 5, 49,236 and in year 2019 was 6, 07,123. And in the year 2030 the population will be 6, 86,718 [according to the statistical department of Kolhapur Municipal Corporation KMC)]. Kolhapur Municipal Corporation [KMC] is responsible for their basic local infrastructure needs. This paper is all about future requirements of Kolhapur city and KMC's work on infrastructure facilities like Water, Roads, Transport facilities and Sewage Network etc. for the future population of Kolhapur city for the year 2030 and population in year 2030 will be 6, 86,718. This paper consists of some current issues/problems of infrastructure facilities provided by KMC to city's people and simultaneously some recommendations over those issues/problems with its advantages. Methodology consists of collecting information from respective departments then site visits, calculating future requirements and then giving recommendations, suggestions and monitoring points after discussing with respective department officers.**

***Keywords*: Urban sprawl, Population, Local infrastructure facilities, Water supply, Sewage network, Road and Transport facility.**

## 1. Introduction

The developing countries like India having population over 130 crores and thus it's a challenge for science, technology and engineering to provide them each and every basic needs like housing facilities, drinkable water, health, roads and transport and many more in adequate manner. Now in each city the population is increasing. Migrated people from surrounding villages live in cities for better jobs, education and also for better lifestyles. Therefore, it's important for the municipal corporation to provide them all basic local infrastructure facilities in an adequate manner.

Sprawl is seen as 'the occurrence of growth in places where it is difficult to provide public services'. Additional transport infrastructures, utilities, and facilities for certain age groups are necessary when new residential areas are developed. These costs generally arise if urban development takes place in a dispersed manner toward the municipal borders [1]. The proportion of people living in the cities grows each year, either in developed countries such as the United States or in developing countries like China and India. The result of this population growth observed as an urban Sprawl [2]. If urbanization is fast and unplanned then it results into two negative impacts on the city, (a) Unavailability of green spaces that is Agricultural land, and (b) Unused vacant land as empty plots and abandoned structures, which results into urban sprawl to house the population. The studies of the core cities in developed and developing countries with high economic, social, and environmental costs [3].

Kolhapur city is one of the fast developing cities in Maharashtra due its location, due to the number of highways passing through the city, it's an ancient place, famous tourist place like Mahalaxmi temple, Educational hub like Shivaji University plus many colleges and IT hubs in recent years. Many people from surrounding districts and villages live in Kolhapur city for jobs and education. In future the urban population in Kolhapur City will continue to grow because of the migration of people from the nearby villages. Therefore, the city needs careful planning regarding basic facilities like Roads, Water, Sewage System and transport facility etc. in an adequate manner. Therefore, in recent years the city's population has tremendously increased. The population of Kolhapur city in 2001 was 4, 93,167, in year 2011 was 5, 49,236 and in year 2019 was 6, 07,123. From this we understand that population will also increase in recent coming years. So it's important to Kolhapur Municipal Corporation [KMC] to provide all basic infrastructure facilities to these people. And KMC is doing really good work. But in coming years the population will increase more and simultaneously the requirement also increases. So it's important to calculate the future requirements of infrastructure facilities for the future population situated in Kolhapur city for the year 2030, the population of Kolhapur city in year 2030 will be 6,86,718.

From the above all the information it is clear that much work has been done related to sprawl growth but now it's important

to work on future growth and its effect on respective Municipal Corporation. In future it's very important to provide all the basic needs like Water, Sewage Treatment, Roads & Transportation facilities in adequate manner to the people and for this responsibility lies with Municipal Corporation

## 2. Objectives

Following are the objectives of this paper:

1. Analyze the current situation of local infrastructures and calculate future requirements of local infrastructure facilities.
2. Develop a recommendation model over issues/problems of local infrastructure facilities for Kolhapur city.

## 3. Study Area

For current study, the selected Kolhapur city corporation area comes near Sangli and Satara district (Fig. 1). Kolhapur is a very ancient city. Kolhapur is one of the most important cities of Maharashtra. Due to this from the last three to four decades Kolhapur city has observed rapid growth. It is undoubtedly true that the population of the city increased very fast after independence. Due to population growth an urban sprawl means unplanned growth occurs which can disturbed and create problems on local infrastructure facilities for e.g. Transport facility, Water and Sewage network, etc.

The total Kolhapur city area is 69 sq.km. Kolhapur City is located in the south-west part of Maharashtra. The Geographical Coordinates are 16.42 north latitude and 74.14 east longitude. On the western part of the city lies the range of Sahyadri Hills; the Warana river flows along the northern boundary. Kolhapur city abutted by Belgaum District on the southern side. The population of Kolhapur city in 2019 is 6, 07,123.


Fig. 1. Location of Study Area

Fig. 1 shows the location of Kolhapur city in Maharashtra, India.

## 4. Methodology

To achieve above objectives following steps are adopted:

a) Visit Kolhapur Municipal Corporation departments like Water, Sewage, Road and Transport department.
b) Visit the Statistical Department of Kolhapur City for collecting information regarding population.
c) Collect all the basic information of these infrastructure facilities from respective departments.
d) Visit some sites like Water treatment plants, Sewage treatment plants, Bus depot, Major roads in the city, etc.
e) Study the current population with respect to available infrastructure facilities.
f) Evaluate the future requirements of these infrastructure facilities for the year 2030, for the population of 6, 86,718.
g) Develop a recommendation model which consists of recommendations over current issues/problems with its advantages.

## 5. Local Infrastructure Facilities

Local (physical) infrastructure is the sum of point and network infrastructure and utilities including public and semipublic facilities: Roads, Bridges, Public Mass Transport, Water System, Electricity, Postal Services, and Sewage. [1].

Local Infrastructure facilities are the basic facilities and installations provided by the corporation to the public within the city area. Roads, Public transport, Sewage network, Water network and Communication facility are some examples of local infrastructure. Cities need to provide some basic infrastructure services like clean water, sewage, roads etc. The infrastructure is important for faster economic growth and alleviation of poverty in the country. With urban population on a continuous rise the urban infrastructure is proving to be highly inadequate. The low capacity of urban local bodies, limited financial resources and multiple clearance channels have led to a mismatch in the demand and supply of urban services and development.

To study current situation of local infrastructure facility and analyze it for future, four major infrastructure parameters were selected;

1. Kolhapur Municipal Transport (KMT).
2. Road Network.
3. Water System.
4. Sewage System.

All the information regarding Road, Water, Sewage and Municipal Transport facility etc. are gathered from the Kolhapur Municipal Corporation [KMC], and also visited many sites for example Water Treatment plant, Sewage Treatment plant, Kolhapur Bus Transport Depot, etc. and the population related data is collected from Kolhapur Municipal Corporations [KMC] Statistical Department.

### *A. Road Network*

Kolhapur city is well connected through road transport

facility.

Its location on the National Highway, which has been recently converted into four lanes and may be converted to six lanes, provides ample opportunity for tour and travel services. It is a well-developed city and is steadily developing into an investment zone in the last few years. A five star MIDC, textile industries, and IT park are now being planned in nearby areas within the district.

Kolhapur city has adequate length of roads plus well connected through each and every part of the city by roads.

The major roads in Kolhapur city are of 6m-12m width. The five approach roads intersecting the city are of 15m-18m width. Major approach roads to the city are as follows: Shiroli Naka to CPR Hospital (Station Road), Rajaram Road (Railway gate no. 2 to Bindu Chowk), Shahu Naka-university-Baicha Putala-Shahu Stadium- Dewal Club-Mirajkar Tikti, Kasaba Bawada-Town hall-Shivaji Putala, Shivaji Pool to CPR hospital, Shivaji Putala to Gangawesh, Phulewadi to Gangawesh, Sane Guruji Vasahat to Rankala Wesh, Kalamba to Filter House and RK nagar- Subhash Nagar- Renuka Mandir.

Major traffic links in the city: Dabholkar Corner to Tarabai Park; Jawahar Nagar - Parvati Talkies- Gavat Mandai-Shahupuri- Gokul Hotel; Gangawesh- Papachi tikati-Corporation to Mutton Market; Timber Market- Gandhi maidan-Varun Tirth- Rankala Wesh- Gangawesh; Blood Bank-Collector's office- Dhairyaprasad; Station Road- Basant Bahar-Collector Office- Mahavir College; Hockey stadium -Gokhale College-Uma Talkies- Ford corner- Dasara Chowk; SSC Board- SIBER college- Takala.

The highways that pass through the city are: Kolhapur – Ratnagiri Road; Kolhapur – GaganBawda Road; Kolhapur – Radhanagari Road; Kolhapur – Gargoti Road; Sahunaka – Temblai Railway Gate.

Kolhapur city has adequate length of roads plus well connected through each and every part of the city by roads. Kolhapur city is well developed and as well as a famous tourist place. Therefore, tourists and visitors visit this city frequently. Mainly they come with their vehicles. KMC is exploring the involvement of the private sector in the form of a BOT project. In Kolhapur various projects are completed under UIDSSMT [Urban Infrastructure Development scheme for Small & Medium Towns]. But by 2030 PWD is required to do some major work in maintenance and repair works for roads.

### *B. Completed Projects*

#### *1) IRDP - Integrated Road Development Project*

In order to tackle the traffic and connectivity problems, KMC has proposed an IRDP under the UIDSSMT [Urban Infrastructure Development scheme for Small & Medium Towns] scheme and completed it in year 2013.Under this project KMC has done work like laying down of storm water drains, provision of footpaths and dividers, street lighting and beautification of roads.

#### *2) ORRP - Outer Ring Road Project*

This project aims to establish a developed network of main roads in the city joining the national highways. Under this project six entrance roads to the city, 2 internal roads, 10 link roads constructed and 1 underpass constructed. This project is almost complete.

### *C. Projects Required in Future*

#### *1) Truck Terminus*

Goods transport accounts for about 70-75 % of transportation in and around the suburbs of the city. Agricultural and commercial commodities are the primary goods being transported. The city is a transit point for interstate transport routes between Maharashtra, Goa, Karnataka and the Southern states and also serves as a key transport location. Emerging trends in transportation have caused problems of severe traffic congestion. Major business takes place in the heart of city like Shivaji road, Bhausingaji road, Mahalaxmi temple, Mahadwar road, Tarabai road, Rajarampuri road, Shahupuri, laxmipuri, Vyapar peth etc. So thousands of heavy trucks and tempos are entered in the city, resulting in traffic congestion.

Vehicles entering in city daily are as follows:

Trucks = 1500-1600,

Tempos = 2000-2100,

Other Vehicles = 20000-25000.

To tackle this problem KMC has proposed the development of truck terminus at the junction of NH-4 and road approaching Kolhapur city.

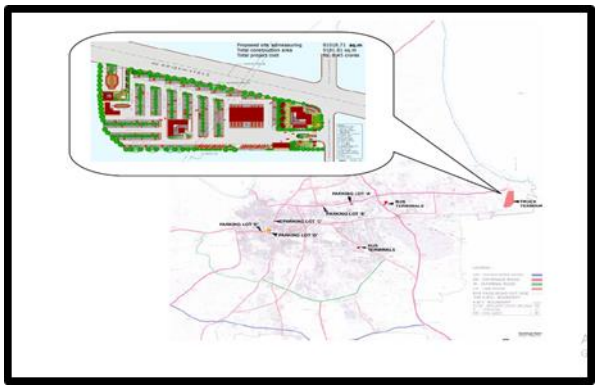

Fig. 2. Location of truck Terminus

Above image 2 shows the location of truck terminus at the junction of NH-4 and road approaching Kolhapur city. This project needs to be started as fast as possible to solve the traffic congestion problem.

#### *2) Bus Terminus*

All private buses start around the central bus stand (CBS) due to which the whole area experiences traffic congestion. Due to the increasing problems of traffic congestion, the Government of Maharashtra has enacted that private buses shall not start from within the 200 m circumstances from the central bus stand. All private buses now start from major approach roads to the central bus station; thus, traffic congestion takes place beyond this area and major accidents occur in this zone. As a result, travel operators and passengers face several constraints such as

the lack of dedicated berths for parking space, limited parking time, absence of passenger seating capacity at the terminal, issues of unofficial/ illegal parking charges, and lack of security in business.

In order to address these issues, the corporation has proposed to build a modern bus terminus with supporting infrastructure facilities for the passengers travelling in and out of Kolhapur. KMC has proposed this project under UIDSSMT [Urban Infrastructure Development scheme for Small & Medium Towns] scheme. The idea is to develop modern transportation facilities of required standards as per transportation guidelines. The function of bus terminus is to provide with the necessary facilities that would ensure smooth flow of the vehicles and passengers. The design will take into consideration traffic demand, traffic characteristics, and function of terminal and assessment capacity.

It will include a Grade one hotel with modern amenities like a gym and health club, a fast food Centre with pool side activities, booking offices, a conference hall, luxurious accommodation for tourists, shops, waiting areas, showrooms, space for local commodities etc. it will also include 24 hours restaurant, dormitories and good quality lodging for families. The total cost of the project has been estimated to be 15.78 crores.

Table 1 shows the current issues/problems in Road Network with its recommendation for solving it and its advantages.

*D. Following are some short term suggestions of road networks for better traffic flow*

1. Remove all the illegal encroachments results in an increase in usable area and also increase the carrying capacity of the road.
2. Increase carrying capacity through widening and improve riding quality through strengthening of existing roads.
3. Increase parking facility near Bus Stand, Gokul Hotel, CPR road, Prant office, Bindu chowk, Urmila Talkies, etc.
4. Construct a new multi storied parking system if possible.
5. Proper signals on important roads.
6. Make arrangements for Bus stops, rickshaw stops etc. must be on the side of the roads.
7. Construction of Truck terminus near entry of city is required.
8. Make arrangements for special Bus Lanes on turning points.
9. Underpass near Padmaraje high school for school children must be constructed as early as possible.
10. Street lighting on each and every road, especially on newly constructed roads.
11. Creation of hawker zones to remove encroaching hawkers from footpaths.
12. The dense areas are marked as core areas and no heavy vehicles are permitted to enter in these areas.
13. Allocate area for hoarding through proper study which will generate revenue.
14. Once a contractor fills the tender and gets selected for particular work, then it should be mandatory for the contractor to complete that project at anyhow.
15. Management of traffic consisting of heavy vehicles by notifying entry and exit to avoid traffic congestion.
16. Beautification of roads.

*E. Following are some long term suggestions of road networks for better traffic flow*

All approved parking lots in commercial buildings should be made accessible to the general public.

Table 1
Problems/Issues Identified with Recommendations and its Advantages.

| S. No. | Issues/Problems | Recommendations | Advantages |
|---|---|---|---|
| 1 | Encroachments in the Gaothan area are very high and results in reduction in the usable area of the road | Have a professional land survey.<br>Removing all illegal encroachment.<br>Fine charges for such encroachment for future.<br>Need to create hawker zones. | Increase in road usable area.<br>Smooth flow of traffic.<br>Roads will remain clean. |
| 2 | Average condition of the roads are bad and worsen during the monsoon. | Contractors should improve the quality of their work.<br>Inspection of quality of work from Kolhapur Municipal Corporation.<br>Maintenance and repair required as per time frame. | Less accidents.<br>Smooth flow of traffic.<br>Increases life span of the roads. |
| 3 | Absence of flyovers at railway crossings causes traffic congestion. | Clearance of NOC certificate from Railway department.<br>Location study required. | Reduction in traffic congestion.<br>Smooth flow of traffic. |
| 4 | For luxury, private buses and regional transport have not been allocated any parking area, through on the main roads causing major traffic congestion. | Proper location study for parking.<br><br>Special pay and parking arrangement for these vehicles is required. | It will provide additional income to the corporation.<br>No traffic congestion on major roads.<br>Smooth flow of traffic. |
| 5 | Street lighting is poor in the newly developed areas | Quick arrangement of street lighting is required. | Increase in safety of people during night.<br>Prevention of accidents. |
| 6 | Development of roads are not done as per City Development Plans. | Strictly follow the development plans of the city and timeframe. | Timely project completion as per development plans. |

1. Relocation of the Railway station and Bus stand from the center of the city.
2. Shifting of Transport offices and Grain Trading offices to market yards.
3. Construction of footpaths/pathways on the side of the roads.
4. Replan the old bazaars in order to bring about efficient utilization of space.

### *F. Kolhapur Municipal Transport (KMT)*

*Transport is essential for cities overall growth:* help people access jobs, support innovation, productivity and economic growth in cities and the national economy, help cities attract new firms, unlock new development sites for business and housing.

Kolhapur Municipal transport [KMT], corporation undertaking, provides public transport in Kolhapur. Currently, 112 buses with KMT on 101 buses are online right now. There are 27 identified bus routes in the city. KMT covers all over the city with nearby 64 villages. The buses operate for 24,000 km every day and cater to the needs of around 1, 25,000 passengers. There are more than 285 bus stops in the city. KMT faces major financial constraints as it is unable to increase the fare and the O & M costs have shot up due to high diesel prices. Besides this, there are more than 15,000 rickshaws plying in Kolhapur. KMT faces severe competition from the three- seaterand six seater rickshaws. These rickshaws have stage carriage. i.e.,

### *G. Current data on KMT Facilities*

Available buses = 101,
Daily passenger = 1 to 1.25 lakh,
Number of drivers = 369,
Number of conductors = 317,
Buses travel on 27 different routes.

KMT covers the overall city plus nearby 64 villages. KMT has more than 258 bus stops.

KMT buses which are in service.

KMT has 112 buses but 101 are on line, remaining are under issues like accident claim, waiting for spare parts, available nos. of drivers and conductors. KMT are managing their fleet from available resources like Money, Man and Machine.

KMT has sent a request for new 75 Electronics or electrical battery operated buses to the central government, each bus cost 1.5 crore.

*Major Income of KMT:*

- From ticket sales i.e. from passengers.
- Interest from banks.
- From hoarding [advertising].

*Major Expenditure of KMT:*

- Salaries of employees.
- Diesel required for buses.
- Repair and Maintenance of buses.

### *H. Future Requirement*

According to CIRT [Central Institute of Road Transport] norm, 37 buses required / 1 lakh of population. Currently in 2019 the city's population is about 6, 07,123.

So according to CIRT norm,

KMT requires 225 buses which is 124 number of buses more than it has now. Similarly, in year 2030 population will be 6, 86,718

6, 86,718 ÷ 1, 00,000 = 6.867
6.867 x 37 = 255

KMT required a total of 255 buses.

For 255 buses following infrastructure is also needed which is very important for any Municipal Transport:

1. Requires huge space for a bus Stand near the city which is not available.

Table 2
Problems/ Issues Identified with Recommendations and its Advantages

| S. No. | Issues/Problems | Recommendations | Advantages |
|---|---|---|---|
| 1 | Absence of separate lanes or bus bays causes traffic congestion. | Route study required.<br>Make separate lanes for buses. | After separate bus lanes, smooth traffic flow will occur.<br>Less traffic congestion |
| 2 | Less parking facility for buses. | Arrangement for more pay & parking facilities in the city. | Smooth traffic flow.<br>No traffic congestion. |
| 3 | Lack of route diversification. | Proper route study.<br>Fix routes which will benefit maximum people. | Increase income.<br>Maximum people will get benefited from this. |
| 4 | Some buses are not cleaned during the services. | Regular cleaning is required<br>Inspection also required. | Increase passenger comfort. |
| 5 | Proper on time efficient service not available in the city. | Must provide shuttle service. | More people will use buses.<br>It will increase revenue. |
| 6 | Less revenue/income. | Efficient bus ticketing system.<br>Increase bus frequency.<br>Increase passenger comfort. | More people will use the buses.<br>It will increase revenue/income of KMT |
| 7 | Environment pollution. | Use electrical battery buses in future. | Environmental friendly.<br>Less pollution. |
| 8 | 3 seater & 6 seater rickshaws competition. | Prohibited within bus stop boundaries. | People will use KMT buses.<br>Increase revenue/income of KMT. |
| 9 | Proper shelter for bus stops to be provided. | Shelters required at each bus stop for passengers.<br>Shelters must have low maintenance, clear visibility and easy access to the bus. | Protection of passengers from weather, and feeling of safety and security. |
| 10 | KMT is not connected with the Gaothan area. | Mini bus facility required. | Gaothan area will connect with KMT.<br>More people will use KMT buses. |

2. Required huge funds for this.
3. The required man power is also high and the payment/salary for these employees are very high.
4. The operations and maintenance required for these all buses are very high.

Table 2 shows the current issues/problems in KMT with its recommendations for solving it and its advantages.

*I. Following are some suggestions points which are important for better functioning of KMT*

1. Optimizing bus routes to minimize overlap and ensure coverage across the city in the line with demand.
2. Minimize the air pollution by shifting to zero emission buses in future.
3. Designing an intuitive network and easy to read bus maps.
4. Improve bus shelters and maintain cleanliness.
5. Deliver effective marketing campaigns to break down cultural barriers; bus agencies must work to overcome the common cultural barriers that discourage people from choosing public transport. Public transport is only for low income people or that it isn't fashionable.

*J. Following are the monitoring points which are important for better functioning of KMT*

1. Cleaning inspection.
2. Regular ticket checking by checker.
3. Drivers & conductors to avoid protests by stopping the work.
4. Emergency buses to be provided as per requirements.

*K. Water System*

The city gets a raw water supply of 120 MLD every day. The city has the following main sources of water: Bhagavati River, Panchaganga River, Kalamba Lake. City has more than 810 bore wells. Water is supplied to citizens through a network consisting of a distribution system and various reservoirs located in the city. City has more than 28 water tanks, more than 90 % of houses in the city are covered by a distribution network. There are four water treatment plants through which water is supplied to the whole city.

Following are the four Water Treatment Plants (WTP) in the city:

Table 3
Name of WTP with their capacity

| S. No. | WTP | CAPACITY (MLD) |
|---|---|---|
| 1 | Puikhadi | 50 |
| 2 | Baling | 43 |
| 3 | Bawada | 36 |
| 4 | kalmba | 08 |
| **Total Capacity** | | **137** |

Table 3 shows the WTP with their capacity situated in Kolhapur city

NRW = Non-Revenue Water

Non-Revenue Water is water that has been produced but is subsequently lost or otherwise unaccounted for in the system. Eventually, costs associated with theft, evaporation, faulty metering, poor data gathering and especially leakages. Normally NRW is generally about 20 %. But in Kolhapur NRW is about 38 %, which is too high. Now KMC is trying to reduce it. City's requirement is not constant due to visitors and tourists. Requirement of water increases day by day, Kolhapur = industrial hub, tourist attraction, robust infrastructure and knowledge industry. Therefore, the city has a permanent population plus a floating population. Floating population consists of tourists and visitors.

*L. Current Situation*

City's Daily per capita water supply is 120 MLD.
[1 MLD = 10, 00,000 lpcd]
Current population = 6, 07,123.

*M. Future Requirement*

As per Bureau of Indian Standards, IS 1172-1993, a

Table 4
Problems/Issues Identified with Recommendations and its Advantages.

| S. No. | Issues/Problems | Recommendations | Advantages |
|---|---|---|---|
| 1 | Problem regarding Non-Revenue of Water [NRW]. | • Closure of public unmonitored connections.<br>• Replacing the damaged leaking pipelines totally.<br>• Proper billing system.<br>• Meter checking.<br>• Collections of pending bills with fine charges. | • Less water theft cases.<br>• Increase in water connections.<br>• It will increase income/revenue of the water department. |
| 2 | Less income | • Proper water supply with time management.<br>• Water distribution according to ward size.<br>• Maintain quality of water supply.<br>• Regular meter checking. | • Increase in water connections.<br>• It will increase income of the water department. |
| 3 | Outdated pipelines. | • Repair it if possible.<br>• Change them totally. | • Less maintenance & repairs.<br>• Money & employees' work is spent on other projects.<br>• It will increase income of the water department. |
| 4 | Less water storage. | • Increase the number of water reservoir tanks.<br>• Reservoir capacity should be 33 % of supply [according to KMC' plan]. | • Continuous water supply during emergency situations. |
| 5 | Inadequate water supply. | • Increase the number of water treatment plants.<br>• Capacity required in 2030 is about 167 mld.<br>• Supply water based on ward. | • Increase water supply capacity.<br>• Ensuring water supply capacity for future. |

minimum water supply of 200 liters per capita per day should be provided. But Kolhapur is a famous tourist place and thousands of tourists visit Kolhapur, so its 243 lpcd (243 lpcd is according to the KMC's future plan).

For the year 2030 population will be 6, 86,718

Water required per capita demand = 243 lpcd.

Therefore 6, 86,718 x 243 = 167 MLD.

Table 4 shows the current issues/problems in the water system with its recommendations for better supply of water throughout the city and its advantages.

*N. Following are some suggestions for better supply of water throughout the city*

1. Make land reservoirs for water zones that are good for water recharge and water conservation to meet future demand.
2. Facilitate regular checking of internal plumbing and storage systems at the consumer end by licensing service providers.
3. Compulsory meters for everyone.
4. Rain water harvesting should be made compulsory.
5. Make the water supply to be 24 x 7.

*O. Following are some monitoring points for better functioning of water supply*

1. Daily per capita demand of water supply min. 243 lpcd.
2. Elevated storage capacity w.r.t. supply 33 %.
3. Distribution network reach as % of road length min. 85 %.
4. Cost recovery through user charges 100%.
5. Operation & maintenance 100%.

*P. Sewage System*

Water supplied to the city = 120 mld.

City generates sewage = 96 mld.

Major Nallahs in the city are: Jayanti Nala, Dudhali Nala, Bapat Nala and Line bazar Nala.

City has a total of 222 km of sewage pipelines, 150 lm constructed in 1974 and remaining 72 km constructed after 72 km. For Kolhapur city sewage system design in 1974. Sewage system design for 30 years. So it is exhausted in 2004 and exceeds 15 years. Water prevention and protection act came into effect in 1974. And Kolhapur sewage system design before this act came into effect. From WP & PA 1974 there is a need for underground gutters but unfortunately there is a lack of underground gutters in Kolhapur city.

Following are some major sewage treatment plants in city:

*1) Kasaba Bawada*

Kasaba bawada was constructed in 2014 and work started in 2015, with a treatment capacity of 76 mld. Kasaba bawada constructed under the NRDC scheme. [National River Conservation Directorate Ministry of Jal Shakti Department of Water Resources & River Department]

*2) Dudhali Nala*

Dudhali Nala starts from the year 2018, having a treatment capacity of 17 mld.

*3) Line bazar Nala*

Treating capacity of 10 mld. The treated water coming from these plants has B.O.D. < 10.

B.O.D. < 10 = It's safe to release water into the river.

Sewage water comes to Kolhapur from nearby villages naturally, like from Kalamba, Pachgaon, Morewadi etc. in KMC's sewage line. These villages are under the KMC's area; they are under Z.P. area building permissions are easy, less property tax, less terms and conditions results in more growth.

Kolhapur city having population right now in 2019 is about 6, 07,123 less than 10, 00,000, results not come under smart city scheme. If a city's population is more than 10, 00,000 then the city comes under the smart city scheme, and will get more funds for different requirements. Right now, cities not under smart city schemes result in less funding and finally less development.

Buildings or houses constructed on sides of Dudhali Nala and Jayanti Nala and sewage and other garbage are released directly into it which is illegal.

*Q. Current Situation*

Total Sewage Treatment Capacity:

Kasaba Bawada = 76 mld

Dudhali Nala = 17 mld

Line Bazar = 10 mld

Total = 103 mld.

City generates = 96 mld, Population = 6, 07,123.

*R. Future Requirements*

For Year 2030, Population will be = 6, 86,718 & City will generate = 109 mld.

KMC constructing new sewage treatment plants at Kasaba Badawa = 4 mld & Dudhali Nala = 6 mld. Total = 10 mld.

Total STP capacity in year 2030 = 103 + 10 = 113 MLD, which is sufficient for the year 2030.

Due to Redevelopment and urbanization more STP require, therefore under Building Development Control Rules, STP and Sewage treatment required in following cases:

1. Big Apartments having more than 20 flats.
2. Big schemes like Townships.
3. Hospitals having more than 40 beds.
4. New Colonies, Area more than 1 acre.
5. Daily use of water is more than 10,000 liters.

Treated water is used in the city for

- Gardening.
- Road Divider trees and cleaning.
- Water tank requirement.
- For municipal solid waste
- Various water treatment processes.

Since most of the nallah are open and easily accessible, especially in slum areas, there is large scale indiscriminate dumping of organic wastes in nallah. This leads to choking and problems of suspended solid waste stagnation at various points,

Table 5
Problems / Issues Identified with Recommendations and its Advantages.

| S. No. | Issues/Problems | Recommendations | Advantages |
|---|---|---|---|
| 1 | Less use of treated water. | • Encourage people by giving them assurance about water quality.<br>• Use them for city gardening, road dividers, various processes. | • Recycling water also prevents pollution by decreasing the amount of waste water that must be discharged.<br>• Recycled water can even be used to help create or replenish wetlands and wildlife sanctuaries. |
| 2 | Disease spreading. | • Isolate sewage systems and storm water from each other.<br>• Regular spraying of medicines in STP's nearby area.<br>• Safety clothes provided to employees. | • Less spread of diseases,<br>• Healthy water available for people.<br>• |
| 3 | Local technical trained staff is not available. | • Educate and train local employees.<br>• Skilled technical staff available locally. | • Continuous working of STP.<br>• Problems will be solved quickly by local employees. |
| 4 | Choking & stagnation problem at various nallas. | • Strict prohibition of disposing solid waste into Nallah.<br>• Fine charges for such activity.<br>• Net should be provided and cleaning of such nets. | • Less choking problems.<br>• Less expenditure on cleaning of nallas, |

the nuisance of flies and mosquitoes and prevalent foul odor.

KMC employees are not trained for STP design, they don't have the technical knowledge about the parts in it. If anything happens to these sewage plants then they have to call experts from other cities like Mumbai, Pune and Bangalore. So it's important to give complete practical knowledge to these KMC's employees to solve problems instantly.

Table 5 shows issues/problems in sewage supply with its recommendations for better working of sewage networks with advantages.

*S. Following are some suggestions for better functioning of sewage network*

1. Capacity expansion and collection system to match additional water supply and provide for environmentally safe disposal.
2. Eradicate conditions for malaria, dengue and other water borne disease.
3. Improve and ensure access to sanitary facilities for the urban poor and slum dwellers.
4. Needed underground gutter system.
5. Also needed setting up of pumping stations, STP and external sewer lines for emergency purposes.

*T. Following are some monitoring points for the sewage network*

1. Regular inspection on choking & stagnation points.
2. Operation & maintenance of plants.
3. Regular checking of Water quality before releasing.

## 6. Conclusion

In 2019 the population of Kolhapur city is 6, 07,123 and in 2030 the population of Kolhapur city will be 6, 86,718. Therefore, it's important to calculate required water capacity, transport capacity, sewage capacity and road network for this population to supply them in an adequate manner. All this study is done for the betterness of Kolhapur city. Conclusions are made by department wise which are as follows:

### *A. For Road Network*

Kolhapur city has adequate length of roads to connect with various neighboring villages. Thus in future there is only strengthening and widening of road network is required. In addition, it is required to remove all illegal encroachments from the roadside to increase the vehicle carrying capacity of the roads. Extra arrangements are needed during monsoon because average road condition becomes worse. Need more parking facilities or parking lots near bus stand and beautification of roads which can help to make Kolhapur city a Green city and tourist spot.

### *B. For Kolhapur Municipal Transport [KMT]*

Right now KMT has only 101 buses, but according to CIRT [Central Institutes of Road & Transport], the number of buses needed per lakh is 37 buses. So according to Kolhapur city's population in 2030 which is around 6, 86,781 so the number of buses required is 225. Also there are needs of special arrangements like special bus lanes, separate parking only for these buses etc. and need to be extra careful on cleaning of buses regularly to maintain hygiene in the bus for all the passengers. Also need a bus shelter on each bus stop to protect the passengers from sun and rain.

### *C. For Water System*

The city gets a total water supply of 120 MLD, plus the city has more than 810 bore wells and the city has more than 28 storage water tanks. Daily per capita water supply is Min. of 243 lpcd. As per Bureau of Indian Standards, IS 1172-1993, a min. water supply of 200 liters per capita per day should be provided. But Kolhapur is a famous tourist place so it's 243 lpcd [set by KMC]. In 2019 having a population of 6, 07,123 and current water supply to the city is 120 MLD. But in 2030, the population will be 6, 86,781 the required water capacity is 243lpcd. Therefore 6, 86,718 x 243 = 167 MLD [1 MLD = 10, 00,000 lpcd].

*D. For Sewage System*

In 2019 City will generate a total of 96 MLD. But in 2030 the city will generate 109 MLD. KMC constructed a new STP of total capacity's 113 MLD. And which is sufficient for the year 2030. Also KMC set new rules and regulations for treatment of sewage under Building Development Control Rules.

## References

[1] Klung, S, "Urban sprawl and local infrastructure in japan and Germany". The Journal of Infrastructure Development, 232-241. (2012).

[2] Lozzie, D., Dupas, S. F, "Dynamics of urban sprawl, vacant land and green spaces on the metropolitan fringe". The Journal of Urban Planning and Development, 274-279. (2013).

[3] Shi, L., Yang, S, "Effects of a compact city on urban resources and environment". The Journal of Urban Planning and Development, 1-9. (2016).

[4] Fernandez, P. (n.d.). "Urban development and municipal fiscal burden in spain". The Journal of Urban Planning and Development, 1-6. (2018).

[5] Zongzhen, Y., Xiaocchong Z, "Optimization of land use in a new urban district". The Journal of Urban Planning and development, 1-10. (2015).

[6] Han, J., Hayashu Y, "Evaluating land-use change in rapidly urbanizing china: case study of shanghai". 166-171. (2009).