Solution and strategy for sustainable development of Pune City

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Abstract: In India, most of the population resides in urban areas. The unorganized urbanization is further fueled by migration and urban slums with the declining groundwater level, and increasing air and noise pollution. The challenges in urban development are lack of planning, ineffective regulation, lack of cooperation among different stakeholders, unsafe drinking water, poor sanitary condition, inefficient public transport, poverty, and unemployment. Hence sustainable cities that meet the needs of the present, as well as the future, become important in the Indian context as land is scarce and limited. The objective of this thesis is to explore challenges, problems, and their impact on cities as well as suggest measures for clean and sustainable environment with good living standard. In this research work we have analyzed the existing data of Pune city and suggested suitable solutions accordingly. The thesis investigates the pollution level of the city and rise in temperature as well as try to counter those problems and achieve more sustainability using ICT and better urban planning.

Keywords: Population, water supply, waste, solid waste management, sustainable development

1. INTRODUCTION

In the modern world, the city should be not only smart but also sustainable to create an equal, prosperous, and environment-friendly place. This modern transformation can be achieved by using advancements in smart and digital technology. Smart Technology can help in maintaining economic growth without ecological destruction[1]. Sustainability transformations can only be done through taking significant initiative, planning, and programs. Development of future vision to solve the current challenges and to meet the objectives of sustainability. Urban Planning and the Use of Information Communication and Technology towards achieving Sustainable Urban Development[2][3]. ICT was used to measure the carbon dioxide emission in cities. Sustainable practices adopted by citizens helps in optimizing the use of resources within city[4]. Making policies combining social economic and environment development for the better live livelihood of poor remains a challenge. Problems related with climate change Environment Degradation effect environment, water supply and transportation[5].In Pune water crisis is a major challenge so to achieve sustainable it rain water harvesting and integrated urban water management is required. Water treatment plant and metering helps in meeting water supply and consumption[6]. The demand for energy is increasing but the source of energy still mostly remains nonrenewable energy. So, the focus exists on using renewable energy sources and installing the record solar capacity[7–9]**.** Increase in solid waste and electronic waste has created a new challenge. Hems it is necessary to use the circular economic model framework of reduce reuse recycle refurbished and repair[10]**.** Increase in urbanization

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due to high economic growth of Pune resulting in Rapid industrialization and very high concentration of city[11]**.** For drinking purpose spring water match the limitation as per BIS and WHO drinking. Such as chemical and physical properties of the water as per drinking water standards[12–14]. The urban landscape is changing and growing bigger in population size and with high cost of land, people are living in urban slums. Indian economy is growing at 7% and high economic growth rate leads to migration towards cities, rapid urbanization and carbon emission. Unorganized and ill planned urbanization leads to water, air and noise pollution as well as groundwater depletion, energy insecurity, frequent power failure and blackouts[15–19]. Hence to ensure safe water, food and energy security, and protect natural resources for future generation. The UN concept of sustainability is "achievement of social, economic and physical development is made available to the last person ". The focus on sustainability is to use less resources and consume less energy so as to move towards carbon neutral environment. Sustainable cities will also be smart, inclusive, efficient and environment friendly. To address the issue of sustainability an integrated approach of different stakeholder towards a greener and healthy city. PUNE is ranked no 1 city in ease of living standards and most livable city as well as 5th cleanest city in country. The use of renewable energy plays the important role in the growth of any city, state as well as the country. So we need to develop or install a source of renewable energy [20–22]. It is better than many cities when it comes to water availability, relatively purer air and affordable rental. But rapid urbanization has led to traffic congestion and rise of urban slums and decline in ground water[23].

Improvement of people quality of life by using digital technologies and effective local development to create better and sustainable outcome for citizens through smart solutions[24]. It is necessary to provide sustainable sanitation, adequate water supply, good solid waste management, better urban mobility, affordable healthcare and housing, providing internet connectivity and e governance. The focus is on using the best international practices and development of state of art infrastructure through better urban planning. The objective is to assess (a) Present status and issues of the city like present uses of land, growth of unorganized jhuggis, movement and mobility, problems related to supply, waste disposal segregation and others. (b) Analysis of existing data and details of installed water distribution supply lines, underground sewers and electronics waste management. (c) To identify new measures and strategic approach towards greater sustainability. (d)Bring multiple stakeholders and urban local bodies together for urban planning and city development. Improvement of people quality of life by using digital technologies and effective local development to create better and sustainable outcome for citizens.

2. MATERIALS AND METHODS

The vision is to collect data, consult different stakeholders, and take priority action. The study is carried out in Pune city covering all citizens of different age gender and different social, and economic statuses. The sample size is almost 4000 people. The collected sample was equal for each word. Sampling was done randomly using Aadhar ID and then different groups of equivalent intervals were formed. To get the starting and end members of successive groups, equal interval numbers were added. With the help of Aadhar ID details of every citizen like age, date of birth, gender, and permanent address, and confirmed with the details available in the municipality.

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3. RESULTS AND DISCUSSION

Different types of questions were asked from house owners and unorganised jhuggi wala (slums). About one third of the sample collected were from Jhuggis Wala. Questions related with slums were only asked from jhuggi wala.

Key findings of survey

- Citizens prefer Pune Municipal Corporation (PMC) buses over other private city services
- Usually, Satisfaction level was found to be higher for general citizen than jhuggis wala.
- The preferences and priorities of different services available were more or less similar for slum and non-slum dweller.
- Citizens wish to have PMC to have 24 hour digital connectivity, water supply and power supply.
- Citizens prefer subsidized service like electricity and water to make it accessible to more people.

3.1 Perception of citizen on services

Enquiry about city basic services like water supply, underground sewers, waste collection and recycling, traffic and transportation were done from citizens. General Citizens were highly satisfied with satisfaction rate of 59% compared to just 51% for slum dwellers. This proves a very good level of service provided by PMC. Among ordinary citizens it varies from 52% in ward 4 to over 78% in ward 11. Among jhuggi walas the satisfaction index is 51%. But at 74 percent ward 5 was highly satisfied closely followed by 64 percent at ward 9. Ward no 3 was least satisfied where satisfaction index was at 49%. The perception of citizens towards different services is discussed below. 67% of the surveyed people belong from Pune and 22% of people have lived for more than 12 years. This suggests a good migration for either education or work. Under migrants more than 85% come from within Maharashtra. Similar proportion was observed among jhuggi Wala.

Table-1 Perception of citizens towards different services

Number	Wards Name	City People	Jhuggi walas	Total
9	Anudh	174	148	322
4	Karve Road	243	48	291
7	Ghole Road	188	96	284
5	Warje	240	56	296
3	Yerwada	139	41	180
11	Dhole Patil	187	139	326
6	Hadapsar	194	84	278
2	Sangamwadi	191	134	325
8	VishramBag Wada	140	116	256
14	Bhavani Peth	136	81	217

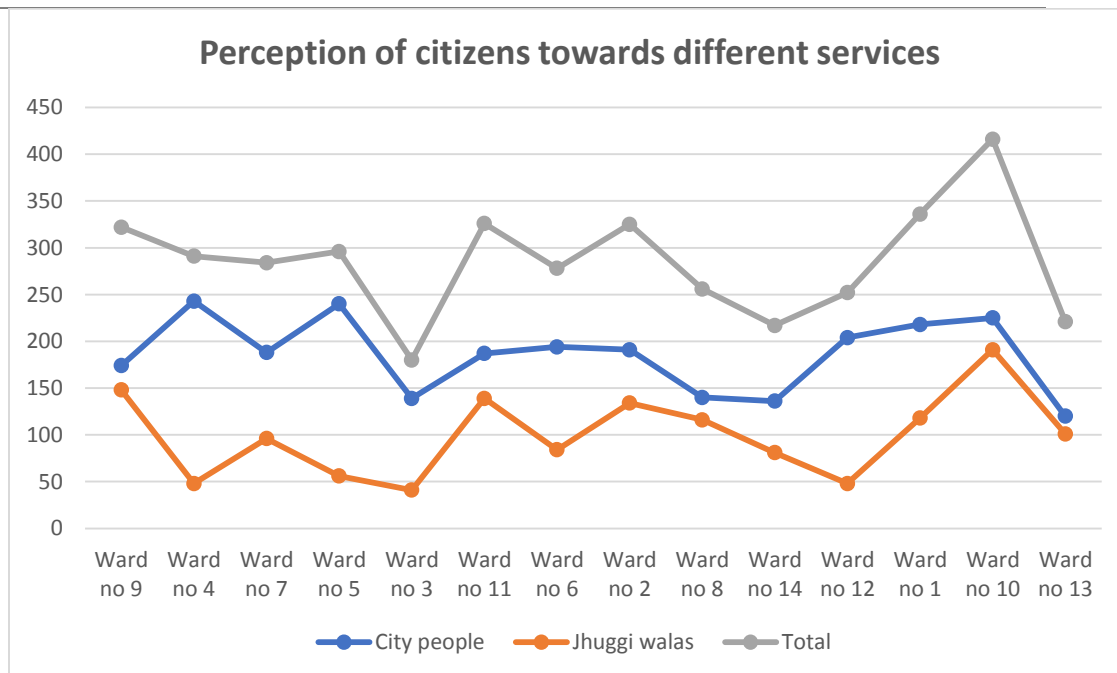| 12	Kasba Peth	204	48	252
1	Bibvewadi	218	118	336
10	Sahakar Nagar	225	191	416
13	Tilak Road	120	101	221
	Total	**2599**	**1401**	**3719**

Fig.-1 Perception of citizens towards different services

3.2 Water Supply

Pune has net water supply of 186 lpcd with 30% water loss in distribution and leakage. Water conveyance is a major challenge which needs proper attention and treatment by restoring and repairing the existing pipe layout and addition of new areas. Citizens were asked about quantity, quality and frequency of water supply. Also, an opinion from general citizens and slum dwellers on smart water metered connection.

3.3 General Citizens

Water supply was good as reported by 51% of city owners. 30% of the opinion that more hours of water supply is needed compared to only 9 hours of existing water supply. 10% of the sample told that water quality parameters were unsatisfactory. Different wards had different response in ward number 7 there was high fluoride content. Ward number 10 had high hardness value. Waterborne diseases were found higher in ward number 6. There was a high discontent regarding the delivery of pipe water supply as a result there was high dependency on water tanks. 20% of the people said either there was no maintenance or severe leakage in water pipes. 12% felt that water supply was more problematic in summer season. 15% of the people suggested that rainwater harvesting and recycling of water maybe the best option to save and conserve water. 45% of the respondents suggested there needs to be improvement in terms of

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quality of water. 10% of the respondents claimed that ground water level had gone down by more than 2 metre. 47% of citizens felt that water supply should be metered.

Table-2 Response of urban people percentage wise in different wards.

Number	Wards Name	Insufficient water supply	Unsatisfactory water quality Parameter	Lack of maintenance
9	Anudh	39	47	38
4	Karve Road	42	52	42
7	Ghole Road	49	43	36
5	Warje	61	46	32
3	Yerwada	51	42	50
11	Dhole Patil	37	39	49
6	Hadapsar	46	46	51
2	Sangamwadi	54	38	56
8	VishramBag Wada	38	41	39
14	Bhavani Peth	49	32	51
12	Kasba Peth	53	39	39
1	Bibvewadi	54	50	46
10	Sahakar Nagar	42	51	48
13	Tilak Road	39	49	42

Fig.-2 Response of urban people percentage wise in different wards.

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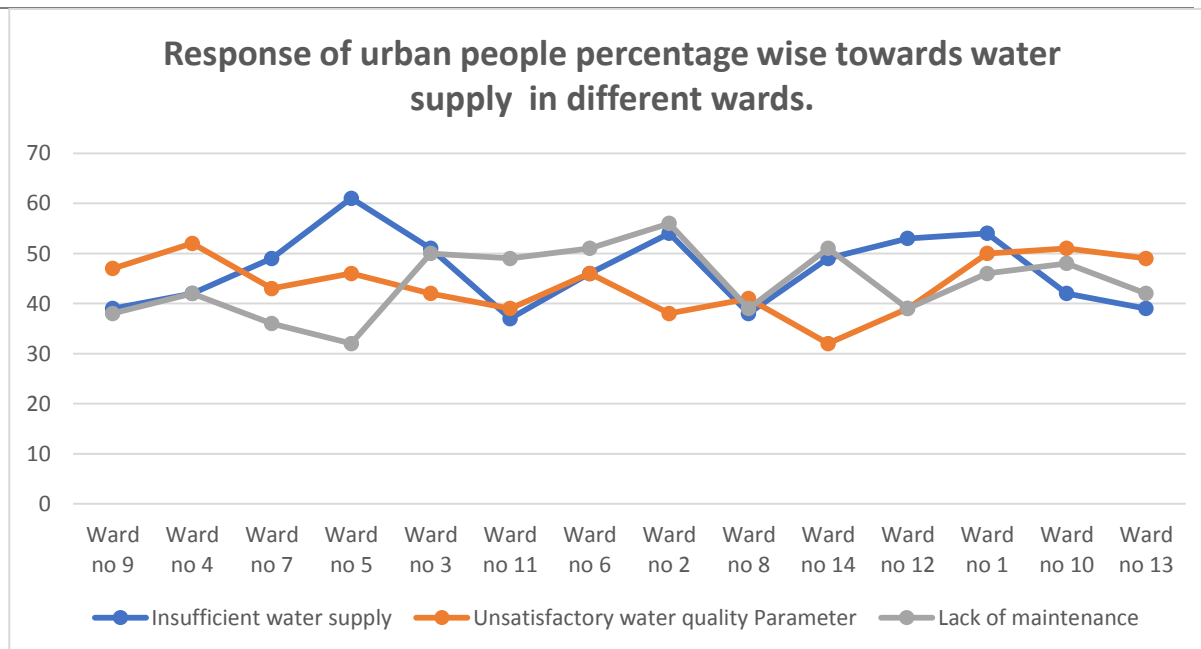
3.4 Jhuggi Wala

Among jhuggi Wala, water supply was good for 32% as reported by people. 25% were of the opinion that less than 8 hours of water supply was done in the area. Some wards have abundant water supply like ward no 6 and then ward 8. 15% told that water quality parameters were highly unsatisfactory. Different wards have different response like in ward number 8 there was high fluoride content. Ward number 11 had high water borne disease. There was a high discontent regarding delivery of pipe water supply as a result there was high dependency on water tank. 30% of the people said either there was no maintenance or severe leakage in water pipe. 20% felt that problem worsened during summer when temperature rises high and water supply dry. 15% suggested that rain water harvesting and groundwater recharge can solve water shortage problems. 59% suggested that quality of water supply needs improvement. 15% claimed that a groundwater has gone down by more than 2 m. People in slums have mixed response towards water meter system. Ward no 5 and 8 welcomed the water meter whereas ward no 6 had negative views about water meter. Those with negative views strongly opposed installation of water meter.

Table-3 Response of Jhuggi wala percentage wise towards water supply in different wards

Number	Wards Name	Insufficient water supply	Unsatisfactory water quality Parameter	Lack of maintenance
9	Anudh	39	48	43
4	Karve Road	45	59	49
7	Ghole Road	51	38	42
5	Warje	57	62	53
3	Yerwada	37	53	54
11	Dhole Patil	52	69	38
6	Hadapsar	49	59	41
2	Sangamwadi	51	48	48
8	VishramBag Wada	71	63	68
14	Bhavani Peth	42	44	48
12	Kasba Peth	39	37	43
1	Bibvewadi	55	38	49
10	Sahakar Nagar	52	69	39
13	Tilak Road	41	57	51

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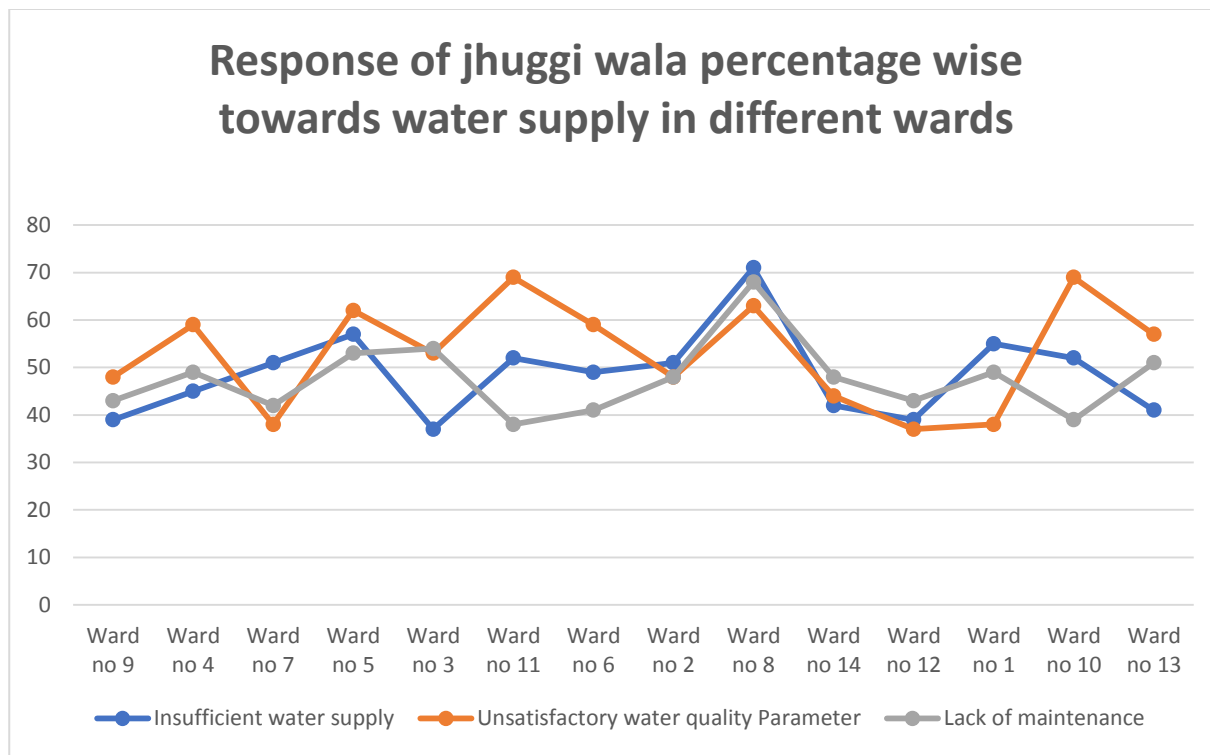Eur. Chem. Bull. 2023, 12(Special Issue 4), 4211-4227

Fig.-3 Response of Jhuggi wala percentage wise towards water supply in different wards

3.5 Sewerage/Drainage:

The big problem existing with sewerage system is that it runs full during rainy season and underground sewer networks are not available in every part of the city. Lack of maintenance and clogging of sewer drains had been reported as major problems. 85% of developed area has access to underground drain which cover 75% of population. Questions were asked to citizens about their opinion regarding disposal of wastewater, blocking of sewer lines and flooding.

3.6 General Citizens

More than 80% reported that they have access to underground drainage system but it very is in different words like more than 95% people in ward 7 has underground drainage and the least was 75% of the people in ward number 6. About 74% of citizens reported that flooding and clogging of sewer drains were the major challenge. 35% of the people suggested that wastewater treatment plants don't exist. 50% of citizens suggested that recycling of waste water can reduce the load on sewage treatment plants.

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Table-4 Response of urban people percentage wise towards sewerage problems in different wards

| Number	Wards Name	Underground drainage	Blocking of drains	Recycling of wastewater
9	Anudh	82	61	39
4	Karve Road	86	82	42
7	Ghole Road	95	78	36
5	Warje	91	72	44
3	Yerwada	78	65	38
11	Dhole Patil	89	59	45
6	Hadapsar	75	62	34
2	Sangamwadi	84	82	46
8	VishramBag Wada	79	76	36
14	Bhavani Peth	88	74	49
12	Kasba Peth	85	71	39
1	Bibvewadi	89	68	46
10	Sahakar Nagar	78	79	34
13	Tilak Road	79	84	42
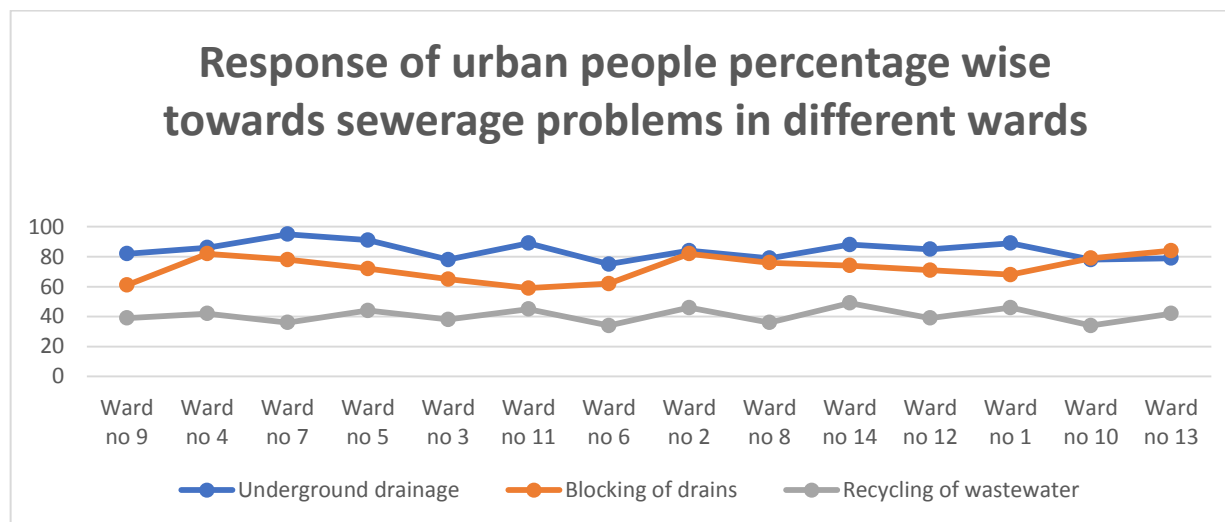
Fig.-4 Response of urban people percentage wise towards sewerage problems in different wards

3.7 Jhuggi Wala

Survey conducted found out that underground and well-maintained drainage system for available to 74% of the surveyed slums. Ward number 7 has the highest 85% and ward number 6 has least 62% had underground drainage system. Therefore, most of them who don't have safe underground sewage disposed it through open drains (25%), septic tank (16%) and ill maintained sanitation (11%). 30% of the respondents felt recycling of wastewater was the good option 87% of respondents felt that choking was

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frequent problem. 51% of citizens said that there was an overflow during peak especially in rainy seasons. In ward 7, 78% people said that PMC failed to clear drains overflowing on time.

Table-5 Response of Jhuggi Wala percentage wise towards sewerage problems in different wards

Number	Wards Name	Underground drainage	Blocking of drains	Recycling of wastewater
9	Anudh	71	63	29
4	Karve Road	68	66	32
7	Ghole Road	85	78	38
5	Warje	74	71	22
3	Yerwada	69	68	27
11	Dhole Patil	74	69	35
6	Hadapsar	62	72	24
2	Sangamwadi	81	74	26
8	Vishram Bag Wada	78	68	34
14	Bhavani Peth	82	76	29
12	Kasba Peth	68	61	33
1	Bibvewadi	69	59	36
10	Sahakar Nagar	64	74	34
13	Tilak Road	68	72	32
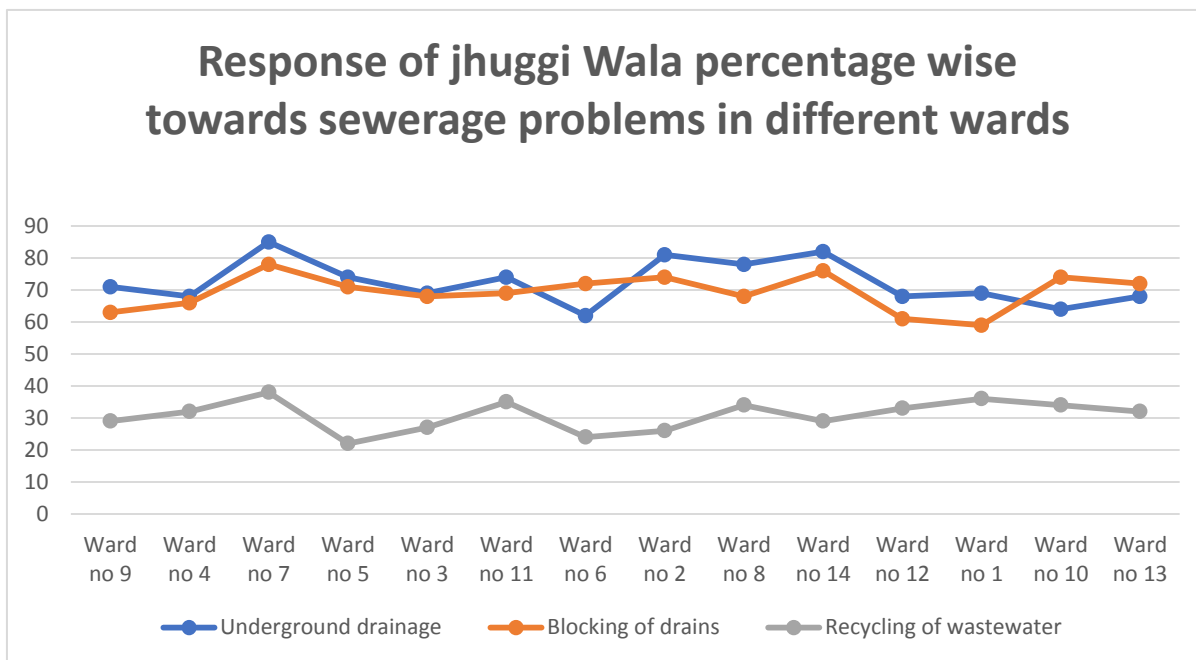
Fig.-5 Response of Jhuggi Wala percentage wise towards sewerage problems in different wards

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3.8 Solid waste management

The total quantity of waste generated per day is about 1100 tonnes (about 400 gram waste generated per capita per day). More than 4500 ragpickers segregate waste and recycle 145 tonnes of waste. Around 500 tonnes of recycling are done by PMC using composting. The survey asked question related to disposal, segregation and frequency of collection of garbage from community and households. We also asked question about satisfaction levels related with road sweeping, public toilet facility and cleanliness.

3.9 General Citizens

60% of the respondents said that garbage was collected on a daily basis by the municipality. 33% said that garbage was collected once a week. 30% stated that garbage was openly dumped and not recycled. 48% of respondents said that they never segregate Waste at home into biodegradable and non-biodegradable. 55% said that Swachh India mission has created awareness regarding Waste management. 70% of the general population felt that rise of Electronics waste has become a major problem. 48% felt that more needs to be done by the municipality for proper and smart waste management.

Table-6 Response of urban people percentage wise towards waste in different wards

Number	Wards Name	Waste collection	Waste segregation	Waste Recycle
9	Anudh	55	52	38
4	Karve Road	54	45	39
7	Ghole Road	49	64	41
5	Warje	63	57	38
3	Yerwada	65	51	46
11	Dhole Patil	58	49	45
6	Hadapsar	69	38	48
2	Sangamwadi	57	46	49
8	VishramBag Wada	46	57	51
14	Bhavani Peth	75	63	43
12	Kasba Peth	58	57	47
1	Bibvewadi	54	50	48
10	Sahakar Nagar	42	51	53
13	Tilak Road	39	49	39

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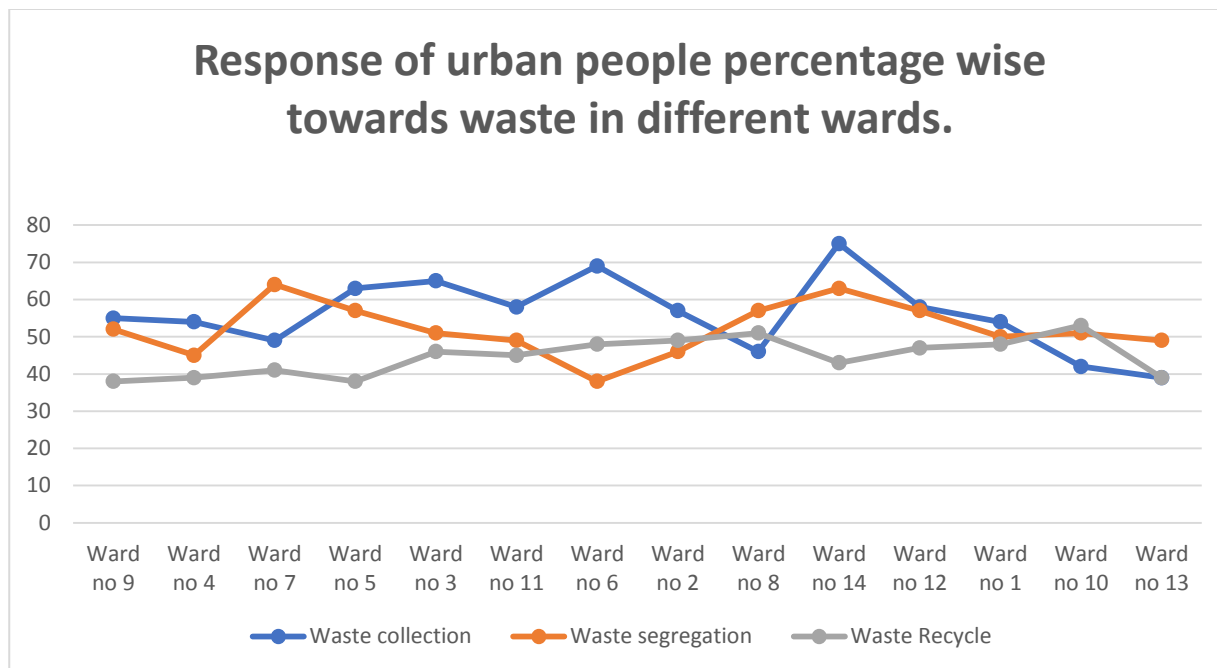Eur. Chem. Bull. 2023, 12(Special Issue 4), 4211-4227

Fig.-6 Response of urban people percentage wise towards waste in different wards

3.10 Jhuggi walas:

40% felt that garbage was collected on a daily basis. 25% said that garbage was collected once a week. 20% said that garbage was openly dumped and not recycled. 70% said that the Never segregate waste into biodegradable and non-biodegradable. 50% said that electronics waste problem is increasing. 40% felt that Swachh Bharat mission has created awareness among the general people at home. 60% felt that smart waste management is not done by municipality.

Table-7 Response of jhuggi Wala percentage wise towards waste in different wards

Number	Wards Name	Waste collection	Waste segregation	Waste Recycle
9	Anudh	42	68	25
4	Karve Road	32	84	32
7	Ghole Road	47	66	38
5	Warje	46	69	36
3	Yerwada	49	61	29
11	Dhole Patil	51	53	26
6	Hadapsar	37	59	37
2	Sangamwadi	46	85	32

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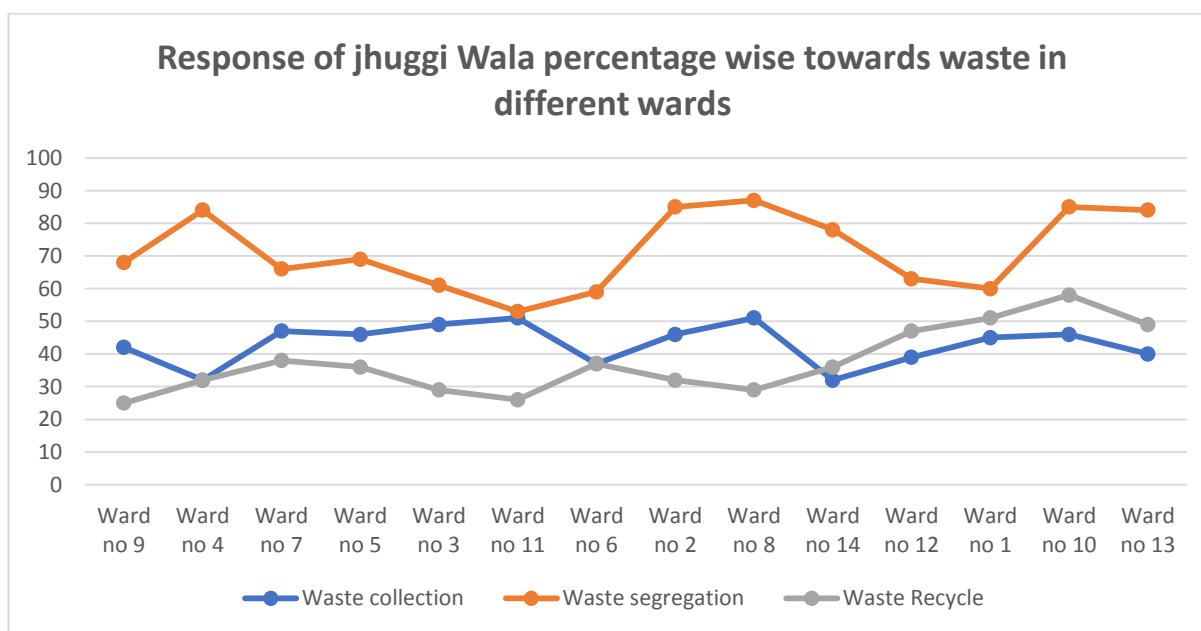| 8	VishramBag Wada	51	87	29
14	Bhavani Peth	32	78	36
12	Kasba Peth	39	63	47
1	Bibvewadi	45	60	51
10	Sahakar Nagar	46	85	58
13	Tilak Road	40	84	49

Fig.-7 Response of jhuggi Wala percentage wise towards waste in different wards

3.11 Roads and Traffic

City population is doubling in every 2 decades while the Road Infrastructure remains same. Increase in population has resulted in a greater number of vehicles on road leading to traffic jams, congestions and affecting mobility. Increase in traffic accidents due to mixed and unregulated traffic movement. Unorganised slums have occupied the footpath and cycle tracks which discourages pedestrians to move on Footpath. To escape traffic most people, prefer two wheelers than a car ride. The perception of citizens about mode of ride, reasons of traffic problem and congestion. Solutions related to the existing traffic jams were also questioned and the areas that require flyovers were asked.

3.12 General Citizens

About more than two third of the population uses public transport like Metro, Bus, mono rail. 75% of daily commuters faced traffic jams. They also suggested solution for increasing traffic problems. Increasing the frequency of bus was the most common answer by about 87%. Road widening was the

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second most popular option with 80% respondents. Construction of Flyovers was an important strategy with 67% of people. The jhuggi Wala response were same as of general citizens with 79% slum dwellers using public transport.

Table-8 Response percentage wise towards traffic and transportation in different wards

Number	Wards Name	Public transport	Traffic jam	Private vehicles
9	Anudh	76	86	35
4	Karve Road	68	84	40
7	Ghole Road	59	81	37
5	Warje	74	75	29
3	Yerwada	56	79	36
11	Dhole Patil	68	68	47
6	Hadapsar	59	88	36
2	Sangamwadi	74	74	28
8	VishramBag Wada	79	67	46
14	Bhavani Peth	82	73	43
12	Kasba Peth	78	67	32
1	Bibvewadi	45	60	51
10	Sahakar Nagar	46	85	58
13	Tilak Road	40	84	49
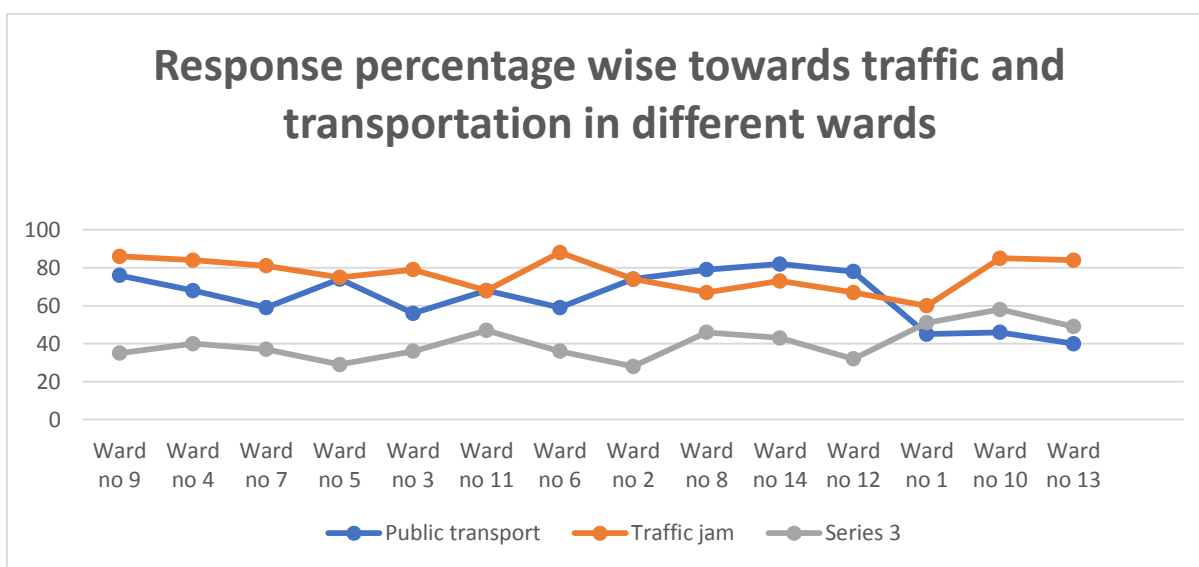
Fig.-8 Response percentage wise towards traffic and transportation in different wards

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3.13 Recommendation and solution

The need of the hour is to create "highly productive efficient equitable and responsive city ". The focus is on to (a) improve existing infrastructure (b) ensure basic service is available at affordable price (c) strengthen the municipal government and their functioning.
Reforms listed for improving pune city are as follows:

3.14 Mobility and transportation

Road design guidelines to be effectively implemented for different land use development (commercial, residential, industrial). Increase the use of public transportation from existing 30% to 60% by the end of this decade or 2030. Mass rapid transit system like metro, mono rail and buses to be extended further. Removing encroachment and increasing parking pace for private vehicles especially cars. Fully implementing all ICT based solution within 5 years for integrated traffic management system to reduce traffic delays and maintain normal flow of traffic. Redesign of existing roads like street, junction and footpath within 5 years. Increase of public transport buses and increase in the network of metro by 2030. Creation of two outer ring roads in the 10 years to address more than 45% bypass traffic. Increasing footpaths and renting of bicycle sharing to be introduced.

3.15 Water Supply

Leak detection plan to reduce water loss. Old water supply distribution network to be repaired and restored and updated for the city expansion. Water audit at regular intervals. Data collection regarding ground water quality and map of available water sources to be present for better planning. One of the key goals is to ensure 24*7 availabilities of water at a least rate of 150lpcd which cover 100% of citizens. This will require both short- term and long-term measures. ICT based smart water meter solution to be implemented across the city. The coverage of underground sewers has to be increased. Reduce the leakage of water supply and repair of existing distribution networks. Waste water treatment to be increased to 100% from existing 68% and promote use of recycled water for non-drinking purpose like gardening, flushing of bathroom. Collection efficiency of sewage network is around 76% only which require more construction of sewer lines.

3.16 Energy

Solar water heater, vermi composting to reduce energy demand of the city. Smart grid setup with installation of smart energy meter to track the existing usage and reduce the consumption. New buildings constructed must come under the category of green building and should be energy efficient. Smart public lighting connected to a centralized office to track the faulty and inefficient lighting. Installation of solar based lighting system with automatic on and off function.

3.17 Cleanliness:

Clean street and public spaces with smart bin facility which alert municipality as soon as bin is full at every 300m. Public toilet coverage should be at 100 percent of population, with 40,000 toilets to be built over next three years. Segregation of waste to be increased to 100% at source which is now only 57% and efficient integrated waste management system. Increase recycling of waste and follow the principle of

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reduce, reuse and recycle. E waste collection and disposal for creating a circular economy. Decentralized method of waste processing and setting up scrap shop centers.

3.18 Safety and Security

Pune has good no of installed CCTV surveillance camera, the vision is to reduce crimes by making cameras smart, replacing faulty camera and connecting all camera on cloud platform with centralized control. Encourage citizens to be vigilant and report incidents. Panic buttons in public places to alert police in emergency situation. GPS enabled tracking and identification of absconders and offender. Increase awareness among citizens and maintain integrated response and emergency situation for collaborative action from multiple agencies including police, fire and health to tackle emergency situations.

4. CONCLUSION

The main goal was to review the existing services and discuss the relevance of these services to the general population of the city. Analysis of existing services and their satisfaction among different sections of society were reviewed. A smart sustainable city is a future and of key importance in the sustainability transition in the city. The primary purpose was to explore alternate paths of development and to meet the increasing demands of the rapidly growing city. The interest is to make lives better for the people living in the city using advanced digital technologies like GIS, GPS, and ICT-based solutions. The interest should be to study smart sustainable cities by urban policymakers to understand the strategic necessity of sustainability in this computerized world. The real challenge is to meet the sustainability targets through effective measures by bringing multiple stakeholders together and making proper interventions through regulatory changes. A way towards sustainability is through a sustainable future vision using institution organization and regulations for efficient policymaking and guiding their actions. Integrated and holistic interdisciplinary approach by taking short- and long-term measures towards sustainable urbanization. Pune has shown the path of embracing new technologies for improving the quality of life and has taken steps towards making a sustainable city. The city has created a healthy city over the passage of time by using electric buses, promoting walking and cycling infrastructure, recycling, and segregation of waste, LED lighting, biogas, solar energy, and many other steps. Despite certain challenges, Pune remains committed and focused on achieving sustainable city transformation through efficient planning, monitoring, and controlling the use of limited land, water, and energy.

Data Availability
All data generated or analyses during this study are included in this article.

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Declaration

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper

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