



---

# ESTIMATION OF INFRASTRUCTURE REQUIREMENTS FOR DEVELOPMENT OF SMART CITY : A MODEL STUDY ON KAKINADA; ANDHRA PRADESH, INDIA

**P. Vinod Kumar Reddy**

PG Student, Department of Civil Engineering K L University, Green fields, Vaddeswaram, A.P., India.

**Raja Sekhar Reddy K**

professor, Department of Civil Engineering, K L University, Green fields, Vaddeswaram, A.P., India.

**SS. Asadi**

Associate Dean Academics & Professor, Department Of Civil Engineering , K L University, Green Fields, Vaddeswaram, A.P., India

## ABSTRACT

*Smart cities is the latest concept when it comes to building the cities of the future. The smart city concept is primarily focused on implement of environment, government and social development. In the present investigation Kakinada (Andhra Pradesh, India) was chosen. The future of Indians growth lies in its cities and a significant proportion of our gross domestic product (GDP) will come from urban centres . Existing cities were never planned to deal with the exponential levels of population growth currently being witnessed. Any development project will be successful only when the concerned stakeholder are made involved in all stages of the project.*

*In the present investigation status of existing infrastructure and proposals for conversion of the city as smart city were collected. Further survey was carried out in Kakinada city covering various categories of citizens to understand the needs of the citizens to make their life in the city comfortable. Gap between the proposals made by Kakinada Municipal Corporation (KMC) and needs identified by the citizens was arrived and budget required for additional needs was prepared .*

**Key words:** Planning, Infrastructure, Smart city, Budget.

**Cite this Article:** P. Vinod Kumar Reddy, Raja Sekhar Reddy K and SS. Asadi Estimation of Infrastructure Requirements for Development of Smart City : A Model Study on Kakinada; Andhra Pradesh, India.. *International Journal of Civil Engineering and Technology*, 8(5), 2017, pp. 984–998.

<http://www.iaeme.com/IJCIET/issues.asp?JType=IJCIET&VType=8&IType=5>

---

## 1. INTRODUCTION

During the latest years of 20<sup>th</sup> century ,two important phenomena have emerged. Urbanization and information and communication technologies.(2) A smart city is an urban development vision to integrate multiple information and communication technology (ICT) solutions in a secure fashion to manage a city 's assets(7) – The city assets include ,but not limited to, local departments information systems, schools ,libraries transportation systems, hospitals ,power plants ,water supply net works ,waste management ,law enforcement, and other community services.(3) Under smart cities mission, Government of India has identified 60 cities to be developed as smart cities in stages . Kakinada city is one among 60 cities.(4)

### 1.1. Description of Study Area

Kakinada is the district head quarter of East Godavari district situated along the east cost of Andhra Pradesh. In the pre independent British rule, Kakinada was most important city along East Coast and appropriate infrastructure had been established and maintained. There are many gas based power plants, port based industries around Kakinada. Gas based fertilizer units and other industries are already working and some more units are in the pipeline .(4)

#### 1.1.1. Climate

Kakinada has a tropical climate with hot, humid weather most of the year. The warmest time of the year is late May and early June, with maximum temperatures around 38–42 °C. January is the coolest month, with minimum temperatures of 18–20 °C.

The city gets most of its seasonal rainfall from the southwest monsoon, although considerable rain also falls during the northeast monsoon (from mid-October to mid-December). Cyclones in the Bay of Bengal frequently strike the city. Kakinada's prevailing winds are from the southwest for most of the year, except from October to January when they are from the northeast. The city's average annual rainfall is 110–115 centimetres.

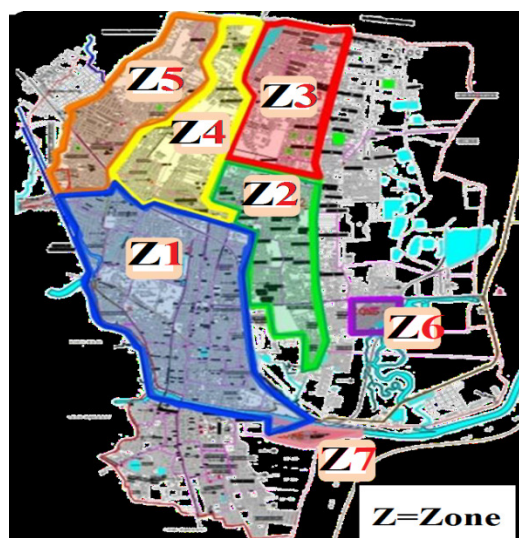
#### 1.1.2. Geographical Conditions

The city consists of two regions, connected by bridges. The southern part of city i.e., Jagannathapuram is separated from the rest of the city by the Buckingham canal. The Dutch East India company maintained a trading post known as Jaggernaikpuram. The northern area of Kakinada is the more modern part of the city, with its recent extension. An industrial belt, running north–south the length of the city, separates the eastern part from the coast.

#### 1.1.3. Geological Conditions

The main soils in the Kakinada are alluvial (clay loamy ), sandy loam and sandy clay. There is mostly alluvial soil in Godavari and sandy clay soil at the tail end portions of Godavari river.

Area Based Development : The Great Kakinada Municipal Corporation area has been conventionally divided into seven zones for the development into smart city. Zone -1 is proposed to the take up initially -Under Smart City program.



Under Retrofitting		
Zones	Area in acres	Population in Percentage
1	1375	65
2	510	12
3	570	8
4	552	7
5	590	8
Under Redevelopment		
6	65	80
7	52	20

Figure 1 Area Based Development Of Kakinada

Table 1 Profile of Kakinada

Municipal area	31.39 sq.km
Population area (2011 census)	3,25,985
Slum population	1,32,185
Literacy rate	72%(average of Andhra Pradesh -67%)
Budget (FY 2015)	Rs 260cr
Internal revenue	Rs 60cr
Grants	Rs 200cr
Per captia annual income	Rs 1,05136
Water supply	107lpcd
Student strength	11,240
Lengths of roads	474km
Length of open drains	670km
Work force	1,06,276
No scientific management of municipal solid waste	

## 2. OBJECTIVE

- To study existing infrastructure and identify needs of Kakinada.
- To estimate the budget required for meeting the needs.

### 3. METHODOLOGY

In the present investigation existing infrastructure facilities are collected and proposals made by Kakinada Municipal corporation (KMC) to convert Kakinada as smart city are collected. A survey is carried out covering various categories of citizens in Kakinada to understand their needs and expectations to make their life comfortable and happy in the city. Comparison is made between the proposals made by KMC and requirements identified by citizens and budget for needs identified by the citizens is prepared and recommendations are made.

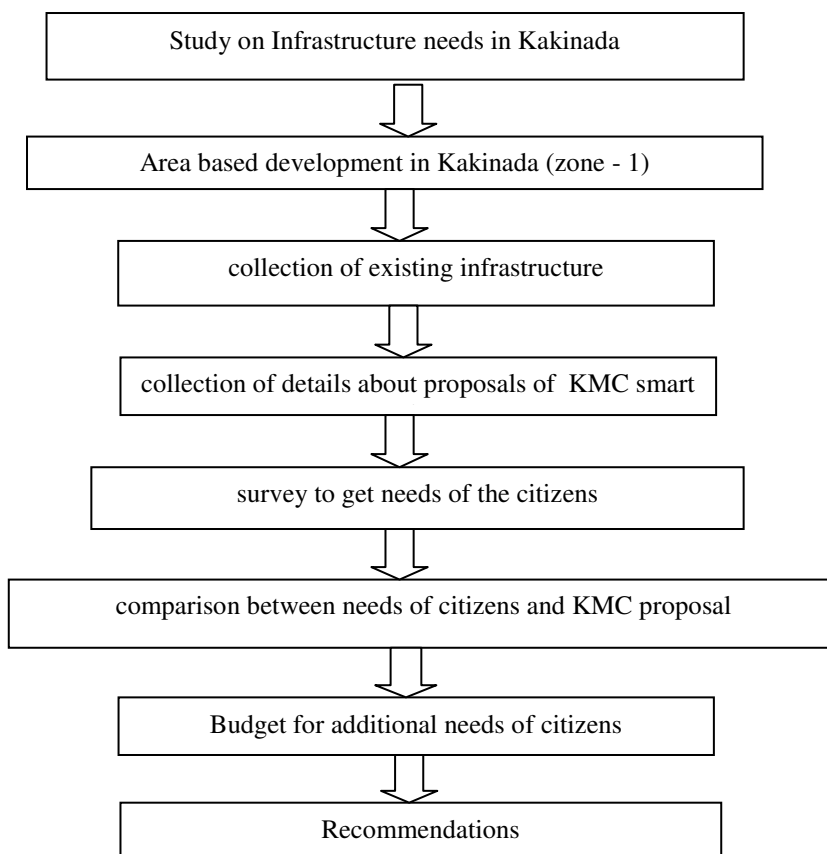


Figure 2 Step by step process of methodology

## 4. RESULTS & DISCUSSION

### 4.1. Existing Data Analysis

The following sectors are to be developed in terms of infrastructure and are to meet the required proposals of Kakinada municipal corporation .They are

#### 4.1.1. Health

The aim is to have medical facilities within easy reach of every citizen through increased bed strength including a mandate 200 specially. Hospital dedicated per lakh population and building of at least one diagnostic centre and one dispensary per 50000 and 15000 citizen respectively . Better and technically advanced equipment also to be provide for as per budget allocation.

### **Existing Infrastructure**

- No of hospitals -42
- Urban health centers -6
- Mother & child centers - 2
- Ayurvedic Dispensaries - 2

#### **4.1.2. Education**

Accordingly a mandate of minimum institutes and schools as per lakh population have also been defined including one school per lakh of population and one college per 1.25 lakh and one technical , engineering and medical college per ten lakh citizens. With provision for physically and mentally challenged students.

### **Existing Infrastructure**

- No. of primary & upper primary schools -54
- No of high schools -14
- No .of students in primary and upper primary schools -3867

#### **4.1.3. Open Spaces**

Identification of Protected Zone—Conserving of water bodies, coastal regulation zone, Swamps, Aquaculture and other ecological sensitive areas. Green Buffers around the Industrial areas and good connectivity to Proposed airdrome, Port and Rail keeping in view the express. Industrial centers to be developed on the Northern Part of the city.

### **Existing Infrastructure**

- Number of major & minor parks -26
- Number of vegetable markets -7
- Number of public toilets -52
- Number of burial grounds -9

#### **4.1.4. Housing**

### **Existing Infrastructure**

- Total no of households : 93,373

#### **4.1.5. Transport & Mobility**

Easy access to transport the for all people within the range of 800 residing in area with average density over with 175 person per hectare of built area criteria for smart cites. Along with supporting charging stations at all high ways by 2027. Momentum is also seen in rails, mono rails and metro train project with increased budget allocation in these sectors.

### **Existing Infrastructure**

- Main Road = 80 ft
- Raja Ram Mohan Roy (RR) Road = 80 ft
- Cinema Road = 50ft

- Temple Road = 40ft

#### **4.1.6. IT Connectivity**

A Technology is to replace man power to fair extent. with a proposed budget of 33 Cr broad band connection are also expected to increase to 17.5 Cr users by 2017. Connecting the smart cities seamlessly. similarly these cities shall also witness more efficient disaster management with allocation of 23Cr towards reducing disaster risks.

##### **Existing Infrastructure**

- 100% IT connectivity
- 28 towers of BSNL and others to be upgraded
- IT Hub proposed near Sarpavaram and IT ,central business district centers nearer the Panduru Penumarti ,Vekataparam are to be developed.

#### **4.1.7. Energy Source**

##### **Existing Infrastructure**

- Conventional energy resources **100%** usage.
- Non conventional energy resources **0%** usage.
- Loss due to power supply distribution with an average of **30%**
- Measure to minimization power loss in distribution are
  - a) Transmitting high voltage through cables
  - b) Low resistance transmission wires .
  - c) Suitable connection with proper insulation
- Demand of power supply in summer season varies from 13KW to 15KW
- Demand of power supply in winter, rainy season varies from 10KW to 11.5KW

#### **4.1.8. Waste Water & Sanitation**

At present waste water and drainage is being disposed through open drainage. Requesting regular Cleaning Due to Clogging and Stagnation, causing inconvenience to the public.

##### **Existing Infrastructure**

- 100% Compliance with swachh Bharat Mission (SBM) guidelines with respect to OD free city
- Andhra Pradesh Municipal Development Project (APMDP) Scheme is taken up to replace age old pipelines with High Density Polyethylene (HDPE) Pipes and construction of filtration plant and Elevated Leveling Service Reservoir (ELSR) are taken up with projected cost of Rs.190 corer. Work is under progress.
- Grant works like 13<sup>th</sup> Finance commission, special development funds, SC/ST sub-plan works, member of parliament local area development system ,community development programme, works are under progress.

#### **4.1.9. Water Supply**

**Existing Infrastructure** At present 107 liter per day treated water is being supplied to the citizens of Kakinada on timely basis in rotation.

#### ***4.1.10. Storm Water***

Kakinada has a hereditary problem for storm water disposal. To overcome this problem a storm water management system is required.

##### **Existing Infrastructure**

- Storm water drain - 11kms

#### ***4.1.11. Solid Waste Management***

##### **Existing Infrastructure**

Kakinada is one of the fastest developing cities in Andhra Pradesh with a population of three lack thirteen thousand in 2011 in urban agglomeration, registering a growth of 5% over the past decade. The city has around 83 thousand houses which generate 260 metric tons of solid waste per day. At present, they are not practicing any scientific processing and disposal of solid.

#### ***4.1.12. Underground Services***

##### **Existing Infrastructure**

- Underground electric wiring of 1375 acres area.
- Construction of sub- stations and installation of smart meters.
- Detailed Project Report(DPR) under Integrated Power Development Scheme (IPDS) has already been prepared and submitted for approval.

#### ***4.1.13. Water Front Development***

Kakinada by its geographical status is a waterfront city with vast beach on east, wide Harbor approach salt creek, servicing on outfalls from Godavari canals, Irrigation drains.

### **4.2. Proposed Action Plan**

Proposals prepared by Kakinada Municipal Corporation for conversion of Kakinada to smart city under phase -1 is presented in table - 2 sector wise details of proposed are given below.

#### ***4.2.1. Health***

- Upgrading existing infrastructure like Government General Hospital ,Government Medical college, Public & Private Medical Staff Training colleges, Multispecialty private Hospital.
- Online records, online medical supplies, Patient info exchange.

#### ***4.2.2. Education***

- Construction of 160 additional classrooms in 24 schools with 2 Science labs in each school.
- Up gradation of Infrastructure such as Digital podium, Computer Lab, Biometric Attendance, Interactive Board, Projector Class & School Buses.

#### **4.2.3. Open Spaces**

- Improvement of greenery in 8.7 acres and 36000 plantations.
- 40000 trees were planted last year and about 50000 trees are planned in the current year.
- Road side plantation along with Geo-tagging of trees.
- Improvement of greenery under a smart area programmed i.e. Public and Private Premises.
- Intensive educating and Propaganda for green city.

#### **4.2.4. Housing**

Provide 4760 houses in 21 slums benefiting the —below poverty line /economically weakened section families under housing for all schemes.

#### **4.2.5. Transport & Mobility**

- To convert Raja Ram Mohan Roy road , Pitapuram & Main Road to 100 ft road.
- To convert Temple Road to 60 ft road.
- To convert Nagarjuna Fertilizers Chemical Industry & Cinema Road to 80ft road.
- Approach Roads to villages to - 60/80 ft road.
- New linkage Roads will be proposed in grid pattern in the vicinity area.
- New Layouts have come up on the Northeast towards samalkot (Overall 663 approved layouts).
- Additional Bus stand proposed near Sarpavaram junction.
- 3 Truck Terminals proposed.
- Air strip near Gurajanapalli on Salt Contours and 200 Hectares of land available.
- To develop Smart pedestrian Facilities & Non motorized transportation facilities such as
  - I. Footpaths -84km
  - II. Cycles Tracks -50km
  - III. Pedestrian Only streets – 4 streets

##### **a. Smart Public transport proposals**

- Prioritizing of city bus routes & phased expansion of bus fleet.
- Smart bus shelters (20No) with Smart E-toilets, E-rickshaws.

##### **b. Smart Public Bicycle Sharing System**

- Bicycle Stations at Bus Stops, Bus terminal and Rail Terminal.

##### **c. Smart Traffic Management**

- Intelligent signalization /Area Traffic Controls.
- 50 CCTV Cameras & 14 pan-tilt-zoom (PTZ) Cameras.



- Smart data Integration of Traffic control Center.
- Junction Improvements (Major -10Nos &Other -70Nos)

**d. Redevelopment of Road Transport Corporation (RTC) on Public Private Partnership**

Redevelopment of RTC Complex Premises on commercial Basis with all public utilizes and modern facilities. Development of new RTC Complex in 8.5 acres with modern facilities.

**e. ROBs, Bridges and Roads Sanctioned by R&B**

- Construction of bridge on East Eluru drain at Indrapalem.
- New Railway over bridge (ROB) at Port area.

**f. To be sanctioned by R&B**

- Approach road to Nadamuri Taraka Rama Rao bridge for temple street.
- New road over bridge at kondayyapalem.

**4.2.6. IT Connectivity**

- No. of additional towers required - 20

**4.2.7. Water Front Development**

- Rejuvenation of 3.74km canal
- Protection from pollution & encroachment
- Promote tourism & health
- Recreational development around the beach road
- Administrative unit with recreational activities to be proposed

**4.2.8. Energy Source**

- 5.2lakhs soft rooftop solar on Government building.
- 11.28 lakhs soft rooftop solar on 188 apartments on public private partnership mechanism.
- 11.38% of energy from RE (Rechargeable Energy) sources.
- 4.In the RE sources 8.92% from solar energy and 2.46% from wind tech energy.

**4.2.9. Water Supply**

- Improvement to the existing water supply by installing latest equipments.
- Installation of advanced type of Automated meter Reading -22500 connections along with one additional summer storage tank.
- Provision of supervisory control and data acquisition system which will enable better control and monitoring of water supply system Introduction of smart billing and collection system.

#### 4.2.10. Under Ground Services

- Ensure Power and Gas supply during natural calamities.
- Smart billing – transparency and efficiency.

#### 4.2.11. Storm Water

- Control inundation, Flood/ storm water management.
- Construction of 254 storm water drainage network in 1375 acres are developed.

#### 4.2.12. Solid Waste Management

- 100% Compliance with Municipal solid waste Rules 2000.
- Recycling of 5MT of waste every day.
- Establishing of dumping yard.

#### 4.2.13. Waste Water Sanitation

- 140 km sewer net work including out falls.
- Decentralized sewage treatment plant to treat 13 Mega liter per day sewage.
- Construct 508 Individual toilets to cover 100% health and human service (HHS) with Individual house hold toilets.

### 4.3. Proposed Budget For Implementation Of Action Plan

Table 2 Estimated Budget in Cores

Feature	GOI	GOAP	KMC	PPP	Smart cities	beneficiaries	CSR	TOTAL Rs in Cr
Health	50.00				0.50			50.50
Education			0.25		10.40		0.50	11.15
Housing	71.40	47.60				109.48		228.48
Open spaces	3.00		0.48			14.32		17.80
Transport & Mobility	29.71	171.75		45.50	122.55			364.41
IT connectivity					4.40			4.40
Energy source	12.00			56.40	84.40			152.80
Waste water sanitation	52.90				211.85			264.75
Water supply					30.11			30.11
Storm water drainage	30.07				276.30			307.37
Solid waste management	2.22				30.88			43.1
Underground wiring	30.48	5.08		14.00	61.23			110.8
Waterfront development		5.00			85.00		2.00	92.00
								1683.77

### Abbreviations

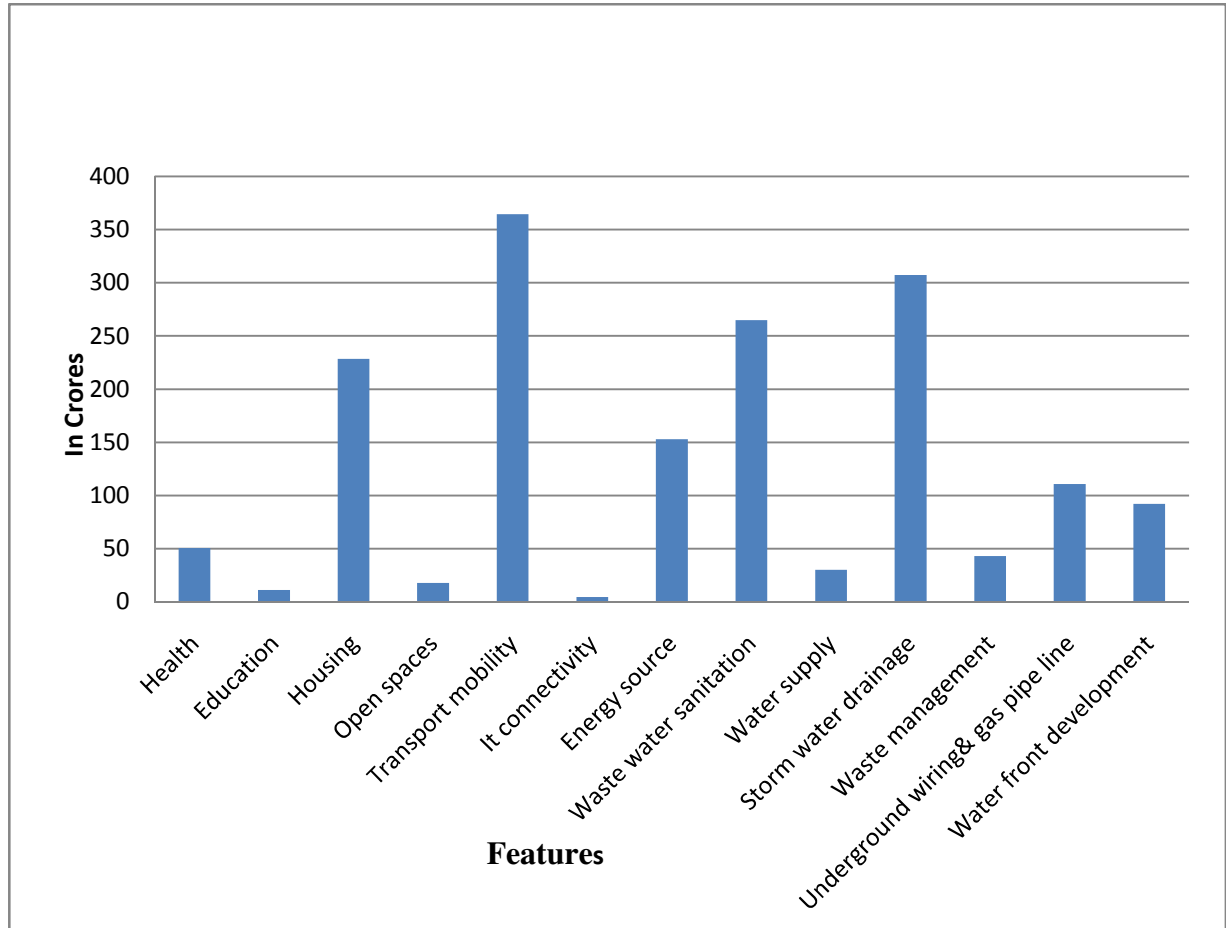
**GOI** - Government of India

**GOAP** - Government of Andhra Pradesh

**CSR** - Corporate Social Responsibility

**PPP** - Public Private Partnership

### ESTIMATED BUDGET



**Figure 3** Bar chart of estimated Budget

#### 4.4. Needs Identified By Various Categories Of Citizens

- Any project is successful when the stake holders take active part in the development process. As a part of involvement of stakeholders , various categories of citizens were met and a survey was carried out to know their requirement on order to make their life comfortable and happy.
- Employees, business man , residents in slum areas, students ,workers , houses wife's , Eleders were met and their needs were collected and presented in Table- 3

**TABLE 3** Needs identified by various categories of citizens

S.No	Stake holders	Extra facilities of smart city
1	Employee	Recreations, greenery, transportation, hospitals, Government schools with English medium, Radio Frequency Identification
2	Business	Prevention of coastal erosion, cold storage, farmer market with complete infrastructure.
3	Slum area	Transportation, electricity, houses, water facilities, sports facilities in private schools .
4	students	Educational institutions, establishment of a cells for employment generation, Wi-Fi zones, science exhibition,
5	Workers	Transportation, conventional halls, generic medicine(24hrs)
6	House wife	Late night protection, Parks, malls, cultural heritage,
7	Elders	Graveyard , parks .

#### **4.5. Details of Proposals for Various Additional Needs Identified by Citizens**

##### **4.5.1. Education**

- Some of the existing Telugu medium classes in government schools are to be converted into English medium schools.
- Providing Radio frequency identification (RFID) tags for students.
- Establishing science exhibitions for students - 1
- Government books stationary stores -5
- Sports facilities in common places for private schools for indoor and outdoor games.

##### **4.4.2. Recreation**

- Developing and protection to Godavari kalakshetram in 3.5 acres and providing parking facilities
- Developing the conventional centers & constructing the 4 new conventional halls with 2.75Acre having a above 2000 capacity and parking area 0.50 Acre.
- Two new conventional halls with 1.50Acre having a above 1000 capacity and parking area 0.30 Acre.

##### **4.4.3. Farmer Market**

- Constructing the market yard in 15 acres with a built up of area and with complete infrastructure like canteen , rest houses food facilities, weighing machines, led display screens etc.
- Providing 4 new cold storages.

##### **4.4.4. Graveyard**

- Providing coffins -10 No
- Ambulance services - 3No

- Burial grounds - 5 No

#### 4.4.5. Health & safety

- Required number of pharmacy stores (Generic Medicine ) to operate 24 hours - 5

#### 4.4.6. Establishment of a cell for employment generation

- Establishment of three multi skill training centers, like stitching , carpentry ,stationary works , crafts , bakery ,food items, TV services, mobile services, plumbing, wiring, embroiders , pantry works under Prime Minister’s Employment Generation Programme.

#### 4.4.7. Prevention of coastal erosion

- coastal area of Kakinada is suffering serve erosion in dew location it is required to initiate following measures to arrest erosion.
- Providing gabions.
- Installation of geo tubes.
- Plantation sea seeds.

**Table - 4** Comparison of needs of the citizen Vs. Proposed Budget of KMC

S.NO	Proposals of KMC sector	Proposed budget (Cr)	Needs of citizens	Variance	Budget Rs in Crores
1	Health	50.50	Hospitals, Generic medicine	Generic medicine (stores)	2.10
2	Education	11.15	Government schools with English medium.	Government schools with English medium,	0.10
3	Housing	228.48	Houses		
4	Open spaces	17.80	greenery ,parks		
5	Transport &mobility	364.41	Transportation, security		
6	IT connectivity	4.40	WI-FI zones		
7	Energy source	152.80	Electricity		
8	Waste water sanitation	264.75			
9	Water supply	30.11	Water facilities		
10	Storm water drainage	307.37			
11	Solid waste management	43.10			
12	Underground wiring &Gas pipe line	110.8			
13	Water front development	92.00			
14			sports facilities	sports facilities	1.53
15			Government book stationary stores	Government book stationary stores	1.25

**Table - 4** Comparison of needs of the citizen Vs. Proposed Budget of KMC (continued)

S.NO	Proposals of KMC sector	Proposed budget (Cr)	Needs of citizens	Variance	Budget Rs in Crores
16			Farmers market with complete infrastructure,	Farmers market with complete infrastructure,	15.00
17			Cold storages	Cold storages	15.20
18			Graveyard	Graveyard	2.30
19			Establishment of a cell for employment generation	Establishment of a cell for employment generation.	4.50
20			Science exhibition.	science exhibition	0.50
21			Cultural heritage Museum,	Cultural heritage Museum,	15.23
22			Conventional hall	Conventional hall	6.58
23			prevention of coastal erosion	prevention of coastal erosion	5.28
24			Radio Frequency Identification for students (EAN) tags	Radio Frequency Identification for students (EAN) tags	0.49
Total=1683.77			Total additional needs = 70.06		

A comparison is made between the proposals made by KMC and needs identified by stake holders and presented in Table-4

## 5. CONCLUSION

The study has revealed that existing infrastructure in the city for education ,health transportation water supply ,sanitation ,storm water drainage ,solid waste disposal ,energy is not sufficient to convert the city as smart city . Kakinada Municipal Corporation has identified various infrastructure needs worth of Rs 1683.77 Cr. Survey carried out among the citizens of Kakinada on their needs to make their life comfortable indicates that citizens are expecting to provide store for generic medicine, a farmer market with complete infrastructure , including stalls for organic produce ,up gradation of Rythu bazaars , Graveyard, centers for employment generation and establishment of culture heritage centre , museum , conventional hall, measure for coastal erosion , science exhibition and site for exhibition when considered the needs of the citizens. Total budget is coming to Rs 1753.83 crores. various sources of funds under various central state government schemes are available for execution of the same. By proper utilization of their schemes the city can be converted as peoples smart city.

## REFERENCES

- [1] Anuj Tiwari and Kamala Jain, "GIS Steering Smart Future for Smart Indian Cities." International Journal of Scientific and Research Publications, Volume 4, Issue 8, August 2014.
- [2] Yunbo LI , Anshen LIU, analysis of the challenges and solution of building a smart city." American society of civil engineers academic & science, volume 12, issue 10, November 2013.

- [3] Somayya Madakam, R. Rama Swamy, The State Of Art : Smart Cities In India : A Literature Review Report. International Journal Of Innovative And Research And Development, Volume2, Issue 12, December 2013.
- [4] BVV Bala Krishna , Smart city: A case study of Kakinada in Andhra Pradesh .International Journal of Applied Research, Volume 2, Issue 6, May 2016.
- [5] Nupur' soni, "smart city": A review &Analysis of India. International journal of computer Engineering and Applications ,volume x issue vii July 16 ISSN 2321-3469.
- [6] Stephen Sussna, Rehabilitation of Infra structure in Infill Sites." American society of civil engineers academic & science, volume 118 issue 4 October 1992.
- [7] Iker Zubizarreta, alessandro seravalli, saioa arrizabalaga . smart city concept: what it is and what it should be." American society of civil engineers academic & science, volume 142, issue 1, march 2016.
- [8] Joshi Sujata, Saxena Saksham, Godbole Tanvi, Shreya. Developing Smart Cities: An Integrated Frame Work. Science Direct , Volume 93, September 2016.
- [9] Umberto Rosatia, Sergio Contia. What is a smart city project? An urban model or a corporate business plan?. Science Direct , Volume 223, June 2016.
- [10] B.Gopala Krishna Reddy, Y.Harsha, N.Lingeshwaran, and SS.Asadi A Critical SWOT Analysis for Smart City Planning: A Model Study From Eluru City, International Journal of Civil Engineering and Technology, 8(4), 2017, pp. 1506-1513.
- [11] N. Jagadeesh and T. Reshma, Study on Smart City to Transform 23rd Ward of Vijayawada Municipal Corporation to Smart Ward. International Journal of Civil Engineering and Technology, 8(1), 2017, pp. 238–244.
- [12] Zhao Xu. "Application of System Dynamics model and GIS in sustainability assessment of urban residential development." 2011
- [13] Iana Vassileva , Erik Dahlquist , Javier Campillo , The Citizen Role In Energy Smart City Development . Science Direct ,Volume 88 June 2016.