

# International Journal of Innovative Research in Science, Engineering and Technology

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## Development of Self Sustainable Township

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**ABSTRACT:** The population of the world is rapidly increasing in contrast to the depleting resources, which will be a problem in the future because of unsustainability. This makes it necessary to develop smart cities. Smart Cities aim at making optimal and sustainable use of all resources while maintaining an appropriate balance between social, environmental and economic costs. In this paper, we would be focusing on the Town Planning part of Smart City development.

Town planning is the process concerned with the development and use of land and design of the urban environment, infrastructure, transportation and distribution networks in which the final product is the habitat for a wide variety of people with diverse wants and needs. The site we have chosen for development into a township, lies close to the highway NH81, between the districts of Tirupur and Karur of Tamil Nadu, encompassing an area of 10.81 km<sup>2</sup> to accommodate 1,00,000 people. The theory which we have chosen is the 'Satellite City theory'. The township consists of built-up area and open spaces, where built-up area includes residential, commercial, industrial, educational areas and open spaces include roads, parks playground agriculture and future development areas. This township proposes solutions through sustainable planning and design concepts. The township is designed circular with ring roads and radial road patterns connecting with NH81. The transport facilities provided are intermediate public transport, para-transit service, bus rapid transit system with separate provision for cycle lanes. Internet of Things (IoT) is equipped in all fields. The maintenance plan includes a centralized office for basic repair work and advanced technologies like district cooling system. The overarching theme is to develop an inhabitable township with all urban facilities.

**KEYWORDS:** Smart City, Town planning, Built Environment, IoT, District cooling system.

### I. INTRODUCTION

Smart city is not based on a single concept; it is a cluster of various technologies and modern construction strategies which are being introduced and getting improvised day by day. The main technology involved is Internet of things (IoT). IoT prefigures a vision of the future internet where connecting physical things, through a network will let them take an active part on the internet, exchanging information about themselves and their surroundings. These technologies support city operation efficiently and reduce the human interaction. Using those technologies great

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quality of service is rendered to the community. This concept of smart city aims in improvising the living standards of a lot of people and also aims in creating employment opportunities for people. Smart city is a prime example of sustainable cities. Sustainability is meeting the needs of the present and simultaneously compromising the needs of the future generations. The proposed township is technically equipped with houses for various income groups, industries to provide employment opportunities, schools and colleges for education, transportation facilities, solid waste management for effective disposal and management of solid waste and various other necessities. Smart cities are looking forward to giving a progressive environment and increasing the efficiency in utilization of available resources while providing a high quality of life. As far as the smart cities are concerned there are various concepts revolving around it. No such conclusions have made or no design produce is available for construction of those cities. Satellite city is the concept of development of new urban area based on which our township has been designed. Satellite cities are those towns which have been built outside the big cities. These have been built to reduce the population from main cities. The towns built on this concept are called as 'Satellite cities' because they surround the main city like a satellite. The first gen satellites built were just like normal towns in which people can just live, but for employment opportunities, they had to move to the main cities. Later these concepts got advanced and modifications were made accordingly thus creating the employment opportunity within the town itself. As the technologies got developed the smart cities also got their pace and thus were being equipped with the modern technologies. The current tendency of satellite towns is that as the size gets increased the distance from the main city is getting increased. In this paper, a town is planned based on satellite city theory which will be further developed into a smart city with IoT facilities.

## II. LITERATURE REVIEW

Various studies on Town Planning has been done for the past few decades, based on which, we have planned our township to be a sustainable one. A few of which are given below:

1. *Keeble (1969)*, an eminent British Town Planner in his book 'Principles of Town Planning', described town planning as the art and science of ordering the use of land, character and siting of buildings and communication routes so as to secure the most feasible level of economy, expediency and beauty. His views were used to decide the pattern of the township. (Keeble, 1969).
2. *Subramaniam (2007)* elaborated the concept of Development Controls as a framework to control and regulate the physical growth of towns and cities in order to make not only the existing but even future human settlements safe, orderly and beautiful. The paper was mainly prepared based on this study. The need for future development and the growth of town was studied from this paper (Subramaniam, 2007).
3. *Thomas (2001)* stated that the key objective of controls is to ensure orderly and rational development of land for creating sustainable human settlements that accommodate a variety of land uses to meet the needs of the people who reside in these settlements. The development control regulations define the limits which should be adhered to while constructing new buildings, infrastructure or carrying out modifications into the existing one. From which the sustainable development to meet the future need is carried out (Thomas, 2001).

## III. GEOGRAPHICAL DETAILS

A farmland has been chosen to be developed into a township. It is a barren land near Madhapur, a hamlet in Pongalur Block which is situated in Tirupur District surrounded by Tirupur block in North, Kundadam block in

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South, Kangeyam block in East and Palladam block in West. It is located 45 km East of Coimbatore city and 18 km towards South from District head-quarters of Tirupur. The township is located at Mean sea level of 305.00 m. The area of the chosen farmland is about 9.0025 km<sup>2</sup>.

## IV. BASIC PLANNING CONCEPTS

The township was planned based on the Satellite City Theory, the idea of which originated in England and was formally presented by Robert Robinson Taylor, an American Architect. Generally, satellite city refers to a relatively smaller independent area which is located near large cities the township developed was in real field. Nowadays, satellite cities are connected to the main city by high-speed traffic lines so that the function of the main city can be extended to the satellite cities, as its main purpose is to control the overpopulation of big cities, disperse industries and population. Based on the case studies done and the study of different road pattern and development of township an effective and a sustainable growth can be there in circular road and radial type roads, hence it leads to sustainable development of township.

## V. METHODOLOGIES

### 5.1 DEMOGRAPHICS

For a population of 1 lakh people in the proposed satellite town under development, they are classified on the basis of their income and age group. Based on income they are classified into four categories namely, Economically Weaker Section (EWS), Low Income Group (LIG), Middle Income Group (MIG) and High-Income Group (HIG). It is assumed that there are 4 persons per family. The total number of houses required is 25,000. As per HUDCO, the allocation percentage for EWS, LIG, MIG, HIG is 30%, 25%, 25%, 20% respectively. As per NBC norms, (Bureau of Indian Standards, 2016) and CMDA norms (Chennai Metropolitan Development Authority, 2013), the minimum dimension of the site required for EWS, LIG, MIG, HIG is 4m x 6m, 5m x 11m, 9m x 12m, 15m x 20m respectively. The required details for various income groups are as follows:

*Table 1: Classification based on income group people*

INCOME GROUP	NO.OF PERSONS	NO. OF HOUSES	RESIDENTIAL AREA REQUIRED (m <sup>2</sup> )
EWS	30,000	7500	2,27,500
LIG	25,000	6250	6,67,740
MIG	25,000	6250	11,61,287
HIG	20,000	5000	15,44,512
TOTAL	1,00,000	25,000	36,01,039

The land profile is chosen as a circle and the total area is rounded off to 10.81 km<sup>2</sup>, hence the diameter of the total land is 3.4 km. Table 2 shows the various allotted spaces in this township. As per IS: 1172-1993, the domestic water demand is 200 l/h/d (litres per head per day) for MIG and HIG (including full flushing system) and 135 l/h/d for EWS and LIG. So, the maximum daily demand for 1 lakh population is 41.1 MLD with peak factor of 2.5 (As per the recommendation of GOI manual on water supply) respectively the total daily maximum water demand, which

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includes residential, industrial, commercial, public use, wastewater, theft and other uses, is 74.85 MLD. The total wastewater will be 59.88 MLD, with the assumption of 80% of the total demand of water required being wastewater.

## 5.2 ESTIMATION OF BUILD-UP AND OPEN SPACES

The built-up area of the proposed township is about 5.491 Km<sup>2</sup>, which includes the area for residential, commercial, industrial, public and semi-public purposes.

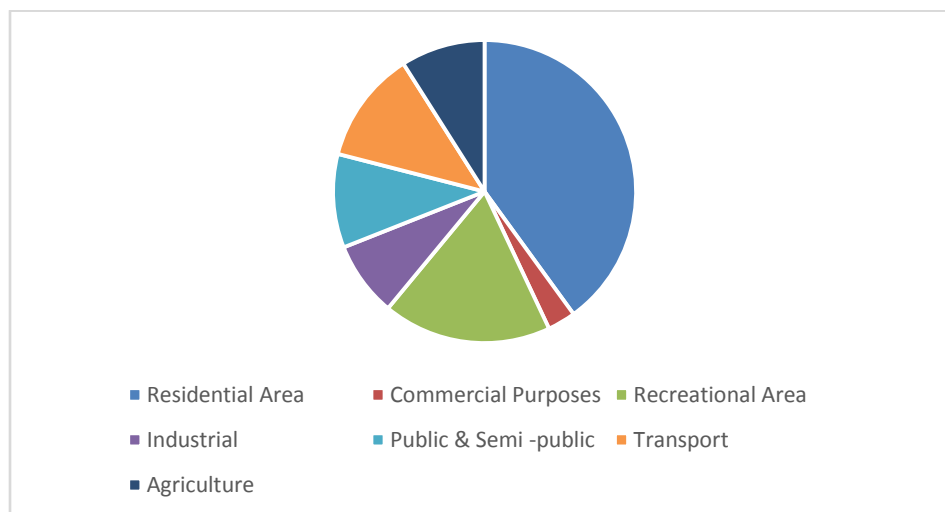


Fig1: (Allotted area for various purposes)

Source: Compiled by authors.

The open space area is about 3.51 Km<sup>2</sup>, which would aid various purposes (Government of India Ministry of Urban Development , 2015). Here, the open spaces include gardens, parks, playgrounds, agriculture lands and future development lands. The high quality in the creation of open spaces confirms the health, sustainability and socially cohesive place for all people in the town. The parks act as stress relievers and relaxation points for all sorts of people and it may also be used for local festivals and civic celebrations. There will be separate provisions for walking and cycling in parks and playgrounds. The playgrounds with seating provisions would allow the senior citizens to watch their grandchildren playing a sport. In addition to the built-up area and open spaces, 20% of the total area is provided for future development purpose.

## 5.3 INFRASTRUCTURE IN PHASES

The phase 1 of the infrastructure in the township being developed is based on the present census of 1,00,000 population. Since the township is a self-sustaining one, it includes an area for residential unit, commercial area, retail shopping, industries, educational unit, hospital zone, agricultural area, transport, recreational area, solid waste management, government sector, sewage treatment, electricity station and also area for future development.

In future, when the population increases, the traffic flow would also increase. So, in phase 2, we are developing new residential units in the future development area. In the road network system, when the intensity of traffic increases, a

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new fly-over would be constructed. But the solid waste management and sewage treatment plant will remain the same as the capacity is given based on future production. The future development area which we have provided in the proposed township is about 0.90025 km<sup>2</sup>.

## 5.4 RESIDENTIAL UNITS AND ITS AMENITIES

Separate residential units suitable for each income group people are provided. Refer clause 4.1 and Table 1 for the details regarding the population, the number of houses and area allocated for each income group. In residential units, both passive and active recreational places are provided. A neutral space where residents in multi-residential units can meet and socialize is also provided.

For EWS and LIG, the residences will be apartments of 1 BHK (1 Bedroom, Hall, Kitchen and Bathroom) with varying dimensions such as 4m x 6m, 5m x 11m respectively.

For MIG, the residential units are apartments and condos of 2 BHK (2 Bedroom with attached bathrooms, Hall, Kitchen, Dining and Portico) with a dimension of 9m x 12m.

For HIG, the residential units are villas and condos of 3 BHK (3 Bedroom with attached bathrooms, Hall, Living room, Kitchen, Dining, Pooja room, Utility room, Garage and Portico) with a dimension of 15m x 20m.

Basic amenities include power back-up, lifts, water supply, security services, parking space, recreational facilities, access to common space, waste disposal, ventilation, garden and play area for children. Modern amenities include IoT, clubhouses, swimming pool, gymnasium, community room, spa, yoga rooms, entertainment centers, library, paved walkways, Wi-Fi, laundry, childcare center etc. A primary health centre is also provided for EWS and LIG.

## 5.5 CONNECTIVITY PLAN

The development of any city depends upon the efficiency of its traffic and transportation system, which in turn influences the shape and size of the city. Traffic is an important component in urban planning. It is essential to know the characteristic of traffic for designing and planning traffic movement in the city. In the proposed township, there are five ring roads, a central round-about and ten smaller roundabouts in the ring roads connecting the radial roads emerging from the central roundabout. All internal roads are designed in such a way that vehicles can travel only within an acceptable speed.

In the round-about, the vehicle moving straight merges with the traffic coming from the other side and diverges in the middle and merge in the end before leaving the rotary. The round-about is circular where ten roads are intersecting with a central island.

The cycle track and pedestrian walkway are provided throughout the township. All service facilities provided near the Centre are easily accessible from the residential areas, with the help of radial roads.

The township is connected to major cities like Coimbatore (44.7 km), Tirupur (22.2 km) and Palladam (6.5 km). The township is connected to the Coimbatore International Airport, which is at a distance of 39.6 km and also to Tirupur Railway station (19.9 km), by road. The South Fire Station is available at a distance of 16.6 km.

To provide safe and easy mobility to people of all ages within and between sectors, Intermediate Public Transport (IPT) or Para-transit services which include cycle rickshaw, auto rickshaw, taxi, mini-buses etc., will be available.

## 5.6 MATERIALS IN CONSTRUCTION

For Economically Weaker Section (EWS), concrete sheets are used for roofing. Recycled plastics are used to save energy and landfill space. Flush doors and PVC doors are used.

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For Low Income Group(LIG), the stone cladding is used for foundation purposes. Recycled wood from the traditionally demolished building is used. Porotherm clay bricks are used for thermal insulation. Fly ash bricks are used for blocks. Bamboos are used for constructing houses.

For Middle Income Group (MIG), traditional red bricks are used for construction. Recycled metals are used for roofing. Prefabricated materials are used so that the wastes are reduced. Permeable concrete is used for pavement, parking areas, etc. Vitrified tiles are used for floors.

For High Income Group (HIG), prefabricated house, a house that can be taken apart to move with its owners is also used. Piezo materials can act as a sensor in smart houses. Solar roof tiles are solar shingles which provide production as well as protection. The other materials used are first class bricks, gypsum for wall plastering and granite for floors.

## 5.7 MAINTENANCE PLAN

Functional checking, servicing, repairing the devices, infrastructure and residential installation is a must in any planned city. And thus, they need to be properly maintained. Here, we use various techniques for the several maintenance activities. The food wastes are managed by a technique called anaerobic digestion, which generates biogas. The bio-medical wastes are managed by autoclaving and incineration. Garbage trucks and other maintenance vehicles are installed with GPS and anti-diesel theft device for betterment. These vehicles are serviced regularly. The wastewater is disposed-off through underground pipes. Blocks in these pipes are removed by the hydro-jetting method.

A new technique named District cooling system is implemented for maintaining controlled temperatures inside the building, which would be implemented in phase 2. Surface run-off water and rooftop water are collected in percolation pits and harvested for future use. Use of pervious concrete on side-walks also helps in rainwater harvesting. Fly ash bricks are used as an alternative for conventional bricks, which are also eco-friendly. A centralized office is provided for maintenance works with separate divisions for each department including monitoring vehicle GPS and labour. Various miscellaneous works are carried out with the employment of labourers and necessary equipment is provided for respective works. Electrical and plumbing assistants are made available all the time.

### 5.7.1. WATER SOURCE AND TREATMENT

To meet the water requirement of the current population of 1 lakh and keeping in mind the increase in population in the future, the Mettupalayam Water Supply Scheme is being built 54km away from Tirupur.

For an effective supply of water, combined pumping and gravity system of water supply is followed, in which the water is supplied to the town by means of both pumping and gravity. A main source pipeline travels along the highway NH-81, from which the water is brought to an elevated reservoir located near the agricultural lands on the east of the township. From the reservoir, water is supplied to the town by gravity method and distributed by the means of radial and ring system of water distribution as referred from the contour map. Since this reservoir is close to the centre of the township, the efficiency of distribution will be high. The total water requirement for the township is 74.85 MLD (Bureau of Indian Standards, 1993).

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*Table 3: (Water requirement for various purpose)*

USE	WATER REQUIREMENT l/h/d
Industrial	50
Commercial	20
Public use	10
Waste & Theft	55
<b>Total</b>	<b>135</b>

*Source:(Bureau of Indian Standards, 1993)*

### 5.7.2. SEWAGE TREATMENT PLANT

Domestic sewage (black water) and sullage (grey water) is the main source of water pollution in India, especially in and around large urban centers. Partially treated or untreated sewage causes the contamination of groundwater and downstream water bodies. Hence the utmost care is taken for wastewater treatment and its disposal. The wastewater treatment involves collection, treatment and disposal. Firstly, the collection of sewage is done by the partially separate system. In this system, part of the storm water especially collected from roofs and paved courtyards of the buildings is admitted in the same drain along with sewage from residences and institutions, etc. The storm water from the other places is collected separately using separate storm water conduits. This system is adopted since it is economical. The perpendicular pattern of collection can be used and storm water drain is collected and used for agriculture purpose. The treatment process in the sewage treatment plant involves the Upflow Anaerobic Sludge Blanket (UASB) after screening through screens and grit chambers.

The reactor can be divided into three parts as sludge bed, sludge blanket and three phase separator (gas-liquid-solid, GLS separator) provided at the top of the reactor. Since it is an anaerobic process, methane is produced in a large amount which will be used. After the UASB reactor, some form of post-treatment is generally desirable depending upon the source of effluent discharge. UASB reactor can hardly remove any nitrogen from the wastewater. Hence, effluent from the UASB reactor is suitable for irrigation purposes. UASB reactor, when followed by post-treatment such as aeration and/or sedimentation could conveniently achieve irrigation standards. The aeration can be obtained to the effluent flowing through a channel to an irrigation area. The sludge production is too low in this system. That sludge will also be converted to manure. The STP will be provided with a sustainable off-grid system where solar panels will supply the electricity needed for the plant. This STP can effectively manage sewage in a way that converts waste into useful products and also recharges the environment and offers a proven strategy for responsible and productive sewage disposal. The total wastewater will be 59.88 MLD (approx.), with the assumption of 80% of the total demand of water required. The treatment plant has a capacity of 60 MLD.

### 5.7.3. ELECTRICITY

Electricity is an aspect of the utility sector that is very essential to the smooth and meaningful development of a town. The power system has three major parts: Generation, Transmission and Distribution.

A 10 MW solar plant has been installed within the city for power generation and the remaining electricity required is obtained from TNEB. Many more power plants of such capacities will be installed in near possible future as the town develops. Also, Solar paneled rooftop system with net metering for individual government and private building, provision of solar panels above cycle track canopies, bus stops with the solar roof are provided which causes a reduction of carbon footprint. For transmission, an approximate of 20 transformers are provided. A

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distribution system may comprise of three-phase transmission lines, with a typical operating voltage of 12 to 25 KV line, and three phases, two phases or single phase tapped lines. As of now the total electricity requirement for the proposed township is 42.5MW (approx.). Renewable electricity is an essential part of a sustainable energy future, for which renewable energy sources like solar energy and wind energy are generated for a sustainable living.

## **5.7.4. SOLID WASTE MANAGEMENT**

Solid Waste Management (SWM) is a universal problem. Solid waste must be properly collected and disposed of without causing harm to the environment. The Waste generated in kg/capita/day is  $(0.21 \times 1,00,000)$  is 21000. The solid waste is disposed of by means of Landfill in the provided area. The waste is dumped at compost depot and processed. A Provision for generating biogas and generating electricity from waste is given. The wastes are segregated as wet and dry waste by means of a contract, which is allotted for managing the waste.

## **5.8 REDRESSAL MECHANISM**

The redressal mechanism usually covers grievances like service unavailability, non-delivery against commitment, excessive delays, injustice concerns (over race, caste, and sex), staff misbehavior, employee disputes etc.

An e-governance redressal module named; "HELPLINE" is implemented here. HELPLINE is a complaint registration and tracking system that uses internet, phone, e-mail and paper to register their grievances and also to track the progress of redressal through a complaint tracking number generated by the system. When a complaint is filed, it is registered by the helpline in the online tool which generates a complaint number for the citizen for tracking the complaint status. Simultaneously the complaint is posted to the concerned section in the ULB, where the ULB staff can access the portal through a username and password.

If the complaint is not addressed within 72 hours, it is transferred to the next level in the hierarchy thereby allowing a censure on the ULB staff which affects their annual performance report and in turn, impacting their career trajectories. The main challenges in this include,

- To convince the citizen that their complaints will be addressed properly
- To ensure efficient and satisfactory redressal
- The requirement for skilled ULB staff to utilize the technologies.



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## VI. LAYOUT OF THE PROPOSED TOWNSHIP:

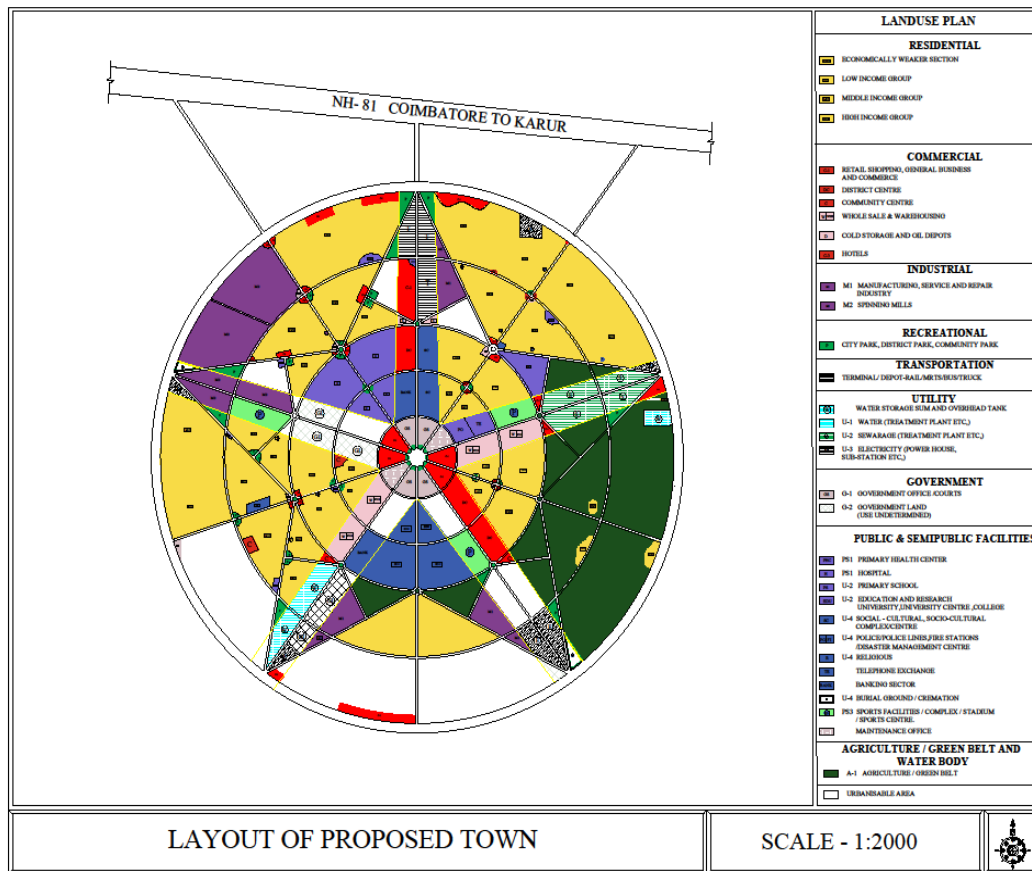


Fig 2: Proposed land use map

## VII. CONCLUSION

Town planning is becoming a must in our tremendously growing nation, as its absence would lead to uneven and chaotic environment, mixed land use and congested transportation network. Our goal is to develop a realistic and sustainable town which is quite essential in this degrading environment. This paper emphasizes and reinforces sustainable practices in order to attain a self-sustaining town, thus reporting various sustainable solutions for the key issues and the problems of today's cities which are tackled, while also seeing to the potential problems the satellite city might face in the coming decades and thus, this township is a sustainable urban area. As the next step, future development demands will also be satisfied by converting this satellite city into a smart city.

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## ABBREVIATIONS

EWS - Economically Weaker Section, LIG - Low Income Group, MIG - Middle Income Group, HIG - High Income Group, HUDCO – Housing and Urban Development Corporation, NBC – National Building code.

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