

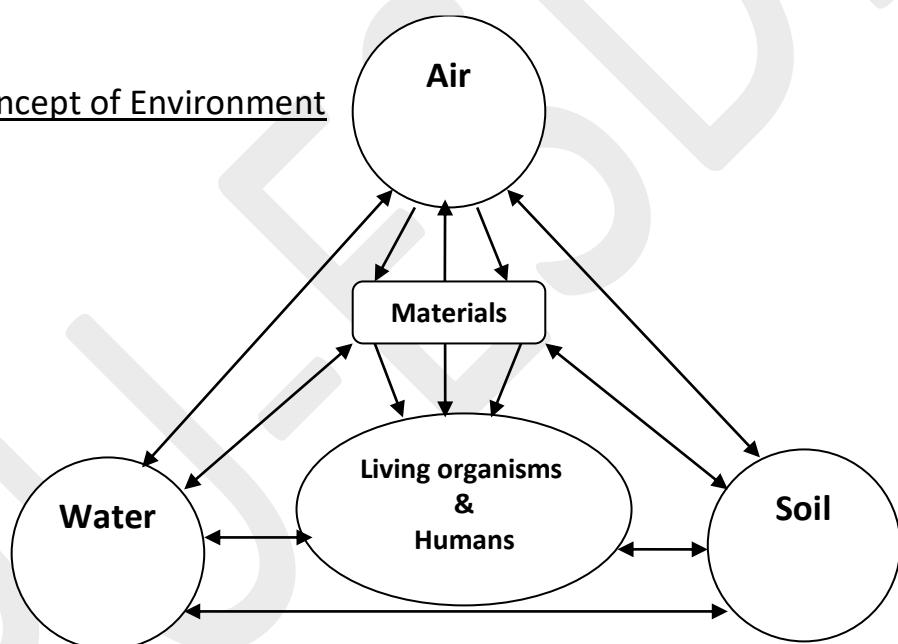
## Module 1: Introduction to Environment & Natural Resources

- An interdisciplinary branch of science that investigates questions related to the human population, resources, and damages caused by pollution.
- Environment is derived from the French word **Environner**, which means encircle or surround.
- Everything that surrounds and affects living organisms is environment.

**Environment is defined** as “*the sum total of water, air and land, the inter-relationships that exist among them and with the human beings, other living organisms and materials*” (*Environment Act – 1986*)

### Concept of Environment:

Fig. Concept of Environment



- Figure depicts the environment of human beings. Air, water and land surrounding us constitute our environment, and influence us directly.
- At the same time we too have an influence on our environment by overuse or overexploitation of resources or by discharge of pollutants in the air, water and land.
- The Flore, Fauna and micro-organisms as well as the man-made structures in our surroundings have a bi-directional interaction with us directly or indirectly.
- The totality of all these components and their interactions constitute the environment.

## **Scope of environmental studies:**

Due to its complex and multidisciplinary nature, EVS as a subject has wide scope. Several career options have emerged in this field that are broadly categorized as

1. Research and Development in environment
2. Green advocacy
3. Green marketing
4. Green media
5. Environment consultancy

- **Research & Development (R & D) in environment:**

Environmental scientists have an important role to play in examining various environmental problems in a scientific manner and carry out R & D activities for developing cleaner technologies and promoting sustainable development.

There is a need for trained manpower at every level to deal with environmental issues. Environmental management and environmental engineering are emerging a new career opportunities for environmental protection and management. With the pollution control laws becoming more stringent, industries are finding it difficult to dispose off the wastes produced. In order to avoid expensive Litigation, companies are now trying to adopt green technologies, which would reduce pollution.

- **Green advocacy:** With increasing emphasis on implementing various Acts and Laws related to environment, need for environmental lawyers has emerged, who should be able to plead the cases related to water and air pollution, forest, wildlife etc.
- **Green marketing:** While ensuring the quality of products with ISO mark, now there is an increasing emphasis on marketing goods that are environment friendly. Such products have eco mark or ISO 14000 Certification. Environmental auditors and environmental managers would be in great demand in the coming years.
- **Green media:** Environmental awareness can be spread amongst masses through mass media like television, radio, newspaper, magazines, hoardings, advertisements etc. for which environmentally educated persons are required.
- **Environment Consultancy:** Many non-government organizations (NGOs), industries and government bodies are engaging environmental consultants for systematically studying and tackling environment related problems.

## **Importance of environmental studies:**

Environment belongs to all and is important to all, whatever be the age and occupation

**1. Global importance:** Issues like global warming. Ozone depletion, dwindling of forest energy resources. Which are going to affect the mankind as a whole/ globally so, we have think and plan globally.

**2. Local importance:** Some environmental problems which are of localized importance. e.g. impact of mining , hydroelectric power project, disposal of solid waste, river or lake pollution, soil erosion, flurosis problem in ground water etc., we have to think and act locally.

**3. Individualistic importance:** It is very important for an individual to deal most mundane problems of life such as safe and clean drinking water, hygienic living conditions, fresh air, and healthy food, safe and secure environment.

## **Need for Public Awareness:**

- Earth's resources are dwindling and our environment is being increasingly degraded by human activities and hence something needs to be done.
- If want to protect and sustain our earth, we have to make everyone environmentally educated.
- Rapidly changing technologies lead to abandoned wastes.
- Our fast and energy demanding life style pollutes the environment
- Crazy consumerism leads to environmental degradation
- The earth has definite capacity to tolerate pollutants and sustain populations
- Government alone cannot perform all the clean-up functions.
- Individual/group efforts in their own every possible way has to be made to protect our environment.
- Mass public awareness: newspapers, radio, television strongly influences public opinion on conserving our environment.

Chinese Proverb:

***“If plan for one year plant rice, if you plan for ten years plant a tree and if you plan for 100 years educate people”***

## **Environmental Calendar:**

World Wetland Day	February 2
World Forest Day	March 21
World Day for Water	March 22
World Meteorological Day	March 23
Earth Day	April 22
International Biodiversity Day	May 22
Anti-tobacco Day	May 31
World Environment Day	June 5
World Ocean Day	June 8
World Population Day	July 11
World Ozone Day	Sept. 16
World Car – free Day	Sept. 22
Green Consumer Day	Sept. 28
World Farm Animals Day	Oct. 2
World Habitat Day	Oct. 3
World Animal Welfare Day	Oct. 4
Wildlife Week	Oct. 1-7
World Conservation Day	Oct. 24

International Day for Natural Disaster Reduction

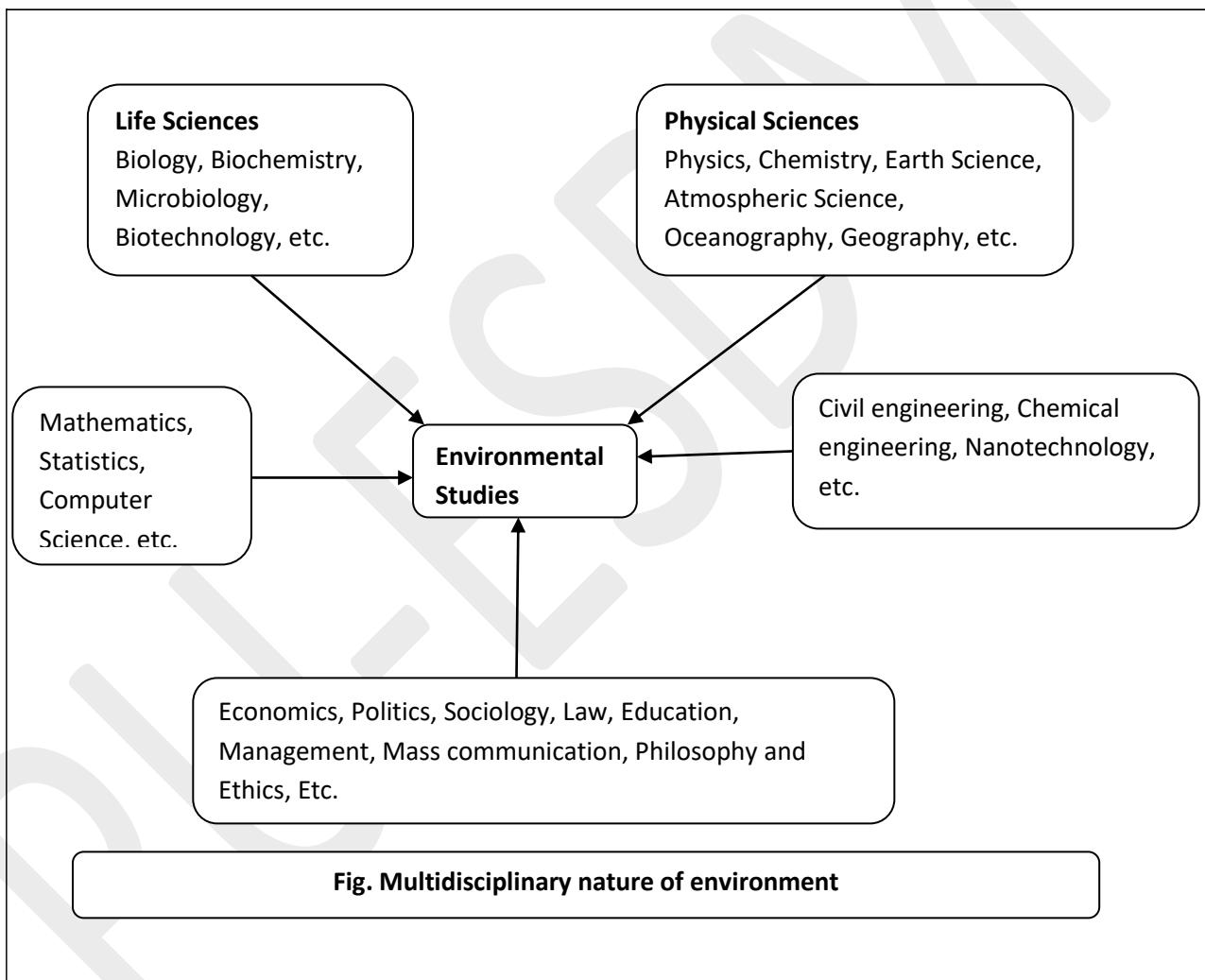
Oct. 23

International Day for biological Diversity

Dec. 29

### **Multidisciplinary Nature of Environmental Studies:**

We know that environment consists of both Physical and biological surroundings and their interactions. Thus in order to study about environment, one needs to have a knowledge of various disciplines.



- Life Science including botany, zoology, microbiology, genetics and biochemistry help in understanding the biotic components and their interactions. Genetics and biotechnology are emerging as useful tools for finding solutions to environmental problems.

- For understanding the physical and chemical structure of abiotic components of environment along with mass and energy transfers we have to make use of the basic concept of physics, chemistry, geology, atmosphere science, oceanography and geography.
  - Mathematics, statistics and computer science likewise serve as effective tools in environmental modeling.
  - Subjects like economics, management and sociology provide the inputs for dealing with the socio-economic aspects associated with various development activities.
  - A synthesis of civil engineering, hydraulics, chemical engineering and nanotechnology provide the technical solutions to environmental pollution control and waste treatment that are extremely important for protection of the environment.
  - Environment laws provide the guidelines and legal measures for effective management and protection of the environment.
  - Environmental education and mass communication are two important subjects that are instrumental in disseminating environmental awareness.
  - Environmental ethics provide the guidelines for a sustainable life style.
- Environmental sciences, therefore, is a multi-disciplinary subject where we deal with different aspects using a holistic approach.

## **Important institutions in Environment**

### ***Bombay Natural History Society (BNHS), Mumbai***

- An NGO founded in 1883.
- Wildlife policy building and Works towards conservation of wildlife species and ecosystems main objective.
- Popular research publications - HORNBILL, journal on natural history, Salim Ali handbook on birds.

### ***World Wide Fund for Nature (WWF-I), New Delhi***

- Initiated in 1969 in Mumbai and then moved to new Delhi with several branch offices all over India.
- Wildlife education and awareness.

***Centre for Environment Education (CEE), Ahmedabad***

- It was initiated in 1989.
- It has wide range of programs on the environment and produces a variety of educational material.

***Salim Ali Center for Ornithology and Natural History (SACON), Coimbatore***

- Dr. Salim Ali wished to support a group of committed conservation scientists on permanent basis and that dream became a reality only after his demise.
- It is an independent organization and is based at Coimbatore since 1990.
- It has instituted a variety of field programs that have added to the country's information on our threatened biodiversity.

***Botanical Survey of India (BSI)***

- It was established in 1890 at the Royal Botanic Gardens, Calcutta.
- However it was closed for several years after 1939 and was reopened in 1954.
- It carries out surveys of plant resources in different regions.

***Zoological Survey of India (ZSI)***

- It was established in 1916.
- Its mandate was to do a systematic survey of fauna in India.

It has done an enormous amount of work on taxonomy and ecology

**People in Environment:**

Individuals who have been instrumental in shaping the environmental history in our country:-

***Salim Ali***

- He has written several great books including the famous 'Book of Indian Birds'.
- His autobiography, 'Fall of a Sparrow' should be read by every nature enthusiast.

- He was our country's leading conservation scientist and influenced environmental policies in our country for over 50 years.

***MS Swaminathan***

- One of India's foremost agricultural scientists and has also been concerned with various aspects of biodiversity conservation both of cultivars and wild biodiversity.
- Founder of the MS Swaminathan Research Foundation in Chennai, which does work on the conservation of biological diversity.

***Madhav Gadgil***

- A well known ecologist in India.
- His interests range from broad ecological issues such as developing Community Biodiversity registers and conserving sacred groves to studies on the behavior of mammals, birds and insects.

Individuals who have been instrumental in shaping the environmental history in our country:-

***MC Mehta***

- India's most famous environmental lawyer (Green advocate)
- Since 1984, he has filed several Public Interest Litigation (PIL) for supporting the cause of environmental conservation.
- Protecting the Taj Mahal, cleaning up the Ganges River, environmental education in schools and colleges, and a variety of other conservation issues.

***Medha Patkar***

- She is known as one of India's Champions who has supported the cause of downtrodden tribal people whose environment is being affected by the dams on the Narmada river popularly known as Narmada Bachao Andolan.

***Sunderlal Bahuguna***

- His Chipko Movement has become an internationally well-known example of a highly successful conservation action program through the efforts of local people for guarding their forest resources.

- The Garhwal Hills will always remember his dedication to the cause for which he has walked over 20 thousand kilometers.

### ***Charles Darwin***

- Author of “Origin of Species” which brought to light the close relationship between habitats and species.
- It also brought about a new thinking of man’s relationship with other species that was based on evolution.

### ***Rachel Carson***

- In the 1960s Rachel Carson published several articles that caused immediate worldwide concern on the effects of pesticide on nature and mankind.
- She wrote a well-known book called ‘Silent Spring’ which eventually led to a change in Government policy and public awareness.

## **Natural Resources**

### **What is natural resources?**

***Definition: Life on this earth planet depends upon varieties of goods and services provided by the nature, which are known as natural resources.***

Any stock or reserve that can be drawn from nature is a natural resource.

### **Kinds of Natural Resources**

- 1. Renewable resources:*** Which are in-exhaustive and can be regenerated within a given span of time.  
e. g. Forests, wildlife, wind energy, biomass energy, tidal energy, hydro power, solar energy, etc.
- 2. Nonrenewable resources:*** Which are exhaustive and cannot be regenerated  
e.g. Fossil fuels like petroleum, coal, minerals etc.

### **Major natural resources:**

- (i) Forest resources
- (ii) Water resources
- (iii) Mineral resources
- (iv) Food resources
- (v) Energy resources

(vi) Land resources.

## **Forest Resources:**

- About one third of world land area is forested, which includes sparse, closed and open forests.  
Brazil- 7 % of the world forest, USA and Canada- 6-7% , USSR- 5%
- Scientists estimates that India should ideally have 33% of its land under forests. Today we have only about 19%. Thus we need not only to protect existing forests but also to increase our forest cover.

## **Forest uses or benefits**

### ***1. Watershed protection:***

(an area or ridge of land that separates waters flowing to different rivers, basins, or seas)

- Reduce the rate of surface run-off of water.
- Prevent flash floods.
- Produces prolonged gradual run-off and thus prevent effects of drought.

### ***2. Atmospheric regulation:***

(The process by which water is transferred from the land to the atmosphere by evaporation from the soil and other surfaces and by transpiration from plants)

- Absorption of solar heat during evapo-transpiration.
- Maintaining carbon dioxide levels for plant growth.
- Maintaining the local climatic conditions.

### ***3. Erosion control:***

- Holding soil (by preventing rain from directly washing soil away).

### ***4. Land bank:***

- Maintenance of soil nutrients and structure.

### ***5. Local use (Consumptive use by local people):***

- Food - gathering plants, fishing, hunting from the forest.
- Fodder - for cattle.
- Fuel wood and charcoal- for cooking, heating.
- Poles - building homes especially in rural areas.
- Timber – household articles and construction.

- Fiber - weaving of baskets, ropes, nets, string.
- Sericulture – for silk.
- Apiculture - bees for honey, bees also pollinate crops.
- Medicinal plants - traditionally used medicines.

#### **6. Market use (Productive use)**

- Most of the forest products used for consumptive purposes are also sold as a source of income for supporting the livelihoods of forest dwelling tribes.
- Minor forest products(non-timber products): fuel wood, fruit, gum, fiber, etc.
- Major timber extraction: construction, industrial uses, paper pulp, etc.

Timber extraction is done in India by the Forest Department, but illegal logging continues in many of the forests of India and the world.

### **REASONS FOR OVER EXPLOITATION OF FORESTS**

- Since time immemorial, humans have depended heavily on forests for food, medicine, shelter, wood and fuel.
- With growing civilization the demands for raw material like timber, pulp, minerals, fuel wood etc. shoted up resulting in large scale logging, mining, road-building and clearing of forests.
- Our forests contribute substantially to the national economy.
- The international timber trade alone is worth over US \$ 40 billion per year.
- Excessive use of fuel wood and charcoal, expansion of urban, agricultural and industrial areas and overgrazing have together led to over-exploitation of our forests leading to their rapid degradation.

### **Deforestation:**

***Definition: Deforestation refers to the loss of forest cover continuously and permanently.***

The United Nations conference on Environment and Development (UNCED), 1992 defines deforestation as land degradation in arid (having little or no rain), semiarid (has little rain but is not completely dry) and sub-humid (slightly humid) areas resulting from various factors including climatic variations and human activities.

### **Causes of deforestation:**

1. ***Shifting cultivation:*** There are an estimated 300 million people living as shifting cultivators who practice slash and burn agriculture and are supposed to clear more than 5 lakh ha of forests for shifting cultivation annually. In India, we have this practice in NorthEast and to some extent in Andhra Pradesh, Bihar and M.P which contribute to nearly half of the forest clearing annually.

2. **Fuel requirements:** Increasing demands for fuel wood by the growing population in India alone has shoted up to 300-500 million tons in 2001 as compared to just 65 million tons during independence, thereby increasing the pressure on forests.
3. **Raw materials for industrial use:** Wood for making boxes, furniture, railway-sleepers, plywood, match-boxes, pulp for paper industry etc. have exerted tremendous pressure on forests. Plywood is in great demand for packing tea for Tea industry of Assam while fir tree wood is exploited greatly for packing apples in J&K.
4. **Development projects:** Massive destruction of forests occur for various development projects like hydroelectric projects, big dams, road construction, mining etc.
5. **Growing food needs:** In developing countries this is the main reason for deforestation. To meet the demands of rapidly growing population, agricultural lands and settlements are created permanently by clearing forests.
6. **Overgrazing:** The poor in the tropics mainly rely on wood as a source of fuel leading to loss of tree cover and the cleared lands are turned into the grazing lands. Overgrazing by the cattle leads to further degradation of these lands.

### **Effects/ Consequences of Deforestation:**

- It threatens the existence of many wild life species due to destruction of their natural habitat.
- Soil erosion and loss of soil fertility
- Desertification
- Migration of the tribal people
- Landslides in hilly region
- Countless plants and animal species becomes endangered
- Changes in climate pattern
- Hydrological cycle gets affected
- Rise in carbon dioxide leads global warming
- Loss of future market for ecotourism

### **Solutions for deforestation**

- ✓ Reduce consumption of forest and its related products
- ✓ Afforestation in open and barren land: to compensate forest loss
- ✓ Stringent forest policies: to avoid illigal deforestation and denotification of forest land for development activities.
- ✓ Environmental awareness and education.

## **Timber Extraction**

- One of India's serious environmental problems is forest degradation due to timber extraction
- Timber extraction continued to remain the Forest Department's main concern up to the 1970s. But now very scientifically and legally timber extraction and logging is carrying out by forest department.

### **Classification of Timber extraction:**

1. ***Clear felling***- It involves extensive modification of the forest after the commercial trees are harvested.

Non-commercial trees may be removed to generate an even-aged group of commercial tree species.

2. ***Selective logging*** – harvesting of selective timber yielding tree species and allow other trees to grow until the following harvest cycle.

3. ***Mechanized logging***- In clear felling and selective logging operations using heavy machineries to transport logs from the forest area

4. ***Hand logging*** – In permanently water logged swamp and peat forest heavy transport machineries cannot be used and commercial logging operations have to employ a method called hand logging.

## **IMPACTS OF TIMBER EXTRACTION AND LOGGING**

- Fragmentation of forest by clear felling and selective logging
- Loss of native species in mechanical logging
- Birds and mammals will significantly disturbed by logging process
- Excessive debris collection in logging make forest more vulnerable to forest fire
- High-volume harvesting can contribute erosion and regenerative capacity.

## **WATER RESOURCES:**

Water is an indispensable natural resource on this earth on which all life depends. About 97% of the earth's surface is covered by water and most of the animals and plants have 60-65% water in their body.

Water is characterized by certain unique features which make it a marvelous resource:

- (i) It exists as a liquid over a wide range of temperature i.e. from 0 ° to 100°C.
- (ii) It has the highest specific heat, due to which it warms up and cools down very slowly without causing shocks of temperature jerks to the aquatic life.
- (iii) It has a high latent heat of vaporization hence, it takes a huge amount of energy for getting vaporized. That's why it produces a cooling effect as it evaporates.

- (iv) It is an excellent solvent for several nutrients. Thus, it can serve as a very good carrier of nutrients, including oxygen, which are essential for life. But, it can also easily dissolve various pollutants and become a carrier of pathogenic microorganisms.
- (v) Due to high surface tension and cohesion it can easily rise through great heights through the trunk even in the tallest of the trees like Sequoia.
- (vi) It has an anomalous expansion behaviour i.e. as it freezes, it expands instead of contracting and thus becomes lighter. It is because of this property that even in extreme cold, the lakes freeze only on the surface. Being lighter the ice keeps floating, whereas the bottom waters remain at a higher temperature and therefore, can sustain aquatic organisms even in extreme cold.

### **WATER USE AND OVER-EXPLOITATION**

- Due to its unique properties water is of multiple uses for all living organisms. Water is absolutely essential for life. Most of the life processes take place in water contained in the body. Uptake of nutrients, their distribution in the body, regulation of temperature, and removal of wastes are all mediated through water.
- Human beings depend on water for almost every developmental activity. Water is used for drinking, irrigation, and transportation, washing and waste disposal for industries and used as a coolant for thermal power plants. Water shapes the earth's surface and regulates our climate.
- Water use by humans is of two types: water withdrawal: taking water from groundwater or surface water resource and water consumption: the water which is taken up but not returned for reuse. Globally, only about 60 percent of the water withdrawn is consumed due to loss through evaporation.
- With increasing human population and rapid development, the world water withdrawal demands have increased many folds and a large proportion of the water withdrawn is polluted due to anthropogenic activities. On a global average 70 percent of the water withdrawn is used for agriculture. In India, we use 93% of water in agricultural sector while in a country like Kuwait, which is water-poor, only 4% is used for watering the crops. About 25% of water on global average is used in industry, which again varies from a high of 70% in European countries to as low as 5% in less developed countries. Per capita use of water shows wide variations. In USA, an average family of 4 consumes more than 1000 M<sup>3</sup> of water per year, which is many times more than that in most developing countries.

Table : Water usage in the World

Sector	Global Use (%)	Industrialized countries (High income) use (%)	Developing countries (low and middle income) use (%)	Use in India (%)
Agriculture	70	30	82	80

Industry	22	59	10	15
Domestic	8	11	8	5

- ✓ Industrialized / developed countries tend to use more water in their industrial production.
- ✓ Other countries tend to use more water for agricultural uses.

#### **Note: URBAN DOMESTIC WATER NEEDS IN INDIA**

In India urban water supply are designed for a consumption of **135 liters/day/person**

Use	Liters/day/person
Drinking	3
Cooking	4
Bathing	20
Flushing toilet	40
Washing cloths	25
Washing utensils	20
Gardening	23
<b>Total</b>	<b>135</b>

**Many urban consume much more than norms and note people in our village manage with much less water than toilet flush consumes.**

#### **Water Footprint:**

- Water foot print is an indicator that measures both direct and virtual water use of a consumer or producer.
- Water foot print of a product is the volume of fresh water used up to produce the item, taking into account the volume of water consumed and polluted in the different steps

<b>Item and Quantity</b>	<b>Water footprint (in Liters)</b>
Bottled water (1L)	3-6
Paper (1 A4 sheet)	10
Potato (100g)	25
Cup of coffee (125ml)	125
Milk (1L)	1000
Cane sugar (1kg)	1800
Rice (1Kg)	2500
Cotton T-Shirt	4100
Pair of shoes (Bovine leather)	8000

## **EFFECTS OF OVER EXPLOITATION OF SURFACE AND GROUNDWATER USAGE**

- (i) ***Subsidence:*** When groundwater withdrawal is more than its recharge rate, the sediments in the aquifer get compacted, a phenomenon known as ground subsidence. Huge economic losses may occur due to this phenomenon because it results in the sinking of overlying land surface. The common problems associated with it include structural damage in buildings, fracture in pipes, reversing the flow of sewers and canals and tidal flooding.
- (ii) ***Lowering of water table:*** Mining of groundwater is done extensively in arid and semi-arid regions for irrigating crop fields. However, it is not advisable to do excessive mining as it would cause a sharp decline in future agricultural production, due to lowering of water table.
- (iii) ***Water logging:*** When excessive irrigation is done with brackish water it raises the water table gradually leading to water-logging and salinity problems.

### Decreasing trend of water availability in India

Year	Per capita availability (Cubic meter)
1951	5000
2001	1820
2011	1545
2030	1300

- In India, >**60,000 villages** exist without a single source of water.
- **45 million people** affected annually by the poor quality of water.
- India has **16% of world's population**, but has only **4% of fresh water**.

### DROUGHTS:

There are about 80 countries in the world, lying in the arid and semiarid regions that experience frequent spells of droughts, very often extending up to year long duration. When annual rainfall is below normal and less than evaporation, drought conditions are created. Ironically, these drought- hit areas are often having a high population growth which leads to poor land use and makes the situation worse.

*Drought is a “meteorological phenomenon, when annual rainfall is below normal and less than evaporation” leads to drought in the region.*

### Causes of drought:

- Overgrazing
- Increased water exploitation for irrigation
- Erroneous and intensive cropping pattern
- Deforestation
- Mining
- Desertification

### REMEDIAL MEASURES

- Carefully selected mixed cropping helps optimize production and minimize the risk of crop failure.
- Water resistant crops

- Farm pond
- Wind breakers (Linear plantings of tree or shrubs)
- Social Forestry and Wasteland development can prove quite effective to fight the problem.

The **Kolar district in Karnataka** is one of the leaders in social forestry with World Bank Aid, but all its **11 taluks** have suffered from drought. It is because the tree used for plantation here was **eucalyptus**. It is now known that this tree is responsible for lowering down the water table because of its very **high transpiration rate**. It is therefore important to select the appropriate crop or plantation depending upon the **climate, soil type and its water requirements**.

### **Dams and their benefits and effects:**

- **Definition:** *Dams are artificial structures built across the river to create reservoir to store water.*
- **Indian Scenario:** Maharashtra = >600 dams, Gujarat = >250 dams, Madhya Pradesh = >130 dams

### **Benefits of Constructing Dams:**

- 40% of the food production comes from irrigated forming, with a direct 16% contribution from land irrigated from dam reservoirs.
- Control flood & store water
- Divert water from river into a channel
- Used for drinking & agricultural purposes
- Hydro-electric powers produce 19% of the worlds energy
- Used for recreational purposes
- Navigation & fishery can be developed in dam areas
- Help for the socio economic development of the society
- Used for irrigation during dry seasons
- Prevent drought

### **Effects of dam on forest:**

- ✓ Thousands of hectares of forest are cleared for river valley projects
- ✓ Forest is also cleared for residential, office, buildings, storing materials, laying roads etc
- ✓ Hydro-electric projects have led to loss of forest.
- ✓ Dam construction kills wild animals & aquatic life

- ✓ Hydro-electric projects spread water borne diseases.
- ✓ Water logging leads to salinity & reduces the fertility of land.

**Effects of dam on tribal people:**

- Displacement of tribal people
- Cultural change affects the tribal people mentally & physically
- They do not accommodate the modern food habits & lifestyles.
- Tribal's are ill treated by modern society
- They are recognized and compensated
- Their body condition will not suit the new area & are affected by many diseases.

**MINERAL RESOURCES:**

**WHAT ARE MINERALS?**

*Minerals are naturally occurring, inorganic, crystalline solids having definite chemical composition.*

There are thousands of minerals occurring in different parts of the world. However, most of the rocks we see everyday are just composed of a few common minerals like quartz, feldspar, biotite, dolomite, calcite, laterite etc. These minerals, in turn, are composed of some elements like silicon, oxygen, iron, magnesium, calcium, aluminium etc.

**Types of Minerals:**



FELDSPAR



CALCITE



BIOTITE



DOLOMITE



QUARTZ



LATERITE

### **TYPES OF MINERALS:**

Based on their **properties** minerals are basically of two types

1. **Non-metallic minerals** - e.g. Graphite, diamond, quartz, feldspar.
2. **Metallic minerals** – e.g. Bauxite, laterite, haematite etc.

Minerals are sometimes classified as

1. **Critical minerals** are essential for the economy of a nation e.g. iron, aluminium, copper , gold etc.
2. **strategic minerals** are those required for the defense of a country e.g. manganese, cobalt, platinum , chromium etc.

### **USES OF SOME METALLIC MINERALS:**

<b>Metal</b>	<b>Major uses</b>
Aluminium	Packaging food items, transportation, utensils, electronics.
Copper	Electric and electronic goods, vessels, building construction.
Iron	Heavy machineries, steel, transportation means.
Chromium	For making high strength steel alloys, textile and tanning industry.
Lead	Leaded gasoline, car batteries, paints.
Platinum	Use in automobiles, catalytic converter, electronics, medical uses.
Gold	Ornaments, medical, electronic, aerospace.
Silver	Photography, electronics, jewelry.

## **USES OF SOME MAJOR NON-METALLIC MINERALS:**

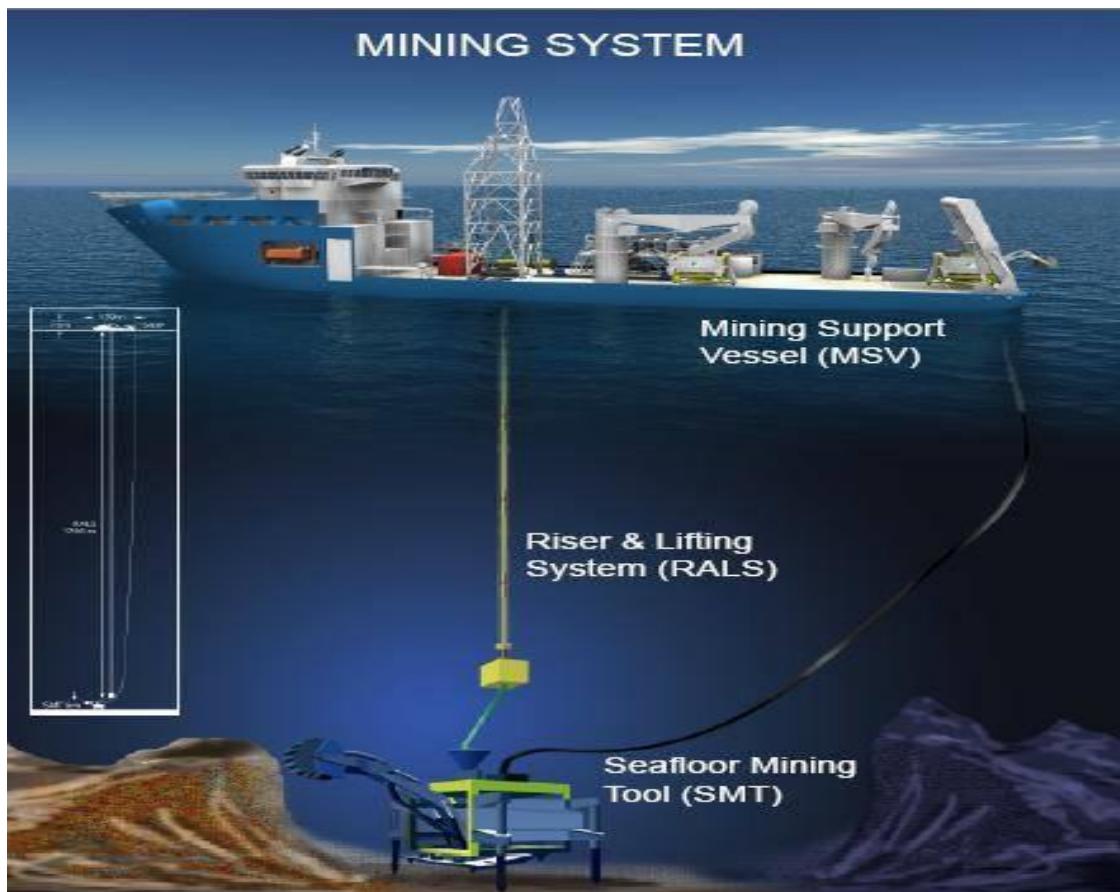
Non-metal mineral	Major uses
Silicate minerals	Sand and gravel for construction
Lime stone	Building stone, concrete, cement, agriculture
Gypsum	plaster wall-board, agriculture fertilizer
Potash, phosphorite	agriculture fertilizer
Sulphur pyrites	Medicine, car battery

**Surface mining** may make use of any one of the following three types:

- 1) **Open pit mining** in which machine dig holes and remove the ores.
- 2) **Dredging** in which chained buckets and draglines are used to scrap up the minerals from under-water deposits
- 3) **Strip mining** in which the ore is stripped off by using bulldozers, power shovels and stripping wheels



**Open Pit Mining**



Dredging

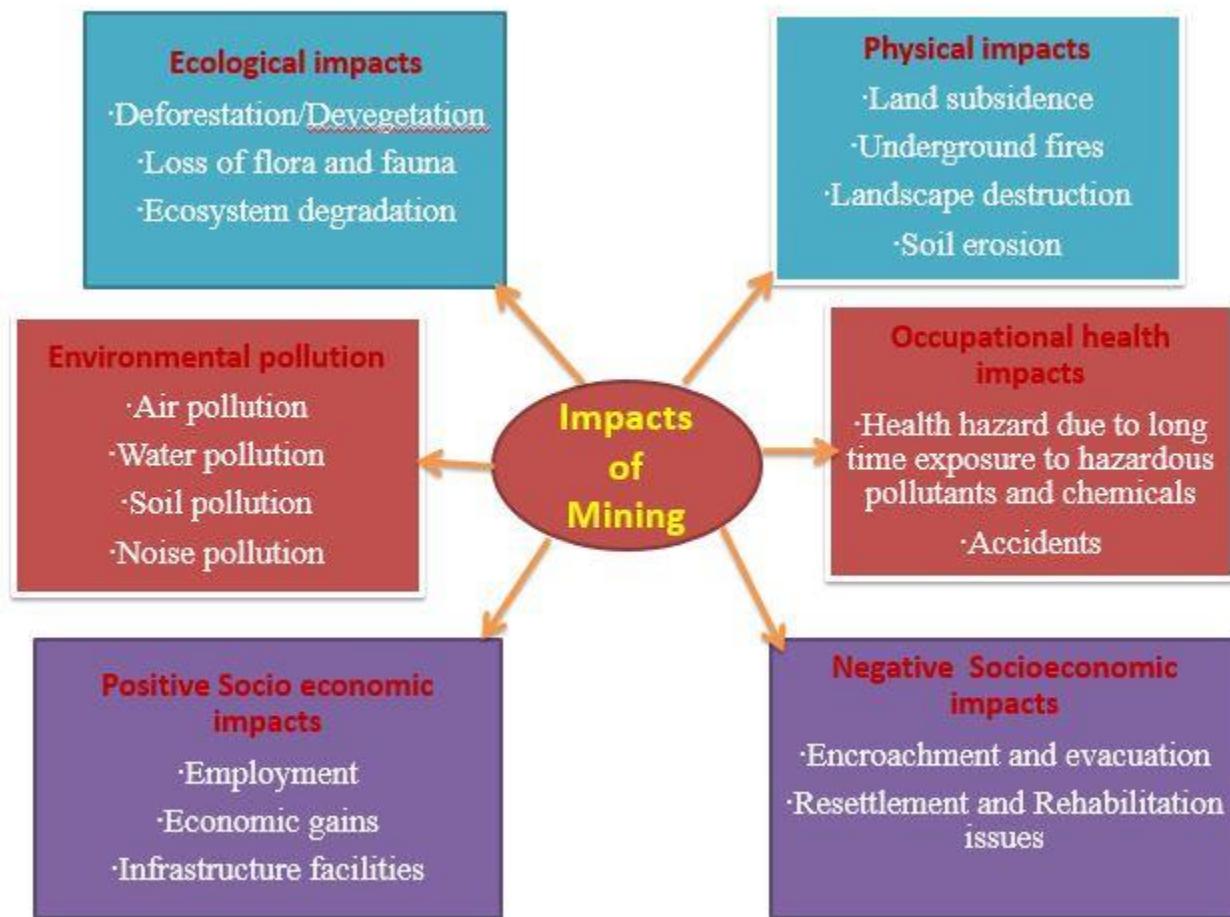


Strip Mining

### **ENVIRONMENTAL IMPACTS OF MINERAL EXTRACTION:**

**Impacts of mining:** Mining is done to extract minerals (or fossil fuels) from deep deposits in soil by using sub-surface mining or from shallow deposits by surface mining. The former method is more destructive, dangerous and expensive including risks of occupational hazards and accidents.

#### **IMPACTS OF MINING:**



- **Ecological impacts**: Deforestation / De-vegetation, Loss of flora and fauna, Ecosystem degradation
- **Environmental pollution**: Air pollution, Water pollution, Soil pollution, Noise pollution.
- **Positive Socio economic impact**: Employment, Economic gains, Infrastructure facilities
- **Physical impacts**: Land subsidence, Underground fires, Landscape destruction, Soil erosion
- **Occupational health impact**: Health hazard due to long time exposure to hazardous pollutants and chemicals Accidents.
- **Negative Socioeconomic impacts**: Encroachment and evacuation, Resettlement and Rehabilitation issues.

### **REMEDIAL MEASURES:**

- **Microbial leaching technique ( *Thiobacillus ferroxidans*)**
- **Microbial leaching** is the process by which metals are dissolved from ore bearing rocks using microorganisms. For the last 10 centuries, microorganisms have assisted in the recovery of copper dissolved in drainage from water
- **Restoration of mined areas by re-vegetating them with appropriate plant species**
- **Prevention of acidic and toxic drainage from the mining site**
- **Adopting eco-friendly mining technique in order to minimize adverse impacts**

### **SIX MAJOR MINES IN INDIA AND THEIR IMPACTS:**

- ✓ Jaduguda uranium mines, Jharkhand – Exposing local people to radioactive substances.
- ✓ Jharia coal mines, Jharkhand – underground fires associated with land subsidence leading to forced displacement of people
- ✓ Sukinda chromite mines, Odisha -- Seeping hexavalent chromium into river posing serious health hazard.
- ✓ Kudremukh iron ore mine, Karnataka – Causing river pollution and threat to biodiversity
- ✓ East coast bauxite mine, Odisha – Land encroachment and issue of rehabilitation unsettled
- ✓ North eastern coal fields, Assam – sulphur contamination of ground water

### **REMEDIAL MEASURES:**

- Microbial leaching technique ( *Thiobacillus ferroxidans*)
- Restoration of mined areas by re-vegetating them with appropriate plant species
- Prevention of acidic and toxic drainage from the mining site
- Adopting eco-friendly mining technique in order to minimize adverse impacts

### **FACTS ABOUT MINING IN INDIA:**

- India produces as many as 86 metals and minerals.
- 80% of mining in India is for coal.
- India produces 75% of the world's mica
- India has over 3500 legal mines
- Over 1 million people are employed in the mining industry
- About 10 million people have been displaced from mining areas

- Political influence very common these days in illegal mining and displacement & rehabilitation of affected people.

## **FOOD RESOURCES:**

We have thousands of edible plants and animals over the world out of which only about three dozen types constitute the major food of humans. The main food resources include wheat, rice, maize, potato, barley, oats, cassava, sweet potato, sugarcane, pulses, sorghum, millet, about twenty or so common fruits and vegetables, milk, meat, fish and seafood. Amongst these rice, wheat and maize are the major grains, about 1500 million metric tons of which are grown each year, which is about half of all the agricultural crops. About 4 billion people in the developing countries have wheat and rice as their staple food.

## **WORLD FOOD PROBLEMS**

- During the last 50 years world grain production has increased almost three times, thereby increasing per capita production by about 50%. But, at the same time population growth increased at such a rate in LDCs (Less developed countries) that it outstripped food production.
- Every year 40 million people (fifty percent of which are young children between 1 to 5 years) die of undernourishment and malnutrition.
- This means that every year our food problem is killing as many people as were killed by the atomic bomb dropped on Hiroshima during World War II. These startling statistical figures more than emphasize the need to increase our food production, equitably distribute it and also to control population growth.
- ***Indian Scenario:*** Although India is the third largest producer of staple crops, an estimated 300 million Indians are still undernourished. India has only half as much land as USA, but it has nearly three times population to feed. Our food problems are directly related to population.
- The World Food Summit, 1996 has set the target to reduce the number of undernourished to just half by 2015, which still means 410 million undernourished people on the earth.

## **Global food availability**

- ✓ The **dietary energy supply (DES)** is the food available for human consumption, expressed in kilocalories/person/day.
- ✓ In 1961 the average global DES was as low as **2193 kcal/person/day** and by 2011, it had reached **2868 kcal/person/day**.
- ✓ **Food and Agriculture organization (FAO):** Average DES for a person is **2500 kcal/person/day** (we could say that enough food in the world).
- ✓ The problem is that many people are too poor to buy the available food.

- ✓ In 2010-2012, **about 870 million** people or one in eight persons in the world did not consume enough food to cover their minimum dietary energy requirement

### **Food production and hunger in India**

- ✓ India producing annually
  - 250million tones of food grains
  - 5million tones of meat products
  - 9.6 million tones of fish
- ✓ FAO report 2014: **191 million** people are undernourished in India.
- ✓ The **Global Hunger Index** ranks India at **63** out of 78 countries.
- ✓ In 1960s India adopted **green revolution** from Mexicans to overcome the hunger and undernourished problems.
- ✓ In green revolution High yielding varieties (HVs) are introduced to increase the food production and at the same time we lost our land quality due to over application of chemical fertilizers.
- ✓ Presently we are with Genetically modified crops (GM) which are pest resistant and requires less chemical fertilizers, but it is proved by scientists that GM crops may affects human health and environment in longer time

### **Malnutrition**

- ✓ Deficiency or lack of nutrition often leads to malnutrition resulting in several diseases.

### **Overgrazing:**

Livestock wealth plays a crucial role in the rural life of our country. India leads in livestock population in the world. The huge population of livestock needs to be fed and the grazing lands or pasture areas are not adequate. Very often we find that the livestock grazing on a particular piece of grassland or pasture surpass the carrying capacity. Carrying capacity of any system is the maximum population that can be supported by it on a sustainable basis. However, most often, the grazing pressure is so high that its carrying capacity is crossed and the sustainability of the grazing lands fails.

### **Impacts of Overgrazing:**

**Soil Erosion:** Due to overgrazing by cattle, the cover of vegetation almost gets removed from the land. The soil becomes exposed and gets eroded by the action of strong wind, rainfall etc. The grass roots are very good binders of soil. When the grasses are removed, the soil becomes loose and susceptible to the action of wind and water.

**Land degradation** – Land Degradation: Overgrazing removes the vegetal cover over the soil and the exposed soil gets compacted. So the roots cannot go much deep, humus content of the soil decreases and overgrazing leads to organically poor, dry, compacted soil. Due to trampling by cattle the soil loses infiltration capacity, which reduces percolation of water into the soil and as a result of this more water

gets lost from the ecosystem along with surface run off. Thus over grazing leads to multiple actions resulting in loss of soil structure, hydraulic conductivity and soil fertility.

**Loss of plant species and regeneration capacity** – Over grazing adversely affects the composition of plant population and their regenerating capacity

## **Traditional agriculture**

What is traditional agriculture?

- Traditional agriculture is the practice of **slash and burn cultivation or shifting cultivation** and usually involves small plot, simple tools, naturally available water, organic fertilizer and a mix of crops.
- It is still in practice especially in **tribal areas** accounting around **half of the global population**.

***The main impacts of traditional agriculture are:***

- **Deforestation:** The slash and burn of trees in forests to clear the land for cultivation and frequent shifting result in loss of forest cover.
- **Soil erosion:** Clearing of forest cover exposes the soil to wind, rain and storms, thereby resulting in loss of top fertile layer of soil.
- **Depletion of nutrients:** During slash and burn the organic matter in the soil gets destroyed and most of the nutrients are taken up by the crops within a short period, thus making the soil nutrient poor which makes the cultivators shift to another area.
- **Loss of microbial population**– In slash and burn cultivation, burning of slash destroy the beneficiary microbes in top soil.

## **Modern agriculture**

What is modern agriculture?

- Modern agriculture makes use of hybrid seeds, high-tech farm machineries, pesticides, fertilizers, farm loans and subsidies to increase the crop yield.

***The main impacts of modern agriculture are:***

- **Problems due to use of high yielding varieties**
  - It encourages monoculture
  - Produced crops are very vulnerable to diseases and pest
- **Fertilizer related problems**
  - **Micronutrient imbalance**- Most of the chemical fertilizers used in modern agriculture have nitrogen, phosphorus and potassium (N, P, K) which are essential macronutrients.

- **Nitrate pollution-** Nitrogenous fertilizers applied in the fields often leach deep into the soil and ultimately contaminate the ground water
- **Eutrophication-** Excessive use of N and P fertilizers in the agricultural fields leads to another problem, which is not related to the soil, but relates to water bodies like lakes.

**□ Pesticide related problems**

- Development of pest resistance and producing super pests
- Death of non-target beneficiary organisms
- Bio magnification of toxic chemicals in food chain

**□ Water Logging:**

- Over irrigation of croplands by farmers for good growth of their crop usually leads to waterlogging. Inadequate drainage causes excess water to accumulate underground and gradually forms a continuous column with the water table.

**□ Salinity problem**

- At present one third of the total cultivable land area of the world is affected by salts. In India about seven million hectares of land are estimated to be salt affected which may be saline or sodic. Saline soils are characterized by the accumulation of soluble salts like sodium chloride, sodium sulphate, calcium chloride, magnesium chloride etc. in the soil profile.

**FERTILIZERS:**

An inorganic chemical or natural substance added to soil or land to increase its fertility is called fertilizers. Eg. Nitrogen phosphorus & potassium.

**USES OF FERTILIZERS:**

Fertilizers is used for healthy and best growth of plants.

Fertilizers contain some chemical these can be considered as major nutrients (NPK)

- Nitrogen:- improve growth of plants.
- Phosphorus:- speeds up crop maturity and improves quality
- Potassium:- helps to fight crop against disease and improves quality

**Types Of Fertilizers: Organic Fertilizers**

1. Compost- Decayed organic material used as a fertilizer for growing plants.
2. Animal manure- such as chicken manure and cow dung, has been used for centuries as a fertilizer for farming.
3. Guano- the excrement of seabirds and bats, used as fertilizer.

### **Inorganic Fertilizers**

1. Nitrogen- nitrogen fertilizers are made from ammonia ( $\text{NH}_3$ ), which is sometimes injected into the ground directly.
2. Phosphate- all phosphate fertilizers are obtained by extraction from minerals containing the anion  $\text{PO}_4^{3-}$ .
3. Potassium- potash is a mixture of potassium minerals used to make potassium fertilizers.

### ***Importance of organic fertilizers***

1. Nutrients are released slower and consistently.
2. Soil nutrients that are already on the grounds are mobilized.
3. Soil structure is vastly improves and keeps soil moisture is optimal.
4. Topsoil erosion is better prevented.
5. Local organic fertilizers are less costly than their artificial counterparts.

### ***Importance of inorganic fertilizers***

1. Fast Acting is the major advantage of inorganic fertilizers
2. Inorganic fertilizers offer the precise content of nutrients, guaranteed by law.
3. Ease of Use Inorganic fertilizers also offer the advantage of coming in several easy-to- use formulations.
4. Inorganic fertilizers are costly than organic fertilizers.

## **NEGATIVE EFFECTS OF FERTILIZERS**

- Micronutrient imbalance: Most of the chemical fertilizers used in modern agriculture have nitrogen, phosphorus and potassium (N, P, K) which are essential macronutrients. Farmers usually use these fertilizers indiscriminately to boost up crop growth. Excessive use of fertilizers cause micronutrient imbalance.
- Nitrate Pollution: Nitrogenous fertilizers applied in the fields often leach deep into the soil and ultimately contaminate the ground water ( $>25\text{mg/lit}$  -Nitrate- Blue Baby diseases).
- Eutrophication: A large proportion of nitrogen and phosphorus used in crop fields is washed off and along with runoff water reach the water bodies causing over nourishment of the lakes, a process known as Eutrophication
- The biggest issue facing the use of chemical fertilizers is groundwater contamination
- It is cause of some dangerous diseases like stomach cancer.
- Over applying inorganic fertilizers can also damage your plants. Common symptoms of over fertilization include decreased growth, defoliation or plant death in extreme case.

What we can do about it?

Knowing and understanding the effects of chemical fertilizers. Knowing how to protect our health is what counts.

1. Support organic and sustainable agriculture.
2. Take part in safeguarding organic practices and standards.

**PESTICIDES:** A substance used for destroying insects or other organisms harmful to cultivated plants or to animals.

### **TYPES OF PESTICIDES:**

1. Insecticides- Insecticides are used to control insects.
2. Matricides and Acaricides- Matricides or Acaricides are used to control mites and ticks.
3. Fungicides- fungicides are used to control fungi which cause plant diseases.
4. Herbicides- herbicides are used to control unwanted plants.
5. Rodenticides- rodenticides are used to protect from rats, mice and other rodents.

### **Uses of pesticides**

- Pesticides normally used for protecting plants from weeds.
- DDT, sprayed on the walls of houses, is an organic chlorine that has been used to fight malaria since the 1950s.

### **Health effects of pesticides**

- Health effects of pesticides may be acute or delayed in those who are exposed.
- According to The Stockholm Convention on Persistent Organic Pollutants, 9 of the 12 most dangerous and persistent chemicals are pesticides.
- Pesticides can cause some serious diseases like cancer, reproduction effects etc.

### **Environment effect of pesticides**

- Pesticides can contribute to air pollution.
- Creating resistance in pests and producing new pests
- Death of non-target organisms.
- Biological magnification: Many of the pesticides are non-biodegradable and keep on accumulating in the food chain, a process called biological magnification.
- Pesticides were found to pollute every stream and over 90% of wells.
- Many of the chemicals used in pesticides are persistent soil contaminants.
- Nitrogen fixation, which is required for the growth of higher plants, is hindered by pesticides in soil.
- Many kinds of animals are harmed by pesticides, leading many countries to regulate pesticide usage through Biodiversity Action Plans.

### ***Prevention from harmful pesticides***

There are six main way to prevent us from pesticides these are

1. Buy organic and locally grown fruit and vegetables.
2. Wash fruits and vegetables before eating
3. Know which fruits and vegetables have higher levels of pesticide residue.
4. Grow your own produce.
5. Use non-toxic methods for controlling insects in the home and garden.
6. Have a ‘no shoes’ policy in your home.

### **LAND RESOURCES:**

#### **Land as a resource**

- Land is a finite and valuable resource upon which we depend for our food, fibre and fuel wood requirement.
- Soil especially top soil is classified as renewable resource because it can be regenerated naturally.
- About 200 -1000 years are need for the formation of 1 inch or 2.5cm soil depending on climate and type of soil.
- When rate of erosion is faster than rate of renewal than the soil becomes a nonrenewable resource.

### **Land Degradation Causes:**

1. Soil erosion
2. Over exploitation of arable land (land capable of being ploughed and used to grow crops)
3. Water logging
4. Salinity
5. industrial wastes (fly-ash, heavy metals etc.)

### **Soil erosion**

**Definition:** Wearing away of top layer of soil and its components from running water and wind action.

- Also termed as Loss of soil.
- Measured as Mass/unit area

**Types:** Basically, there are two types of erosion based upon the cause of erosion:

- Normal erosion or geologic erosion: caused by natural processes
- Accelerated erosion: caused by anthropogenic (man-made) activities

**Agents:** There are two types of agents which cause soil erosion:

- Climatic agents (Water and wind)
- Biotic agents (Deforestation, Overgrazing)

### **A)Climatic agents**

#### *a)Water induced soil erosion: it is of following types*

1. **Sheet erosion:** when there is uniform removal of a thin layer of soil from a large surface area, it is called sheet erosion. This is usually due to run-off water.
2. **Rill erosion:** When there is rainfall and rapidly running water produces finger-shaped grooves or rills over the area, it is called rill erosion.
3. **Gully erosion:** It is a more prominent type of soil erosion. When the rainfall is very heavy, deeper cavities or gullies are formed, which may be U or V shaped.
4. **Slip erosion:** This occurs due to heavy rainfall on slopes of hills and mountains.
5. **Stream bank erosion:** During the rainy season, when fast running streams take a turn in some other direction, they cut the soil and make caves in the banks.



*Sheet erosion*



*Rill erosion*



*Gully erosion*



*Slip erosion*



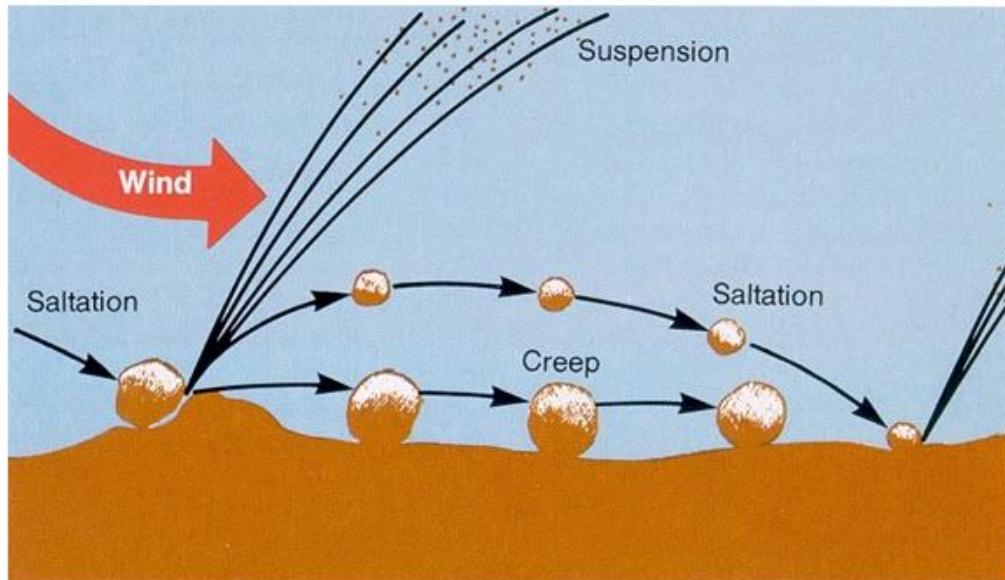
**Stream bank erosion**

**b) Wind erosion** is responsible for the following three types of soil movements:

**Saltation:** This occurs under the influence of direct pressure of stormy wind and the soil particles of 1-1.5 mm diameter move up in vertical direction.

**Suspension:** Here fine soil particles (less than 1 mm dia) which are suspended in the air are kicked up and taken away to distant places.

**Surface creep:** Here larger particles (5-10 mm diameter) creep over the soil surface along with wind.



## B) Biotic agents:

**Gazing livestock:** Excessive grazing, mining and deforestation are the major biotic agents responsible for soil erosion. Due to these processes the top soil is disturbed or rendered devoid of vegetation cover. So the land is directly exposed to the action of various physical forces facilitating erosion. Overgrazing

accounts for 35% of the world's soil erosion while deforestation is responsible for 30% of the earth's seriously eroded lands. Unsustainable methods of farming cause 28% of soil erosion.

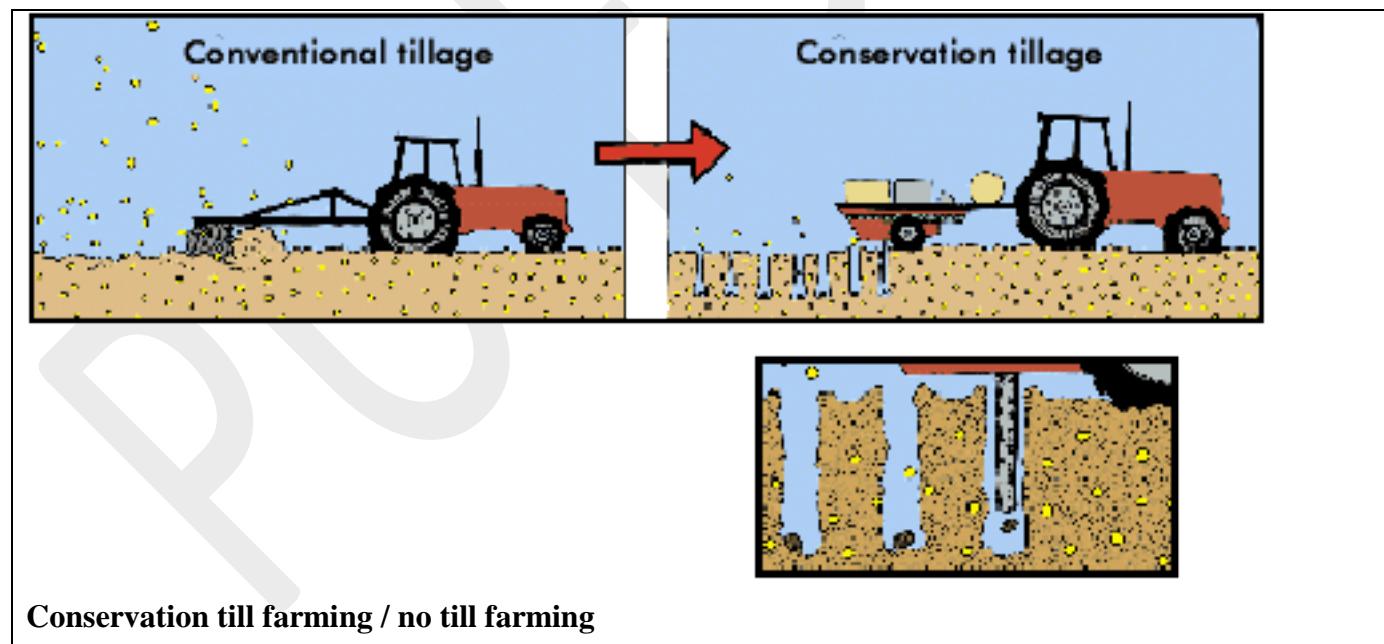
**Anthropogenic means:** Deforestation without reforestation, overgrazing by cattle, surface mining without land reclamation, irrigation techniques that lead to salt build-up, water-logged soil, farming on land with unsuitable terrain, soil compaction by agricultural machinery, action of cattle trampling etc make the top soil vulnerable to erosion.

### **Control of soil erosion**

1. Conservational till farming/ No-till-farming
2. Contour farming
3. Terracing
4. Strip farming
5. Alley cropping or Agro forestry
6. Wind breaks or shelterbelts
7. Grassed waterways

#### **Conservation till farming / no till farming:**

- In traditional method: land is ploughed and the soil is broken up and smoothed to make a planting surface. This disturbs soil and cause soil erosion.
- Conservational till farming causes minimum disturbance to the top soil. Here special tillers break up and loosen the subsurface soil without turning over the topsoil.

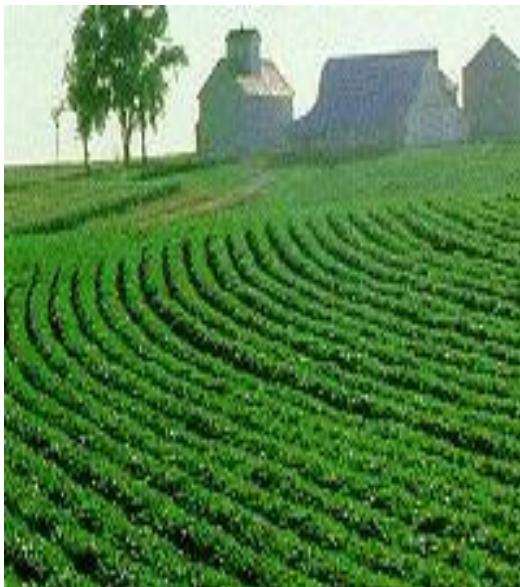


#### **Contour Farming:**

- On gentle slopes, crops are grown in rows across is known as contour farming.
- Each row planted horizontally along the slope of the land acts as a small dam to hold soil and slow down loss of soil through run-off water.

**Terrace farming:**

- Still steeper slopes are converted into a series of broad terraces which run across the contour.
- Terracing retains water for crops at all levels and cuts down soil erosion by controlling run off.
- In high rainfall areas, ditches are also provided behind the terrace to permit adequate drainage



Contour Forming



Terrace Forming

**Strip Cropping:**

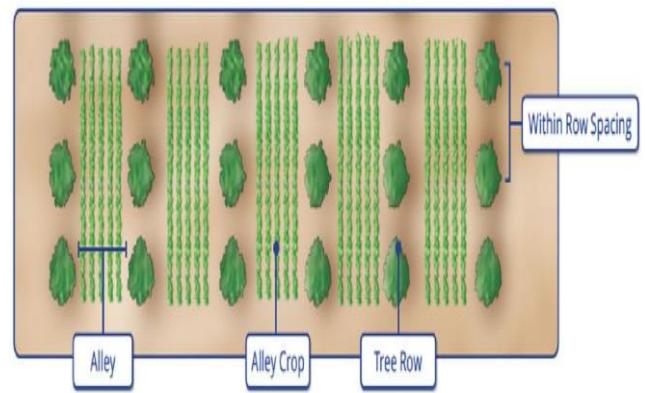
- Strips of crops are alternated with strips of soil saving covercrops like grasses or grass-legume mixture.
- Whatever run-off comes from the cropped soil is retained by the strip of cover crop and this reduces soil erosion
- Nitrogen fixing legumes also help in restoring soil fertility

**Alley cropping/ Agro foresting:**

- It is a form of inter-cropping in which crops are planted between rows of trees or shrubs.
- Even when the crop is harvested, the soil is not fallow because trees and shrubs still remain on the soil holding the soil particles and prevent soil erosion



**Strip Cropping**



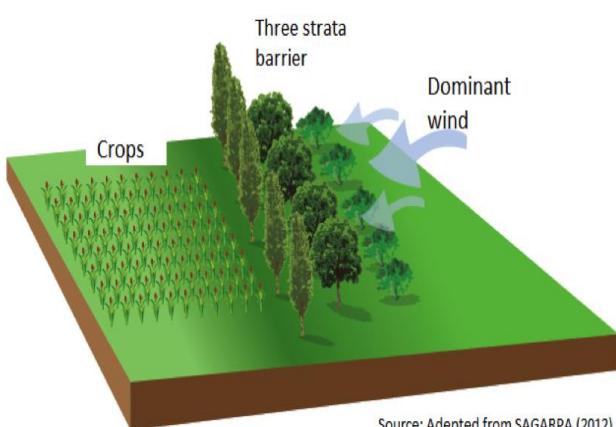
**Alley cropping/ Agro forestry**

#### **Wind breaks or shelter belts:**

- They help in reducing erosion caused by strong winds.
- The trees are planted in long rows along the cultivated land boundary so that wind is blocked. • The wind speed is substantially reduced which helps in preventing wind erosion of soil

#### **Grassed Waterways:**

- Grassed waterways are broad, shallow channels designed to move surface water across farmland without causing soil erosion.
- Constructed in natural depressions where water collects and flows to outlet.
- Vegetative cover in waterway slows water flow and protects channel surface from rill and gully erosion.



Source: Adapted from SAGARPA (2012).

**Wind breaks or shelter belts**

#### **Grassed Waterway with Vegetative Filter**



**A grassed conveyance can protect against erosion and helps to filter sediment and pollutants carried in runoff.**

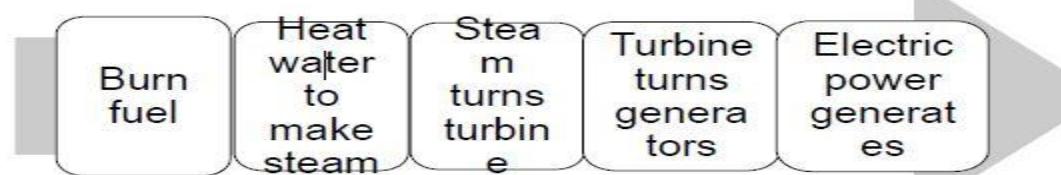
## **ENERGY RESOURCES:**

### **Fossil fuels**

#### **Non renewable energy:**

- Coal, Oil and Gas are called "fossil fuels" because they have been formed from the fossilized remains of prehistoric plants and animals.
- Fossil fuels provide around 66% of world's electrical power, and 95% of world's total energy demands

#### **How fossil fuels work:**



- Coal provides around 28% of our energy and oil provides 40%.
- Crude oil (called "petroleum") is easier to get out of the ground than coal, as it can flow along pipes. This also makes it cheaper to transport.
- Natural gas provides around 20% of the world's consumption of energy

#### **Advantages of using Fossil fuels:**

- Very large amounts of electricity can be generated in one place using coal, fairly cheaply.
- Transportation of oil and gas to the power stations is easy.
- Gas-fired power stations are very efficient.
- A fossil-fuelled power station can be built almost anywhere

#### **Disadvantages of using fossil fuels**

- Pollution: main drawback of fossil fuels is pollution.
- GHG emission: Any fossil fuel produces GHGs, which contributes to the "greenhouse effect", warming the Earth.
- Acid rain: Burning coal produces sulphur dioxide, a gas that contributes to acid rain.
- Oil Spills: oil spills are a serious problem. With the United States importing 55% of its oil.
- Mining: Mining coal can be difficult and dangerous. Strip mining destroys large areas of the landscape.
- Sea environment: Some power stations are built on the coast, so they can use sea water to cool the steam instead. However, this warms the sea and can affect the environment, although the fish seem to like it.

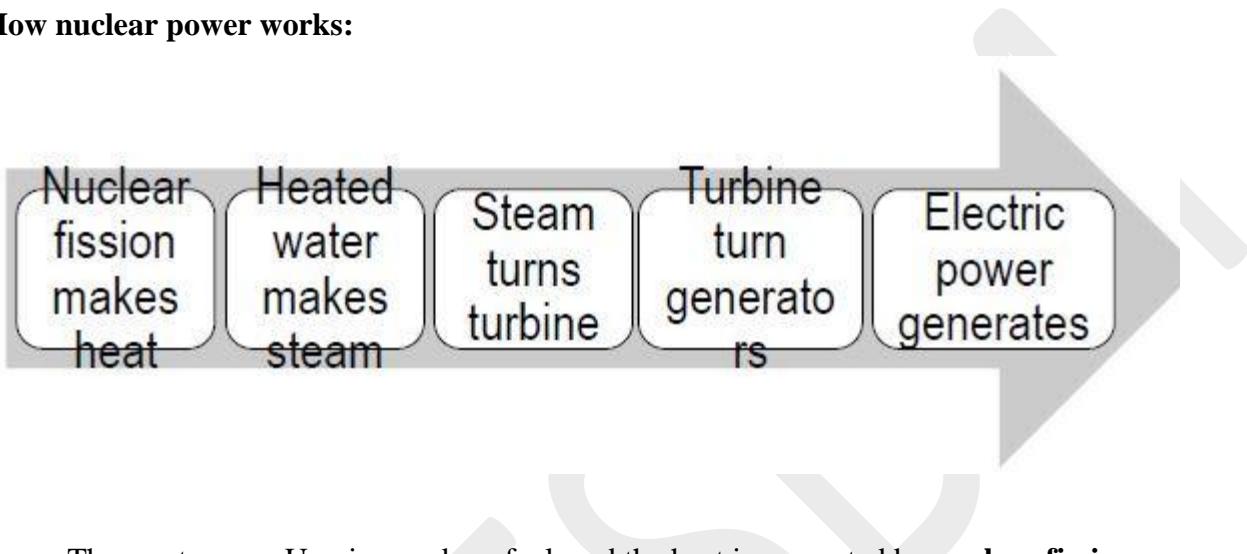
**NOTE:** Fossil fuels are NOT a renewable energy resource

**Once we've burned them all, there isn't any more, and our consumption of fossil fuels has nearly doubled every 20 years since 1900.**

## **Nuclear Power:**

- Nuclear power is generated using Uranium, which is a metal mined in various parts of the world.
- Nuclear power produces around 11% of the world's energy needs.
- It produces huge amounts of energy from small amounts of fuel, without the pollution that you'd get from burning fossil fuels.

### **How nuclear power works:**



- The reactor uses Uranium rods as fuel, and the heat is generated by **nuclear fission**.
- Neutrons smash into the nucleus of the uranium atoms, which split roughly in half and release energy in the form of heat.

### **Advantages of using Nuclear Power:**

- Nuclear power costs about the same as coal, so it's **not expensive** to make.
- **Does not produce smoke or carbon dioxide**, so it does not contribute to the greenhouse effect.
- **Produces huge amounts of energy** from small amounts of fuel.
- Produces **small amounts of waste**.
- Nuclear power is **reliable**.

### ***Disadvantages of using Nuclear Power:***

**Waste disposal:** Although not much waste is produced, it is very, very dangerous. It must be sealed up and buried for many years to allow the radioactivity to die away.

**NOTE: Nuclear energy from Uranium is NOT renewable.**

Once we've dug up all the Earth's uranium and used it, there isn't any more.

## **Solar Power ( Renewable Energy):**

- **Solar Cells** is called photovoltaic" or "photoelectric" cells which convert light directly into electricity.
- In a sunny climate, you can get enough power to run a 100W light bulb from just one square meter of solar panel.

- Solar Water heating system:
  - heat from the Sun is used to heat water in glass panels on your roof.
  - Solar heating is worthwhile in places like California and Australia, where you get lots of sunshine.

### **Solar Furnaces:**

- Use a huge array of mirrors to concentrate the Sun's energy into a small space and produce very high temperatures.

### **Advantages of using Solar Power:**

- Solar energy is free - it needs no fuel and produces no waste or pollution.
- In sunny countries, solar power can be used where there is no easy way to get electricity to a remote place.
- Handy for low-power uses such as solar powered garden lights and battery chargers

### **Disadvantages of using Solar Powers:**

- Doesn't work at night.
- Very expensive to build solar power stations.
- Solar cells cost a great deal compared to the amount of electricity they'll produce in their lifetime.
- Can be unreliable unless you're in a very sunny climate.

**NOTE: Solar power is renewable.**

**The Sun will keep on shining, so it can be reused.**

### **Wind Power:**

- We've used the wind as an energy source for a long time.
- The Babylonians and Chinese were using wind power to pump water for irrigating crops 4,000 years ago, and sailing boats were around long before that.
- Wind power was used in the Middle Ages, in Europe, to grind corn, which is where the term "windmill" comes from.

How wind power works?

- The Sun heats our atmosphere unevenly, so some patches become warmer than others.
- These warm patches of air rise, other air blows in to replace them - and we feel a wind blowing.
- We can use the energy in the wind by building a tall tower, with a large propellor on the

### ***Advantages of wind power:***

- Wind is free, wind farms need no fuel.
- Produces no waste or greenhouse gases.
- The land beneath can usually still be used for farming.
- Wind farms can be tourist attractions.
- A good method of supplying energy to remote areas.

### ***Disadvantages of wind power;***

- The wind is not always predictable some days have no wind.
- Suitable areas for wind farms are often near the coast, where land is expensive.
- Can kill birds - migrating flocks tend to like strong winds. Splat!
- Can affect television reception if you live nearby.
- Noisy. A wind generator makes a constant, low, "swooshing" noise day and night.

**NOTE: Wind power is renewable.**

**Winds will keep on blowing, it makes sense to use them.**

### **Hydroelectricity:**

- A dam is built to trap water, usually in a valley.
- Water is allowed to flow through tunnels in the dam, to turn turbines and thus drive generators.
- Hydro-electricity provides 20% of the world's power

#### ***Advantages of Hydroelectricity:***

- Once the dam is built, the energy is virtually free.
- No waste or pollution produced.
- Much more reliable than wind, solar or wave power.
- Water can be stored above the dam ready to cope with peaks in demand.
- Hydro-electric power stations can increase to full power very quickly, unlike other power stations.
- Electricity can be generated constantly.

#### ***Disadvantages of using Hydroelectricity;***

- The dams are very expensive to build.
- Building a large dam will flood a very large area upstream, causing problems for animals that used to live there.
- Finding a suitable site can be difficult - the impact on residents and the environment may be unacceptable.
- Water quality and quantity downstream can be affected, which can have an impact on plant life.

**NOTE: Hydro-electric power is renewable.**

- The Sun provides the water by evaporation from the sea, and will keep on doing so.

### **Biomass**

#### **How Biomass works;**

- Plant and animal waste is used to produce fuels such as methanol natural gas, and oil. We can use rubbish, animal manure, woodchips, seaweed, corn stalks and other wastes. Sugar cane is harvested and taken to a mill, where it is crushed to extract the juice.
- The juice is used to make sugar, whilst the left-over pulp, called "bagasse" can be burned in a power station. Other solid wastes, can be burned to provide heat, or used to make steam for a power station.

- Burn fuel>heat water to make steam>steam turns turbine>turbine turns generator>electrical power sent around the country

***Advantages of Biomass;***

- It makes sense to use waste materials where we can.
- The fuel tends to be cheap.
- Less demand on the Earth's resources.

***Disadvantages of using Biomass;***

- Collecting the waste in sufficient quantities can be difficult.
- We burn the fuel, so it makes greenhouse gases.
- Some waste materials are not available all year round.

**NOTE: Biomass is renewable**

**We will always make waste products.**

**We can always plant & grow more sugar cane and more trees, so those are renewable too.**

**GEO THERMAL POWER:**

- Hot rocks underground heat water to produce steam. We drill holes down to the hot region, steam comes up, is purified and used to drive turbines, which drive electric generators.
- There may be natural "groundwater" in the hot rocks anyway, or we may need to drill more holes and pump water down to them.

***Advantages of using geo thermal power;***

- Geothermal energy does not produce any pollution, and does not contribute to the greenhouse effect.
- The power stations do not take up much room, so there is not much impact on the environment.
- No fuel is needed.
- Once you've built a geothermal power station, the energy is almost free.
- It may need a little energy to run a pump, but this can be taken from the energy being generated

**Disadvantages of using Geo thermal ;power:**

- The big problem is that there are not many places where you can build a geothermal power station.
- You need hot rocks of a suitable type, at a depth where we can drill down to them.
- The type of rock above is also important, it must be of a type that we can easily drill through.
- Sometimes a geothermal site may "run out of steam", perhaps for decades.
- Hazardous gases and minerals may come up from underground, and can be difficult to safely dispose of.

**NOTE: Geothermal energy is renewable.**

The energy keeps on coming, as long as we don't pump too much cold water down and cool the rocks too much.

**TIDAL POWER:**

- Tidal power works rather like a hydro-electric scheme, except that the dam is much bigger.
- A huge dam (called a "barrage") is built across a river estuary. When the tide goes in and out, the water flows through tunnels in the dam.
- The ebb and flow of the tides can be used to turn a turbine, or it can be used to push air through a pipe, which then turns a turbine. Large lock gates, like the ones used on canals, allow ships to pass.
- Only around 20 sites in the world have been identified as possible tidal power stations.

Advantages of using Tidal power:

- Once you've built it, tidal power is free.
- It produces no greenhouse gases or other waste.
- It needs no fuel.
- It produces electricity reliably.
- Not expensive to maintain.
- Tides are totally predictable.

Disadvantages of using Tidal powers:

- A barrage across an estuary is very expensive to build, and affects a very wide area - the environment is changed for many miles upstream and downstream. Many birds rely on the tide uncovering the mud flats so that they can feed. There are few suitable sites for tidal barrages.
- Only provides power for around 10 hours each day, when the tide is actually moving in or out.

**NOTE: Tidal energy is renewable.**

**The tides will continue to ebb and flow, and the energy is there for the taking.**

# L9 Smart City Documentation GOI

## Learning Objective:

To understand the smart city documentation (Government of India) in the development of the smart cities.

## Contributors

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# L9 Smart City Documentation GOI

## Learning Objective:

To understand the smart city documentation (Government of India) in the development of the smart cities.

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**15.2021**

# Smart Cities Mission Strategy

- Pan-city initiative in which at least one Smart Solution is applied city-wide.
- Develop Areas step-by-step – three models of area-based developments –
  - Retrofitting,
  - Redevelopment,
  - Greenfield

# Area based Development Models

- **Retrofitting**

Development of an existing built area greater than 500 acres so as to achieve the objective of smart cities mission to make it more efficient and livable e.g. Local Area Development (Ahmedabad)

- **Redevelopment**

Replace existing built environment in an area of more than 50 acres and enable co-creation of a new layout, especially enhanced infrastructure, mixed land use and increased density e.g. Bhendi Bazar, Mumbai

- **Greenfield**

Develop a previously vacant area of more than 250 acres using innovative planning, plan financing and plan implementation tools with provision for affordable housing, especially for the poor e.g. New Town, Kolkotta, Naya Raipur, GIFT City.

# Components of area-based development

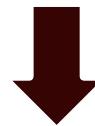
- Holistic development of existing and new areas.
  - One area catalyzes the development of other areas, and
  - Sets an example for other cities.
- Quality of life in Areas meets citizens expectations and has
  - Planned mixed land use,
  - Housing, especially for the poor,
- Walkable localities – accessibility to parks, transport,
- Preservation and development of open space,
- Public transport, last mile connectivity,
- Governance is citizen friendly and cost effective.

# Smart City selection Process

- The city selection process is based on the idea of Cooperative and Competitive Federalism.
- Cities are diverse - Each city has to construct its idea and vision of a smart city that is aligned to its local context.
- The city selection process follows a Challenge method - two stages, in conjunct, to select cities.
  - Stage-I : Intra-State city selection on objective criteria to identify cities to compete in stage-II.
  - Stage-II: All India competition to select smart cities for multiple rounds of selection.

# Stage-I Competition (within State)

Number of potential Smart Cities will be intimated to each State, based on an ***equitable & objective based*** formula.



An intra-state competition to select proposed Smart Cities, based on the Stage – I criteria



The selected cities will be called the **short listed** Smart Cities.

## Proposal of Stage 2

- No particular model prescribed – each city has to develop its own idea of a smart city, vision, and submit a Smart City Proposal (SCP) during the All India competition.
- Convergence important.
- Proposal format is given in the Toolkit,
- The Proposal by the short listed city has to,
  - Contain a retrofitting or redevelopment or greenfield or a mix thereof plus a Pan-city feature with Smart Solution(s),
  - Area based developments should include some essential elements.

# Area based Development – Essential Features

- Applicable to all three type of area based developments
  - Adequate water supply including waste water recycling and storm water reuse,
  - Assured electricity supply - least 10% of the energy requirement coming from solar power,
  - Sanitation, including solid waste management, Efficient urban mobility and public transport, Affordable Housing, especially for poor, Robust IT connectivity and digitalization,

Good Governance, especially citizen participation, Sustainable environment,

e-Governance and ensuring safety of citizens, especially women and Health and education.

# Area based Development – Essential Features (Cont..)

## Additionally, for greenfield areas

80% buildings would be energy efficient green building,  
15% of the building will be in the affordable housing category.

# City Selection Criteria : Stage-II

The 100 short listed potential Smart Cities are selected through an inter-state competition



The 100 selected cities prepare their Proposals for All India competition with capacity assistance

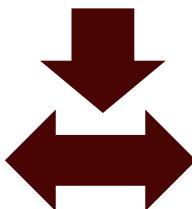


Based on pre-defined Stage 2 criteria, the evaluation is done by national and international organisations



Winners declared for Round – 1

Winners set-up SPV and start implementation. Preparation of DPRs, tenders etc.



Non-Winners prepare to improve their proposal for Round - 2

# Capacity Assistance for SCP

- Preparing Smart City Proposals is challenging and assistance is required. For preparation of the SCP financial assistance will be provided – Rs. 2 crore will be released to shortlisted 100 cities. MoUD will assist in two ways –
- Technically qualified firms and States/UTs are free to draw upon this Panel using the RfP given in the Toolkit
  - Scope is also given in Annexure 1 of Guidelines, OR
- Tying up arrangements to get Technical Assistance from foreign Governments who have volunteered to provide such support.

# Implementation & Financing

- Each city will have a Special Purpose Vehicle (SPV). The SPV will have complete flexibility to plan, implement, manage & operate and will be headed by a full time CEO. Articles of Association will be given in Toolkit.
- Centre will invest a total of Rs. 48,000 crore in 100 cities across the country for 5 years – each Smart city will get Rs. 100 crore each for five years.
- State / ULBs will mobilize additional resources required of Rs. 48,000 crore as per 50:50 funding pattern.
- These funds will act as a catalyst to attract funding from internal and external sources.

# Funds release and distribution

- Funds can be used as follows –
  - Project funds – 93%,
  - State/ULB (Administrative & Office Expenses) – 5%,
  - MoUD (Administrative & Office Expenses) – 2%,
- Advance of Rs. 2 crore to shortlisted cities to prepare SCP.
- First year Rs. 200 crore, thereafter Rs. 100 crore every year.
- Funds release – timely submission of Score Card, satisfactory physical and financial progress as shown from UC and Score Card, achievement of milestones in the Proposal – to be certified.

## Citizen collaboration

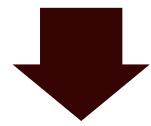
- At city level Smart City Advisory Forum will be established.
- The Smart City Advisory Forum will include the District Collector, MP, MLA, Mayor, CEO of SPV, local youths, technical experts, and representative of Associations.
- The CEO of the SPV will be the convener of the Smart City Forum.

# Mission monitoring

National level – Apex Committee (AC) headed by Secretary



State level -State level High Powered Steering Committee (HPSC) - chaired by the Chief Secretary



City Level - CEO of the SPV is convener of the Smart City Forum.

# Challenges

- This is the first time a MoUD programme is using the ‘Challenge’ or competition method to select cities for funding.
- Strategy of area-based development.
- Citizen involvement is a key to the success of the Smart Cities Mission. The involvement has to start from beginning to the end.

# Stage 1 Selection Criteria

S.No.	Criteria	Score
1	Increase over Census 2011 or Swachh Bharat baseline on number of household sanitary latrines (whichever is less)	10
2	Making operable Online Grievance Redressal System with response being sent back to complainant	5
3	At-least first monthly e-newsletter published	5
4	Electronically place project-wise municipal budget expenditure information for the last two financial years on the website	5
5	Levy of compensatory penalty for delays in service delivery	5
6	Collection of internally generated revenue (e.g. taxes, fees, charges) during the last three FYs (2012-15)	10

# Stage 1 Selection Criteria (Contd.)

S.No.	Criteria	Score
7	Payment of salaries by ULB up-to last month	5
8	Audit of accounts for FY 12-13	5
9	Percentage contribution of tax revenue, fees and user charges, rents and other internal revenue sources	10
10	Percentage of establishment and maintenance cost of water supply	10
11	Percentage contribution of internal revenue sources (self-generated) used for capital works during FY 2014-15	10
12	Percentage of City-level JnNURM Reforms achieved	10
13	Percentage of completion of Projects sanctioned upto March, 2012 under JnNURM	10
<b>Total</b>		<b>100</b>

## QUIZ 9

Provide 6 MCQs here based on previous slides you have discussed

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## **Stage 2 Selection Criteria**

### **Challenge criteria developed after extensive consultation**

- City Level Evaluation Criteria.....30%

#### **➤ Credibility of Implementation**

- ✓ % of JnNURM projects completed;
- ✓ Number of JnNURM reforms completed;
- ✓ Property tax collection as a % of annual demand;
- ✓ Water and Sewerage user charges collected as a % of current annual demand, etc.

#### **➤ City Vision and Strategy**

- ✓ How well does the vision come out of aspirations and wishes of people;
- ✓ Does the vision show: why ? The big idea, picture of the future;
- ✓ Does the vision show the city's true purpose and is connected to its economic base?

## Stage 2 Selection Criteria (Cont..)

- Proposal based Evaluation criteria.....70%
  - Impact of Proposal
    - ✓ Do the vision flow from vision identified through citizen consultation,
    - ✓ To what extent are the goals and objectives aligned, etc.
  - Cost Effectiveness
    - ✓ Does the proposal have smart component i.e. doing something in more resourceful and efficient manner,
    - ✓ Are different sources of funding tapped, etc.
  - Innovation & Scalability
    - ✓ Have any best practices been used,
    - ✓ Is the project scalable to entire city, etc.
  - Process Followed
    - ✓ Details of process for co creating every step through an extensive consultation,
    - ✓ Use of social media for citizen consultation, etc.

# L10 Smart City Documentation GOI-Role of SPV

## Learning Objective:

To understand the Role of SPV in the development of the smart cities.

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# L10. Smart City Documentation GOI-Role of SPV

## Presenter

### Learning Objective:

To understand the Role of SPV in the development of the smart cities.

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# Proposal Preparation

- The Government is not prescribing any particular model to be adopted by the Smart Cities.
- The approach is not ‘one-size-fits-all’; each city has to formulate its own **concept, vision, mission and plan** (proposal) for a Smart City that is appropriate to its local context, resources and levels of ambition.
- Accordingly, they have to choose their model of Smart City and answer the question:
- **What kind of Smart City do they want?**
- For this, cities will prepare their **Smart City Proposal** (SCP) containing
  - the vision,
  - Plan for **mobilisation of resources**
  - Intended outcomes in terms **of infrastructure up-gradation and smart applications**.

# Special Purpose Vehicle (SPV)

- A Special Purpose Vehicle (SPV) is a separate legal entity created by an organization. The SPV is a distinct company with its own assets and liabilities, as well as its own legal status. Usually, they are created for a specific objective, often to isolate financial risk.

Note: Implementation will be studied in next lesson



Source:<https://corporatefinanceinstitute.com/resources/knowledge/strategy/special-purpose-vehicle-spv/>

## Implementation by Special Purpose Vehicle (SPV)

- The implementation of the Mission at the City level will be done by a Special Purpose Vehicle (SPV) created for the purpose.
- The SPV will plan, appraise, approve, release funds, implement, manage, operate, monitor and evaluate the Smart City development projects.
- Each Smart City will have a SPV which will be headed by a full time CEO and have nominees of Central Government, State Government and ULB on its Board.
- The States/ULBs shall ensure that,
  - (a) a dedicated and substantial revenue stream is made available to the SPV so as to make it self-sustainable and could evolve its own credit worthiness for raising additional resources from the market
  - (b) Government contribution for Smart City is used only to create infrastructure that has public benefit outcomes. The execution of projects may be done through joint ventures, subsidiaries, public-private partnership (PPP), turnkey contracts, etc. suitably dovetailed with revenue streams.

- The SPV will be a limited company incorporated under the Companies Act, 2013 at the city-level, in which the State/UT and the ULB will be the promoters having 50:50 equity shareholding.
- The private sector or financial institutions could be considered for taking equity stake in the SPV, provided the shareholding pattern of 50:50 of the State/UT and the ULB is maintained and the State/UT and the ULB together have majority shareholding and control of the SPV.
- Funds provided by the Government of India in the Smart Cities Mission to the SPV will be in the form of tied grant and kept in a separate Grant Fund.
- These funds will be utilized only for the purposes for which the grants have been given and subject to the conditions laid down by the MoUD.

- The State Government and the ULB will determine the paid up capital requirements of the SPV commensurate with the size of the project, commercial financing required and the financing modalities.
- To enable the building up of the equity base of the SPV and to enable ULBs to contribute their share of the equity capital, Gol grants will be permitted to be utilized as ULBs share of equity capital in the SPV.
- Initially, to ensure a minimum capital base for the SPV, the paid up capital of the SPV should be such that the ULB's share is at least equal to Rs.100 crore with an option to increase it to the full amount of the first instalment of Funds provided by Gol (Rs.194 crore).
- With a matching equity contribution by State/ULB, the initial paid up capital of the SPV will thus be Rs. 200 crore (Rs. 100 crore of Gol contribution and Rs. 100 crore of State/UT share).
- Since the initial Gol contribution is Rs.194 crore, along with the matching contribution of the State Government, the initial paid up capital can go up to Rs.384 crore at the option of the SPV.
- The paid up capital may be enhanced in the subsequent years as per project requirements, with the provision mentioned above ensuring that ULB is enabled to match its shareholding in the SPV with that of the State/UT.

- After selection of the cities in Stage II of the Challenge, the process of implementation will start with the setting up of the SPV.
- As already stated, it is proposed to give complete flexibility to the SPV to implement and manage the Smart City project and the State/ULB
- The SPV may appoint Project Management Consultants (PMC) for designing, developing, managing and implementing area-based projects.
- SPVs may take assistance from any of the empanelled consulting firms in the list prepared by MoUD and the handholding agencies.
- For procurement of goods and services, transparent and fair procedures as prescribed under the State/ULB financial rules may be followed.
- Model frameworks as developed by MoUD may also be used for Smart City projects.

# Financing of Smart Cities

- The Smart City Mission will be operated as a Centrally Sponsored Scheme (CSS) and the Central Government proposes to give financial support to the Mission to the extent of Rs. 48,000 crores over five years i.e. on an average Rs. 100 crore per city per year.
- An equal amount, on a matching basis, will have to be contributed by the State/ULB; therefore, nearly Rupees one lakh crore of Government/ULB funds will be available for Smart Cities development.
- The project cost of each Smart City proposal will vary depending upon the level of ambition, model and capacity to execute and repay.
- It is anticipated that substantial funds will be required to implement the Smart City proposal and towards this end, Government grants of both the Centre and State will be leveraged to attract funding from internal and external sources.

- The success of this endeavour will depend upon the robustness of SPV's revenue model and comfort provided to lenders and investors.
- A number of State Governments have successfully set up financial intermediaries (such as Tamil Nadu, Gujarat, Orissa, Punjab, Maharashtra, Karnataka, Madhya Pradesh and Bihar) which can be tapped for support and other States may consider some similar set up in their respective States.
- Some form of guarantee by the State or such a financial intermediary could also be considered as instrument of comfort referred to above.
- It is expected that a number of schemes in the Smart City will be taken up on PPP basis and the SPVs have to accomplish this.

The GOI funds and the matching contribution by the States/ULB will meet only a part of the project cost. Balance funds are expected to be mobilized from:

- States/ ULBs own resources from collection of user fees, beneficiary charges and impact fees, land monetization, debt, loans, etc.
- Additional resources transferred due to acceptance of the recommendations of the Fourteenth Finance Commission (FFC).
- Innovative finance mechanisms such as municipal bonds with credit rating of ULBs, Pooled Finance Mechanism, Tax Increment Financing (TIF).
- Other Central Government schemes like Swachh Bharat Mission, AMRUT, National Heritage City Development and Augmentation Yojana (HRIDAY).
- Leverage borrowings from financial institutions, including bilateral and multilateral institutions, both domestic and external sources.
- States/UTs may also access the National Investment and Infrastructure Fund (NIIF), which was announced by the Finance Minister in his 2015 Budget Speech, and is likely to be set up this year.
- Private sector through PPPs.

The distribution of funds under the Scheme will be as follows:

- 93% project funds.
- 5% Administrative and Office Expenses (A&OE) funds for state/ULB (towards preparation of SCPs and for PMCs, Pilot studies connected to area-based developments and deployment and generation of Smart Solutions, capacity building as approved in the Challenge and online services).
- 2% A&OE funds for MoUD (Mission Directorate and connected activities/structures, Research, Pilot studies, Capacity Building, and concurrent evaluation).

## Funds Release

- After the Stage 1 of the challenge, each potential Smart City will be given an advance of Rs. two crore for preparation of SCP which will come from the city's share of the A&OE funds and will be adjusted in the share of the city.
- In the first year, Government proposes to give Rs.200 crore to each selected Smart City to create a higher initial corpus.
- After deducting the Rs. two crore advance and A&OE share of the MoUD, each selected Smart City will be given Rs. 194 crore out of Rs. 200 crore in the first year followed by Rs. 98 crore out of Rs. 100 crore every year for the next three years.

The yearly instalment of funds will be released to SPVs after they meet the following conditions:

- timely submission of the City Score Card every quarter to the MoUD,
- satisfactory physical and financial progress as shown in the Utilization Certificate (Annexure 6) and the annual City Score Card (Annexure 7),
- achievement of milestones given in the roadmap contained in SCP, and
- fully functioning SPV as set out in the Guidelines and the Articles of Association. A Board Resolution should certify that all these conditions have been met, including a certificate that all the conditions relating to establishment, structure, functions and operations of the SPV as given in para 10 and Annexure 5 are complied with.

# Mission Monitoring

## National Level

An Apex Committee (AC), headed by the Secretary, MoUD and comprising representatives of related Ministries and organisations will approve the Proposals for Smart Cities Mission, monitor their progress and release funds. This Committee will meet periodically, as considered necessary. The AC will consist of the following indicative members:

i.	Secretary, Housing and Poverty Alleviation	Member
ii.	Secretary (Expenditure)	Member
iii.	Joint Secretary, Finance, MoUD	Member
iv.	Director, NIUA	Member
v.	Chief Planner, Town and Country Planning	Member
vi.	Select Principal Secretaries of States	Member
vii.	Select CEOs of SPVs	Member
viii.	Mission Director	Member Secretary

The Representatives of stakeholders like UN Habitat, World Bank, TERI, Centre for Development of Advanced Computing (C-DAC), Centre for Smart Cities (CSC), Bangalore or other bilateral and multilateral agencies and urban planning experts may be invited with the approval of the Chair.

The AC will provide overall guidance and play an advisory role to the Mission and its key responsibilities are given below.

- Review the list of the names of Cities sent by the State Governments after Stage 1. Review the proposals evaluated by panel of experts after Stage 2.
- Approve the release of funds based on progress in implementation.
- Recommend mid-course correction in the implementation tools as and when required.

Undertake quarterly review of activities of the scheme including budget, implementation and co-ordination with other missions/ schemes and activities of various ministries.

There will be a National Mission Director, not below the rank of Joint Secretary to Government of India who will be the overall in-charge of all activities related to the Mission. A Mission Directorate will take support from subject matter experts and such staff as considered necessary. The key responsibilities of the Mission Directorate are given below.

- Develop strategic blueprint and detailed implementation roadmap of the Smart Cities Mission, including the detailed design of the City Challenge.
- Coordinate across Centre, States, ULBs and external stakeholders in order to ensure that external agencies are efficiently used for preparation of SCP, DPRs, sharing of best practices, developing Smart Solution, etc.
- Oversee Capacity building and assisting in handholding of SPVs, State and ULBs. This includes developing and retaining a best practice repository (Model RFP documents, Draft DPRs, Financial models, land monetization ideas, best practices in SPV formation, use of financial instruments and risk mitigation techniques) and mechanism for knowledge sharing across States and ULBs (through publications, workshops, seminars).

## State Level

There shall be a State level High Powered Steering Committee (HPSC) chaired by the Chief Secretary, which would steer the Mission Programme in its entirety. The HPSC will have representatives of State Government departments. The Mayor and Municipal Commissioner of the ULB relating to the Smart City would be represented in the HPSC. There would also be a State Mission Director who will be an officer not below the rank of Secretary to the State Government, nominated by the State Government. The State Mission Director will function as the Member-Secretary of the State HPSC. The indicative composition of HPSC is given below:

Principal Secretary, Finance, Principal Secretary, Planning,

Principal Secretary/Director, Town & Country Planning Department, State/UT Governments,

Representative of MoUD, Select CEO of SPV in the State,\*

Select Mayors and Municipal Commissioners /Chief Executive of the ULBs, and Heads of the concerned State Line Departments,

Secretary/Engineer-in-Chief or equivalent, Public Health Engineering Department, Principal Secretary, Urban Development – Member Secretary.

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\*As and when it is formed.

- The key responsibilities of the HPSC are given below.

Provide guidance to the Mission and provide State level platform for exchange of ideas pertaining to development of Smart Cities. Oversee the process of first stage intra-State competition on the basis of Stage 1 criteria. Review the SCPs and send to the MoUD for participation in the Challenge.

- City Level

A Smart City Advisory Forum will be established at the city level for all 100 Smart Cities to advise and enable collaboration among various stakeholders and will include the District Collector, MP, MLA, Mayor, CEO of SPV, local youths, technical experts, and at least one member from the area who is a,

- President / secretary representing registered Residents Welfare Association,
- Member of registered Tax Payers Association / Rate Payers Association,
- President / Secretary of slum level federation, and
- Members of a Non-Governmental Organization (NGO) or Mahila Mandali / Chamber of Commerce / Youth Associations.

The CEO of the SPV will be the convener of the Smart City Advisory Forum.

## Convergence with Other Government Schemes

1. Comprehensive development occurs in areas by integrating the physical, institutional, social and economic infrastructure. Many of the sectoral schemes of the Government converge in this goal, although the path is different. There is a strong complementarity between the Atal Mission for Rejuvenation and Urban Transformation (AMRUT) and Smart Cities Mission in achieving urban transformation. While AMRUT follows a project-based approach, the Smart Cities Mission follows an area-based strategy.
2. Similarly, great benefit can be derived by seeking convergence of other Central and State Government Programs/Schemes with the Smart Cities Mission. At the planning stage itself, cities must seek convergence in the SCP with AMRUT, Swachh Bharat Mission (SBM), National Heritage City Development and Augmentation Yojana (HRIDAY), Digital India, Skill development, Housing for All, construction of Museums funded by the Culture Department and other programs connected to social infrastructure such as Health, Education and Culture. (Annexure 1).

## QUIZ 10

Provide 6 MCQs here based on previous slides you have discussed

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# Bhendi Bazaar



# Bhendi Bazaar



# Bhendi Bazaar

## A Holistic Transformation



To create a sustainable  
living & working  
environment



# Bhendi Bazaar



# GIFT City

## The Location

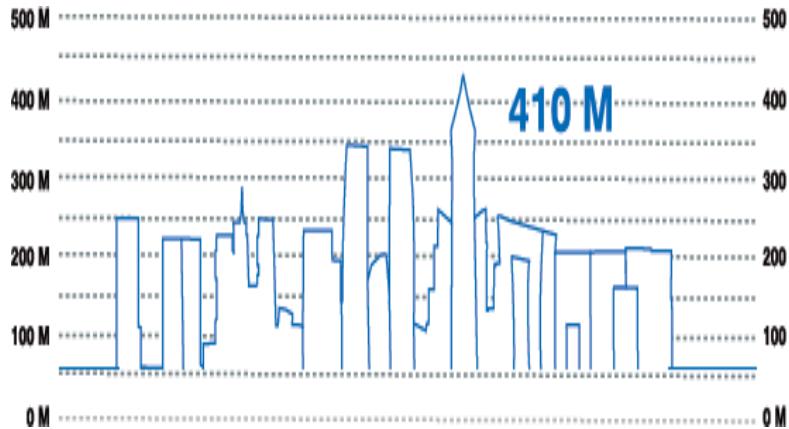
The project is located on the bank of the Sabarmati river and is around 12 km from Ahmedabad International Airport. GIFT is easily accessible from all directions through 4-6 lane State and National Highways.



# Master Plan - GIFT City



# Visionary Skyline - GIFT City



## The Diamond Tower

It will be located on the Fortune Island. The height of this tower will be > 400 m and shall house 80 floors. Ambience and location of the signature building has been designed extraordinarily to stand out in the city fabric.

## The Gateway Towers

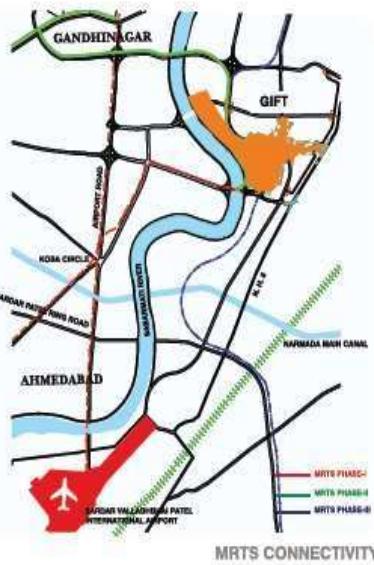
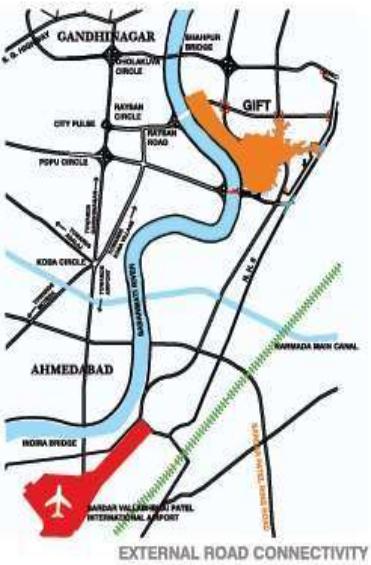
They (each 362 m high) will anchor strategic street intersections which mark entrances to the city from public arterial streets. The building is a key element creating an identifiable area for the city axis.

## The Crystal Towers

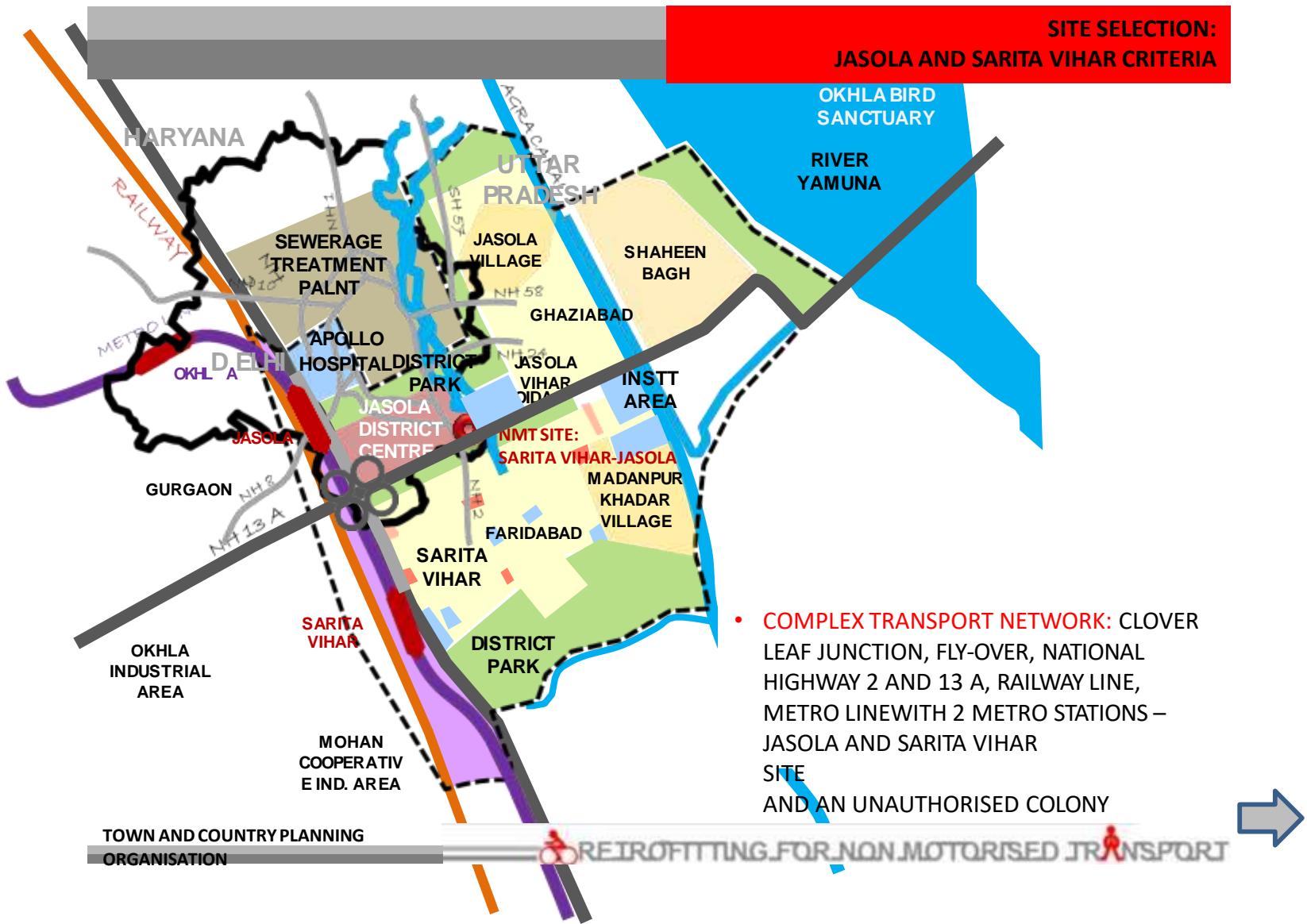
The glowing Crystal Towers will be one of the most beautiful buildings of the city skyline. The four office Crystal Towers will have beautiful terrace gardens and will offer a spectacular view of the Dream River, Diamond Tower and the Convention Centre.



# External Connectivity - GIFT City



[Back](#)

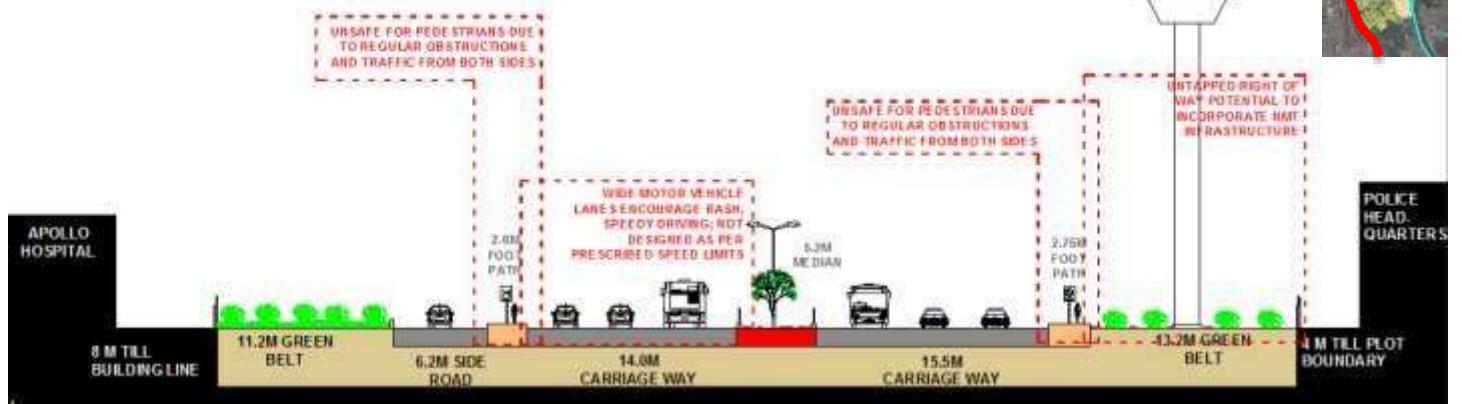


## GENERAL ISSUES IDENTIFIED ON SITE

### OBSTRUCTIONS ON FOOTPATHS



(A) EXISTING



(A) PROPOSED



[Back](#)

# Number of Smart Cities Allocated to each State

State Name	No.s	State Name	No.s	State Name	No.s
A & N Islands	1	Haryana	2	Nagaland	1
Andhra Pradesh	3	Himachal Pradesh	1	Odisha	2
Arunachal Pradesh	1	Jammu & Kashmir	1	Puducherry	1
Assam	1	Jharkhand	1	Punjab	3
Bihar	3	Karnataka	6	Rajasthan	4
Chandigarh	1	Kerala	1	Sikkim	1
Chhattisgarh	2	Lakshadweep	1	Tamil Nadu	12
Daman & Diu	1	Madhya Pradesh	7	Telangana	2
Dadra & Nagar Haveli	1	Maharashtra	10	Tripura	1
Delhi	1	Manipur	1	Uttar Pradesh	13
Goa	1	Meghalaya	1	Uttarakhand	1
Gujarat	6	Mizoram	1	West Bengal	4

# Thank You

# L3. Components of Urban Infrastructure

## Contributor

### Learning Objective:

To identify the most important components of urban infrastructure in the development of the smart city

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<https://images.financialexpress.com/2016/01/Smart-city-re2.jpg>

# L3. Components of Urban Infrastructure

## Learning Objective:

To identify the most important components of urban infrastructure in the development of the smart city

## Presenter

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# Components of Urban Infrastructure

## Contents

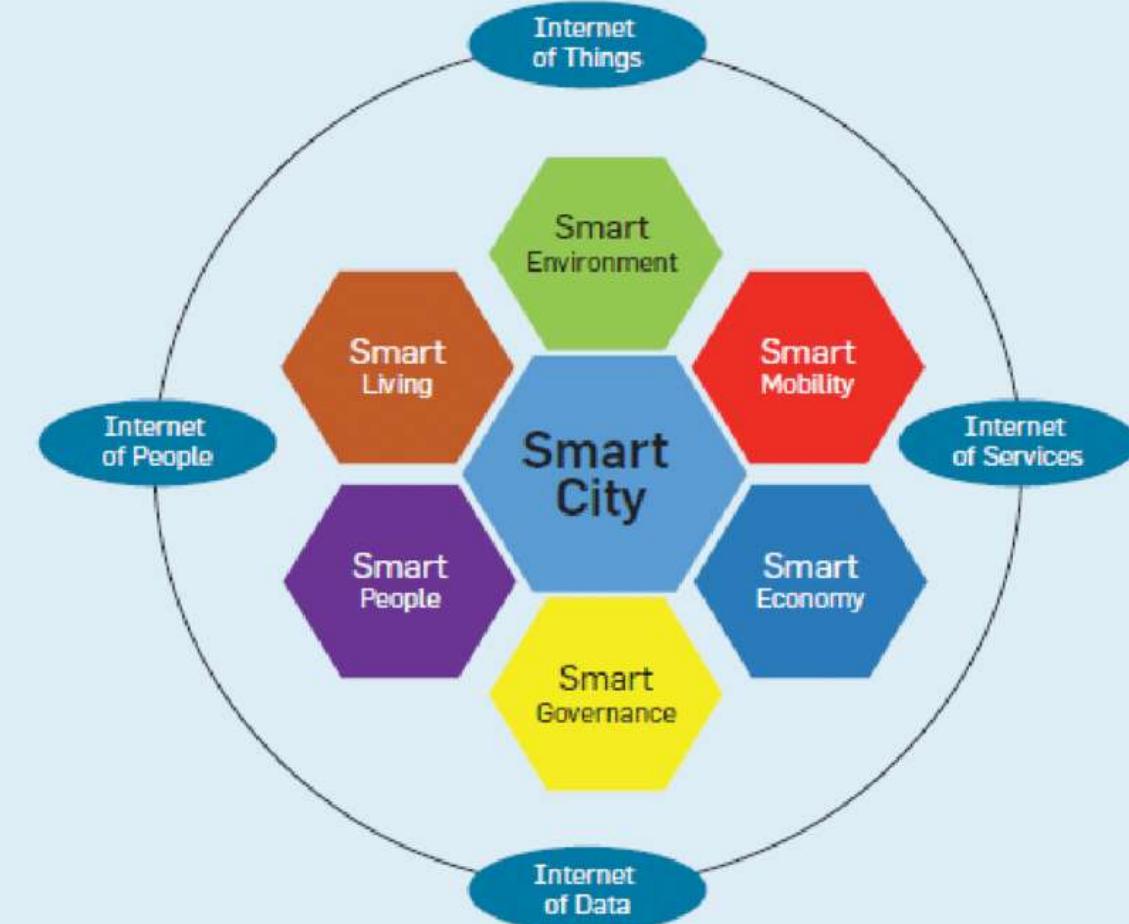
### 1. Definition

1. Any form of technology-based innovation in the planning, development, and operation of cities.

### 2. Capacity – Inputs, flows and outputs

### 3. Sustainability

### 4. Public sector infrastructure projects



# URBAN INFRASTRUCTURE DEVELOPMENT

## Definition

- Urban infrastructure such as reliable high speed mass transit system, motorways/interstates, and public housing projects have been cited as responsible for the disappearance of major slums.
- As cities expanded and business parks scattered due to cost ineffectiveness, people moved to live in the suburbs; thus retail, logistics, house maintenance and other businesses followed demand patterns.

## Example:

Structures required to support the society such as

- transportation,
- agriculture,
- water management,
- telecommunications,
- industrial and commercial development, power,
- petroleum and natural gas,
- housing and
- other areas:
- mining,
- disaster management services, and
- technology related infrastructure.

# Key concepts in urban infrastructure

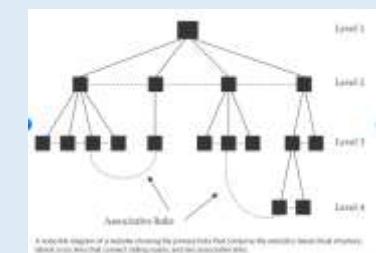
## 1. Capacity – Inputs, flows and outputs

## 2. Sustainability

- Sustainable transport infrastructure, such as mass transit systems (subways / metros / underground systems)
- Appropriate energy sources
- Safe and secure housing e.g. that can withstand hazards such as fire and earthquakes
- ‘Future proofing’, such as by ensuring that infrastructure can be easily adapted to unknown future needs. This includes having a system capacity beyond what is currently needed.
- For example, if there is a new road being planned, it should be capable of carrying more cars than is currently needed so that as the city grows, it doesn’t need to be rebuilt.

## 3. Essential infrastructure

Example: bridge across a river might be essential while a large sports stadium is not. power stations and electricity supplies, sewage systems, clean drinking water systems, major transport systems (metro systems and railways) and telecommunications networks.



## 4. Public sector infrastructure projects

example, a major ring-road (also called radial road) will not only help the commuters who use it, but also reduce congestion in the city for everyone else by redirecting traffic away from gridlocked areas.

# Key concepts in urban infrastructure

## 5. Private sector infrastructure projects

profit making businesses, is generally responsible for non-essential infrastructure. example, the switch from 4G to 5G mobile networks in the United States is predicted to cost US\$104 billion, and will mostly be paid for by private cellular companies

# What is a Smart City?

- A Smart City has-
  - basic infrastructure,
  - uses ‘smart’ solutions to make infrastructure and services better, and
  - relies on Area based development.

# What is basic infrastructure?

- Basic public infrastructure is built by merging and synergizing with other Missions and Schemes
  - **AMRUT** (Atal Mission for Rejuvenation and Urban Transformation)
- Basic infrastructure includes,
  - Assured water & electricity supply,
  - Sanitation & Solid Waste Management,
  - Efficient urban mobility & public transport,
  - Affordable Housing,
  - Robust IT connectivity,
  - e-governance & citizen participation,
  - Safety & security of citizens,
  - Health & Education and
  - Economic Activities & Livelihood Opportunities.

# What are ‘smart solutions’

- Smart solutions are application of IT&C to municipal services and infrastructure to make them better.
- **Examples –**
  - Smart water meters and billing systems,
  - Remotely controlled automatic distribution valves,
  - Real time, online systems of monitoring water quality,
  - City-wide intelligent video surveillance network,
  - Using mobile phones for cyber tour of worksites,

# City wide Smart Solutions

## E-Governance and Citizen Services



- 1 Public Information, Grievance Redressal
- 2 Electronic Service Delivery
- 3 Citizen Engagement
- 4 Citizens - City's Eyes and Ears
- 5 Video Crime Monitoring

## Waste Management



- 6 Waste to Energy & fuel
- 7 Waste to Compost
- 8 Waste Water to be Treated
- 9 Recycling and Reduction of C&D Waste

## Water Management



- 10 Smart Meters & Management
- 11 Leakage Identification, Preventive Maint.
- 12 Water Quality Monitoring

Cities may add any number of smart solutions to the area based developments to make government funds cost effective.

## Energy Management



- 13 Smart Meters & Management
- 14 Renewable Sources of Energy
- 15 Energy Efficient & Green Buildings

## Urban Mobility



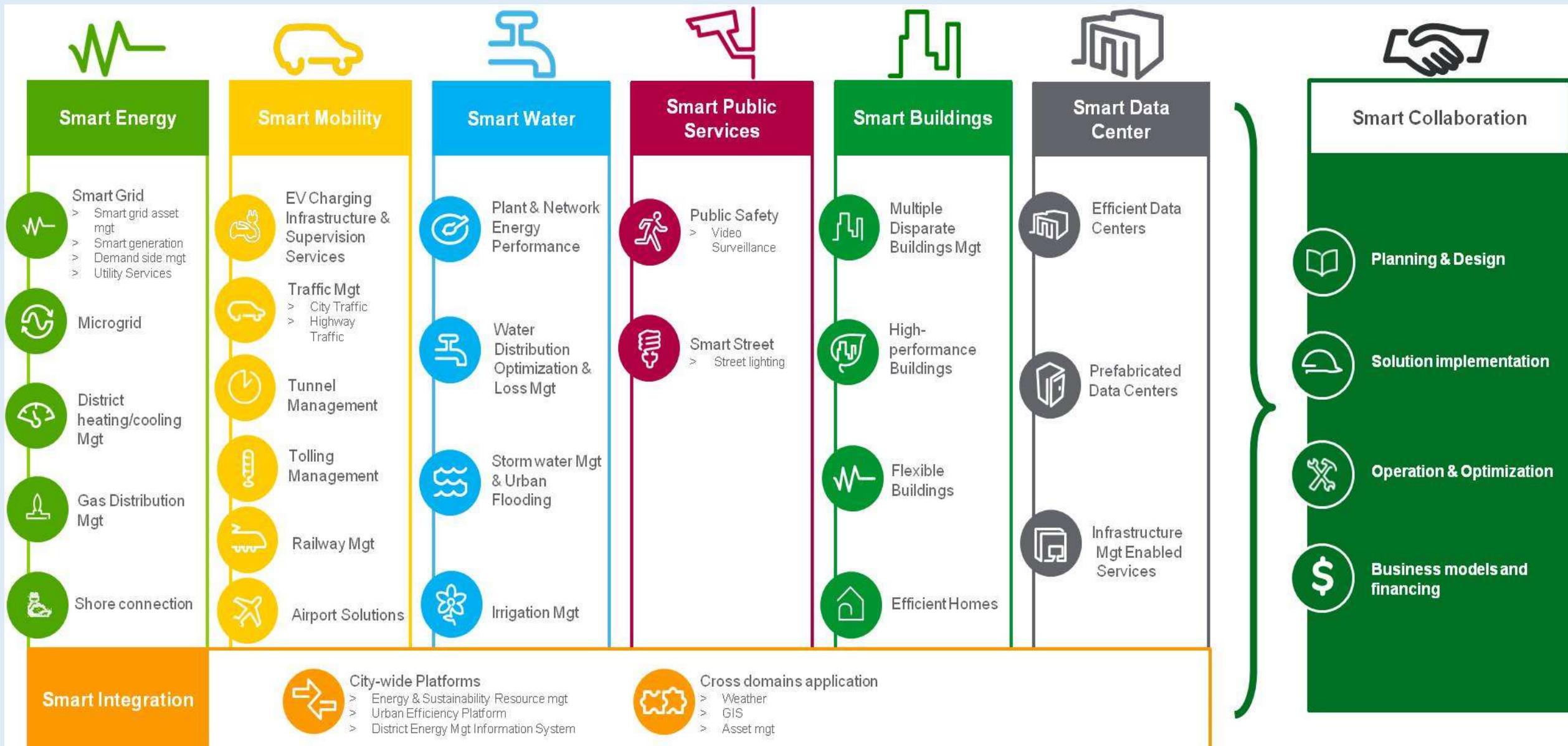
- 16 Smart Parking
- 17 Intelligent Traffic Management
- 18 Integrated Multi-Modal Transport

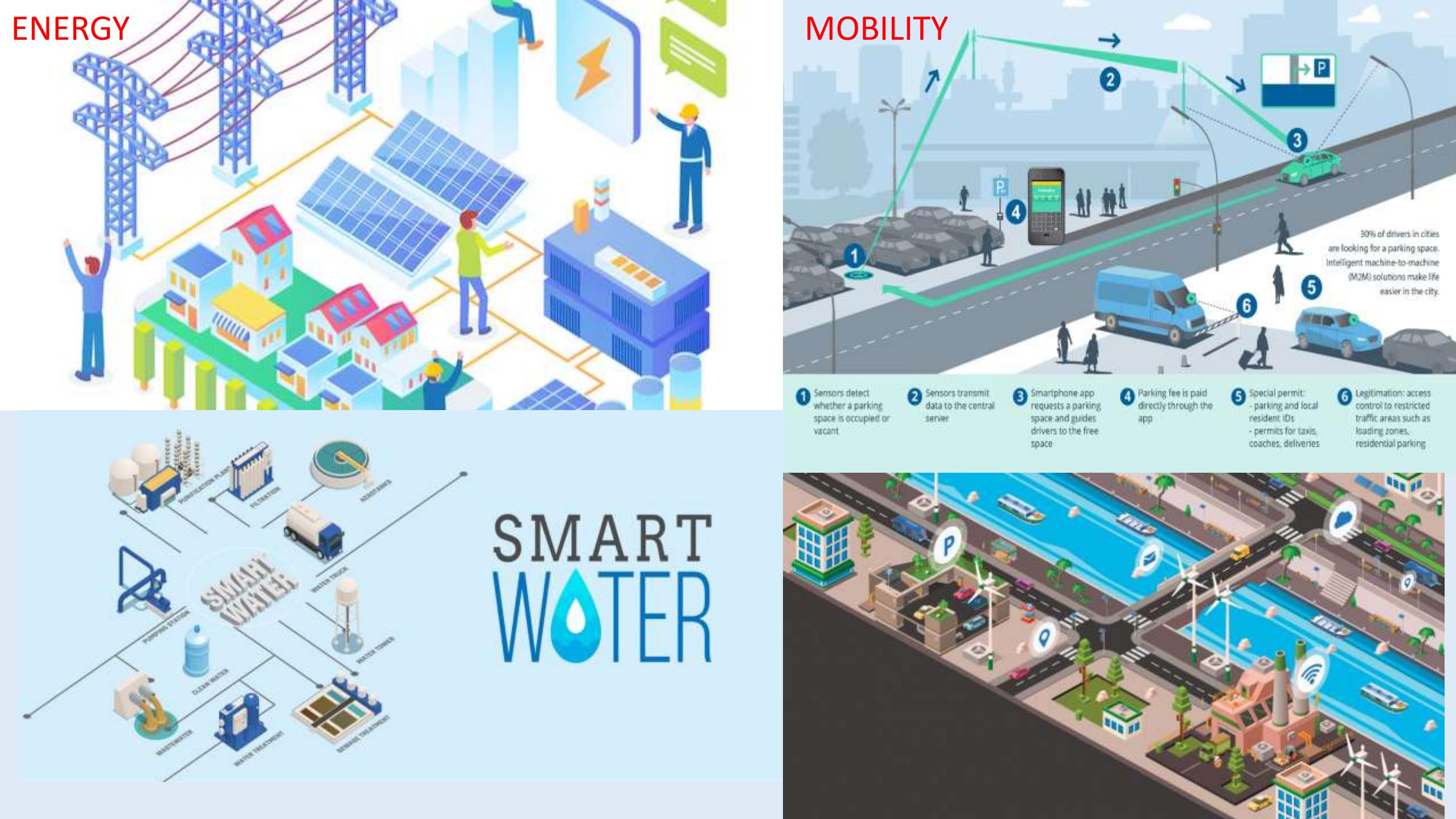
## Others

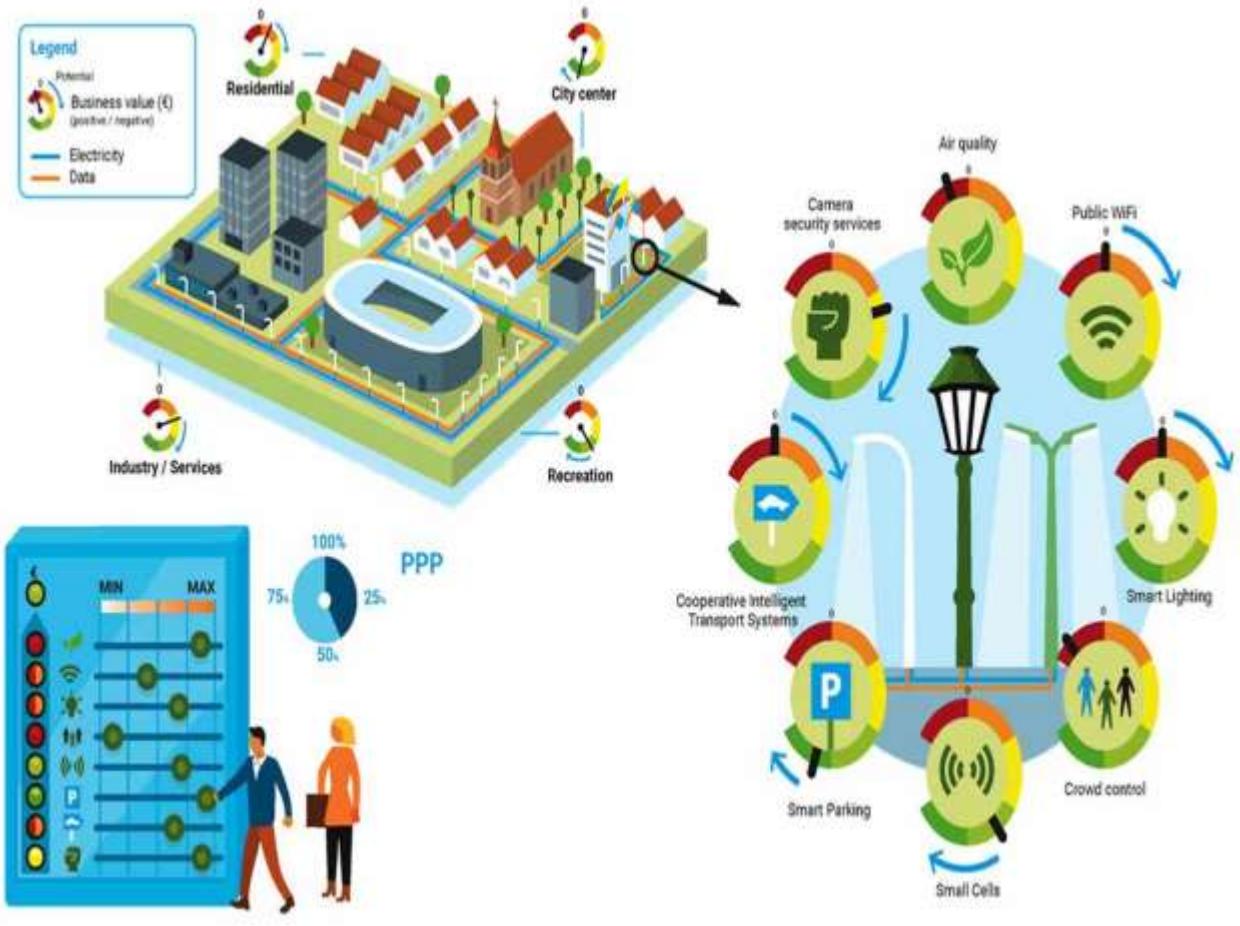


- 19 Tele-Medicine & Tele Education
- 20 Incubation/Trade Facilitation Centers
- 21 Skill Development Centers

# SMART CITY UTILITIES







## SMART UTILITIES



# SMART HOMES

- 1** Windows
- 2** Building Envelopes
- 3** Lighting/Sensors
- 4** Energy Systems
- 5** Furniture Systems
- 6** Roof Systems
- 7** Building Management
- 8** Building Structure/Systems
- 9** Water Systems
- 10** Safety/Security
- 11** Mobility
- 12** Foundations/Pavement



# FEATURES

## Centralized management

Extend company-wide telecommunication network policies, ensuring full control & management.

## •Safety & Security

All network hardware are protected .... wherever it travels with built-in strong user access controls and hardware data encryption.

## •Traffic Management

All solutions are delivered for the best highest performances with no special training required by the end user.

## •Lighting LED

All solutions can be integrated with Customer Organization infrastructures, reducing Cost of Ownership & Time.

## •Parking

All solutions can be redundant for the best efficiency.

## •Water

## •Waste

## •Environment

## •People

## •Digital & Analogic integration

All solutions can manage & integrate all technologies.

## •Full Service

All solutions can be offered in Full Service, without thinking to all equipments, services, support and so on....your organization can receive a full service management without thinking about infrastructures, etc.... just tell us your targets and we do it for you.

## •Auditing & Security Capabilities

If you need a security service, our corporate is ready to provide it as you like.

## •Support Enterprise

All solutions are supported by our helpdesk & emergency staff for providing you the best support.

# BENEFITS

- Open Digital Protocol Communication
  - Telecommunications play an important role in the world economy and the worldwide telecommunication industry's needs to be integrated, efficient and always available.
- Network & Radio Communication
  - Implement and enforce company-wide network infrastructure that ensure to be connected wherever you need it.
- Provide mobility without compromising security policies
  - Our solutions are efficient, secure and always available, avoiding brand damage, customer distrust, competitive disadvantage, and financial losses by securing data communication no matter where workers travels.
- Control Accesses with strong authentication
  - All the communication are secure and allow user access control to restrict and authorize who can access and where.
- Social & Business Impacts
  - Telecommunication has played a significant role in social relationships. Nevertheless devices like the telephone were originally advertised with an emphasis on the practical dimensions of the device (such as the ability to conduct business or order home services) as opposed to the social dimensions.

# “Data & Services are everywhere in the City”



 <p><b>Smart City</b></p>	<b>Smart Economy</b>	<i>Innovative spirit; Entrepreneurship; Productivity; Flexibility of labor market; International embeddedness; Ability to transform</i>
	<b>Smart People</b>	<i>Level of qualification; life long learning ;Social and ethnic plurality; Flexibility; Creativity; Cosmopolitanism/s; Participation in public life</i>
	<b>Smart Governance</b>	<i>Participation in decision-making; Public and social services; Transparent governance; Political strategies &amp; perspectives</i>
	<b>Smart Mobility</b>	<i>Local accessibility; (Inter-)national accessibility; Availability of ICT-infrastructure; Sustainable, innovative and safe transport systems</i>
	<b>Smart Environment</b>	<i>attractive natural conditions (climate, green space etc.), pollution, Sustainable resource management; efforts towards environmental protection.</i>
	<b>Smart Living</b>	<i>Cultural facilities; Health conditions; Individual safety; Housing quality; Education facilities; Touristic attractivity; Social cohesion</i>

# Questions

1. Define Infrastructure?
2. Distinguish between hard and soft infrastructure. What is ‘essential infrastructure’? What is a ‘nodal point’?
3. Explain why many urban infrastructure on a network system?
4. Can you identify any ‘critical points’ in the infrastructure, if they fail or need updating, affect the entire urban area? Outline the possible impacts and explain their severity. (Example, consider the road system: is there anywhere that suffers traffic congestion? If not, explain how the urban infrastructure in this area is networked to prevent this from happening.)
5. Define ‘capacity’ in relation to urban infrastructure?
6. Suggest and explain three problems that an urban area may face if three different infrastructure networks exceed capacity.
7. What is meant by ‘sustainability’ in the context of urban infrastructure?
8. Explain how and why governments are often directly involved with large infrastructure projects.

# L4. Smart City Concepts

Presenter

## Learning Objective:

To Understand the Concepts of smart cities

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Approved by AICTE, New Delhi

# L4. Smart City Concepts

## Learning Objective:

To Understand the Concepts of smart cities

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Approved by AICTE, New Delhi

# Introduction to “Smart City” Concept

The learning outcome of this session is intended to provide a broad overview of the concept of smart cities and an in depth look at the concepts that drive Smart

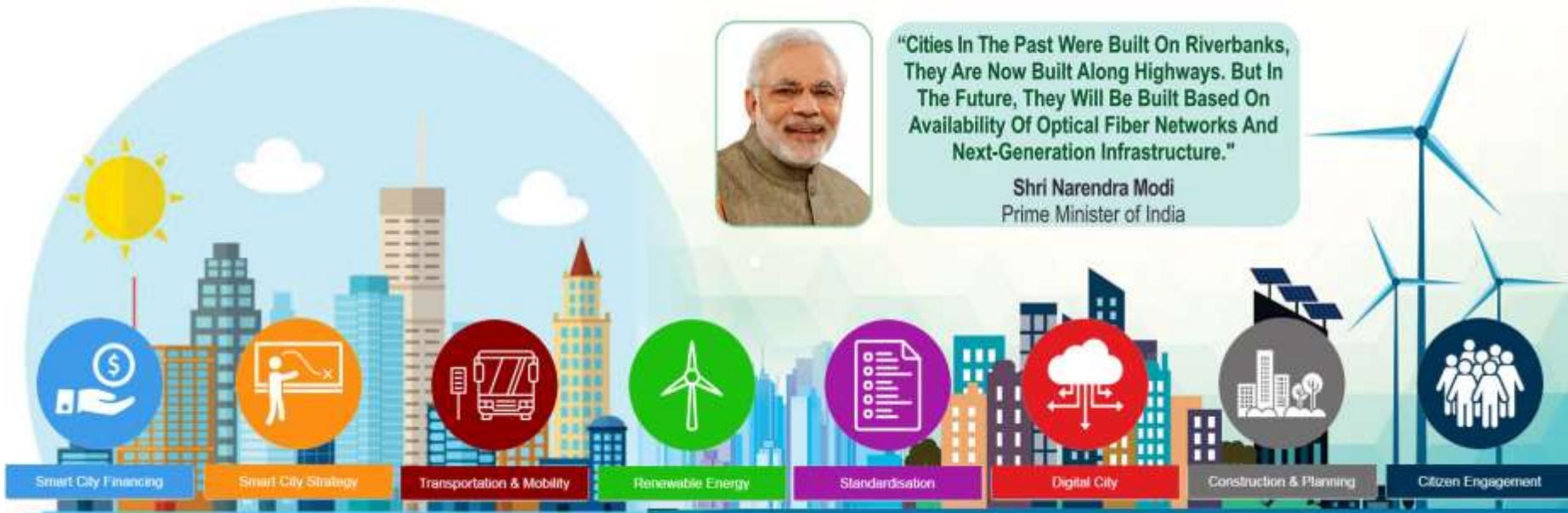


Nearly 31% of India's current population lives in urban areas and contributes 63% of India's GDP (Census 2011).

Across the world, the stride of migration from rural to urban areas is **increasing**. By **2050, about 70 per cent of the population will be living in cities**, and India is no exception. It will need about 500 new cities to accommodate the influx.

Source: The Hindu September 12, 2016

# Introduction to “Smart City” Concept



**Source: National Summit on 100 Smart Cities India 2016**

**Theme "BUILDING TODAY THE CITIES OF TOMORROW"**

With increasing urbanization and the load on rural land, the government has realized the need for cities that can cope with the challenges of urban living and also be magnets for investment. **The announcement of ‘100 smart cities’ falls in line with this vision.**

**Source: The Hindu September 12, 2016**

# “Smart-Sustainable cities in India - Considering innovative solutions and high level strategic planning”

The Smart Cities Mission is an **innovative and new initiative by the Government of India** to drive **economic growth and improve the quality of life of people** by enabling local development and harnessing technology as a means to create smart outcomes for citizens.



The Mission will cover 100 cities and its duration will be five years (FY2015-16 to FY2019-20). The objective is to promote cities that provide core infrastructure and give a decent quality of life to its citizens, a clean and sustainable environment and application of 'Smart' Solutions.

**Source: The Hindu September 12, 2016**

## What Makes a City “Smart”?

**Smart cities** use intelligent solutions to **optimize infrastructure** and **smart and responsive governance** to engage citizens in the management of their city. A **system of sensors, networks, and applications collect useful data, like traffic congestion, energy use, and CO<sub>2</sub> levels.**

Source: iotforall

# Anatomy of a Smart City

Source: iotforall



# 1. Smart Transportation and Mobility



## Transportation

### 1. Driverless Vehicles

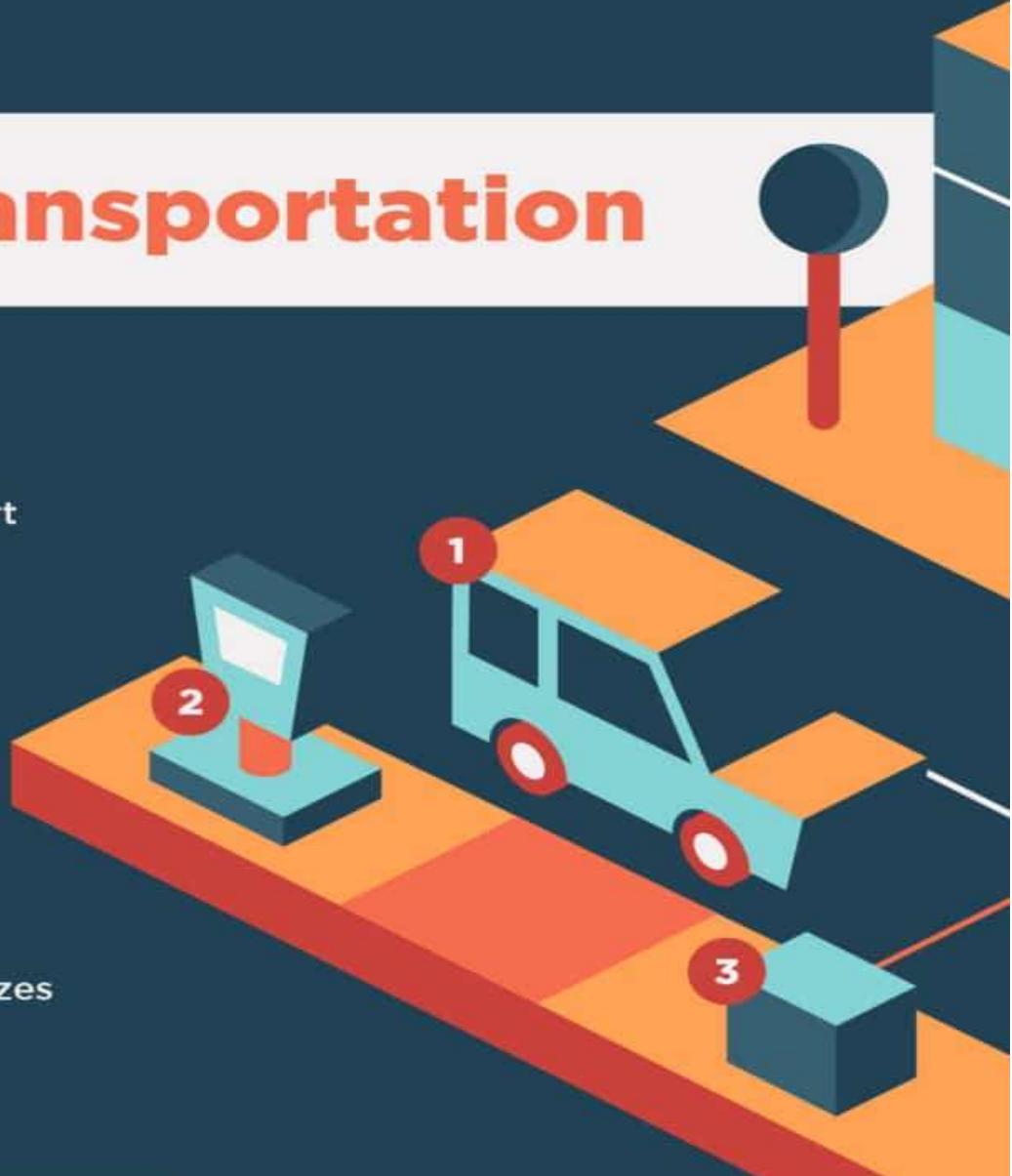
Provides automated transport to public transit stations

### 2. Smart Parking Meters

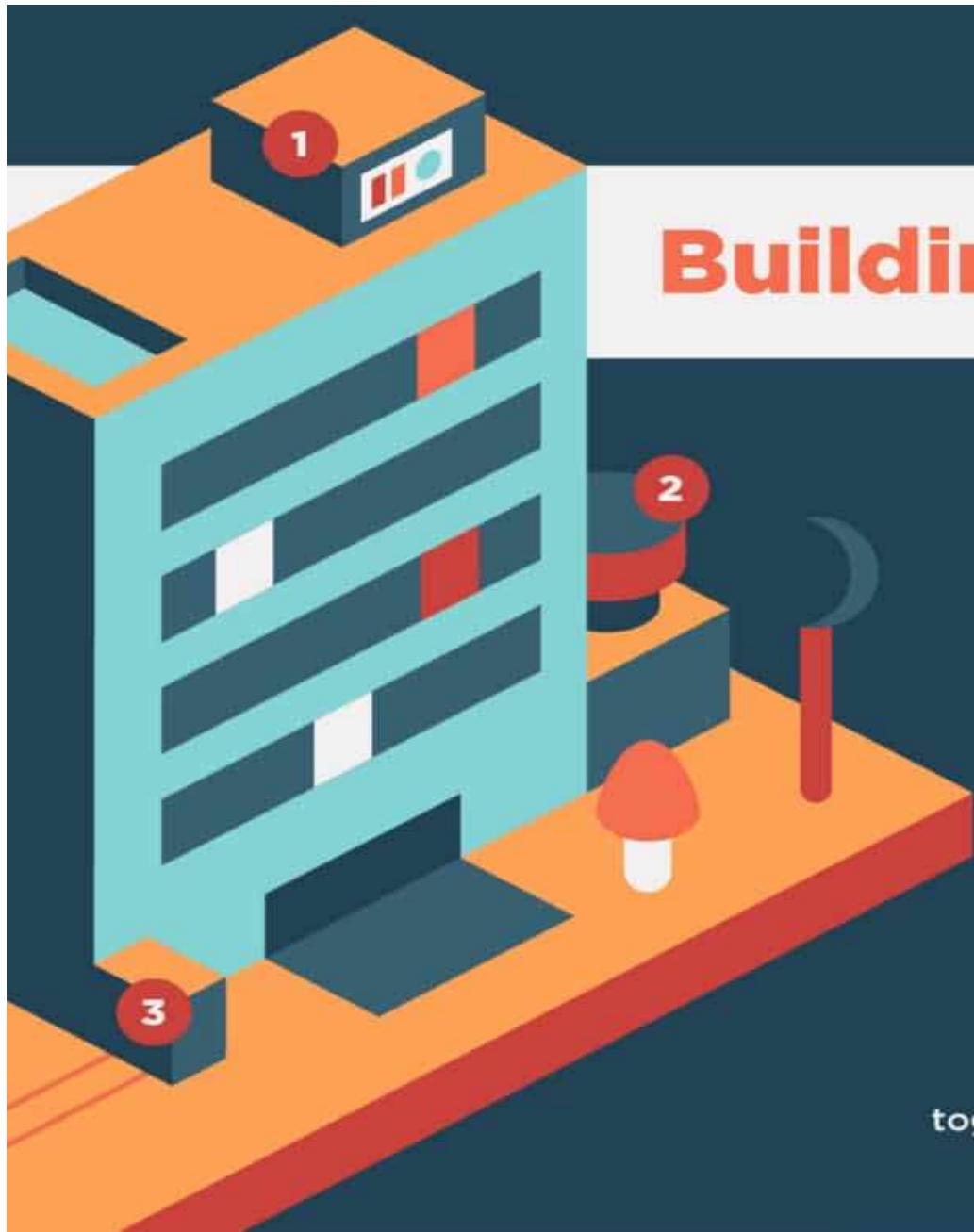
Shows available spots on apps and cuts driving time

### 3. Congestion Sensors

Monitors vehicles and optimizes or diverts traffic conditions



## 2. Autonomous Buildings



# Buildings



### 1. Smart Thermostats

Optimizes heating, cooling,  
and energy usage levels

### 2. Smart Fire Detector

Provides intelligent  
extinguishing based  
on each room

### 3. Connected Controls

Networks multiple buildings  
together to enable maintenance

### 3. Streamlined And Responsive Utilities



## Utilities

### 1. Water Monitors

Assesses tap water quality and detects leaks outside tanks and pipes

### 2. Smart LED Lamp Posts

Adjusts brightness to light and weather conditions

### 3. Smart Grid

Analyzes energy consumption and delivers optimal electricity supply



## 4. Environmental Harmony



### Environment



#### 1. Green Buildings

Helps with insulation, absorbing CO<sub>2</sub>, and producing oxygen

#### 2. Air Pollution Sensors

Monitors CO<sub>2</sub> emissions and car pollution

#### 3. Weather Prediction Monitors

Senses atmospheric conditions and seismic activity to improve response planning

## 5. Dynamic And Adaptive Infrastructure



### Infrastructure

#### 1. Waste Sensors

Detects garbage levels and maximizes waste collection routes

#### 2. Earthquake Detection

Monitors specific places underground that are prone to tremors

#### 3. Structural Sensors

Monitors vibrations and conditions of materials in buildings



## 6. Public Engagement And Security

The infographic illustrates three types of public engagement and security technologies:

- 1. Emergency Cameras**  
Helps dispatchers determine the severity of emergencies and find optimal routes
- 2. Facial Recognition Cameras**  
Creates criminal profiles and crime forecasts
- 3. Wearable Detection**  
Detects smartphones, provides wifi, and allows users to communicate with the city

**Public**

# QUIZ 4.1

Provide 6 MCQs here based on previous slides you have discussed

**1. The announcement of \_\_\_smart cities' falls in line with this vision.**

- a).....
- b) .....
- c).....
- d) .....

**2. a smart city vision is about**

- a).....
- b) .....

**3. Anatomy of a Smart City are;**

- a).....
- b) .....
- c).....
- d) .....
- e).....
- f) .....

**4. Smart Transportation and Mobility includes**

- a).....
- b) .....
- c).....
- d) .....

**5. What are the three components of urban motilities**

- a).....
- b) .....
- c).....

**6. Name any three Dynamic And Adaptive Infrastructure**

- a).....
- b) .....
- c).....

## Smart City Definition

There is no simple definition for smart cities.

*The term encompasses a vision of an urban space that is ecologically friendly, technically integrated and meticulously planned with a particular reliance on the use of information technology to improve efficiency.*

In most parts of the world, the idea begins with using digital technology to make a city more efficient and to improve general well-being of its people

**Source: Making of a smart city Dr S L Goel and Dr Shalini Rajneesh, IAS**



## Smart City Definition

Smart cities are those that are able to attract investments, experts and professionals. Good quality infrastructure , simple and transparent on-line business and public service processes that make it easy to practice one's profession or to establish an enterprise and run it efficiently, without any bureaucratic hassles, these are essential features of a citizen centric and investor friendly smart city.

*Indian Government 2014: “ Smart city offers sustainability in terms of economic activities and employment opportunities to a wide section of its residents, regardless of their level of education , skills or income levels”*

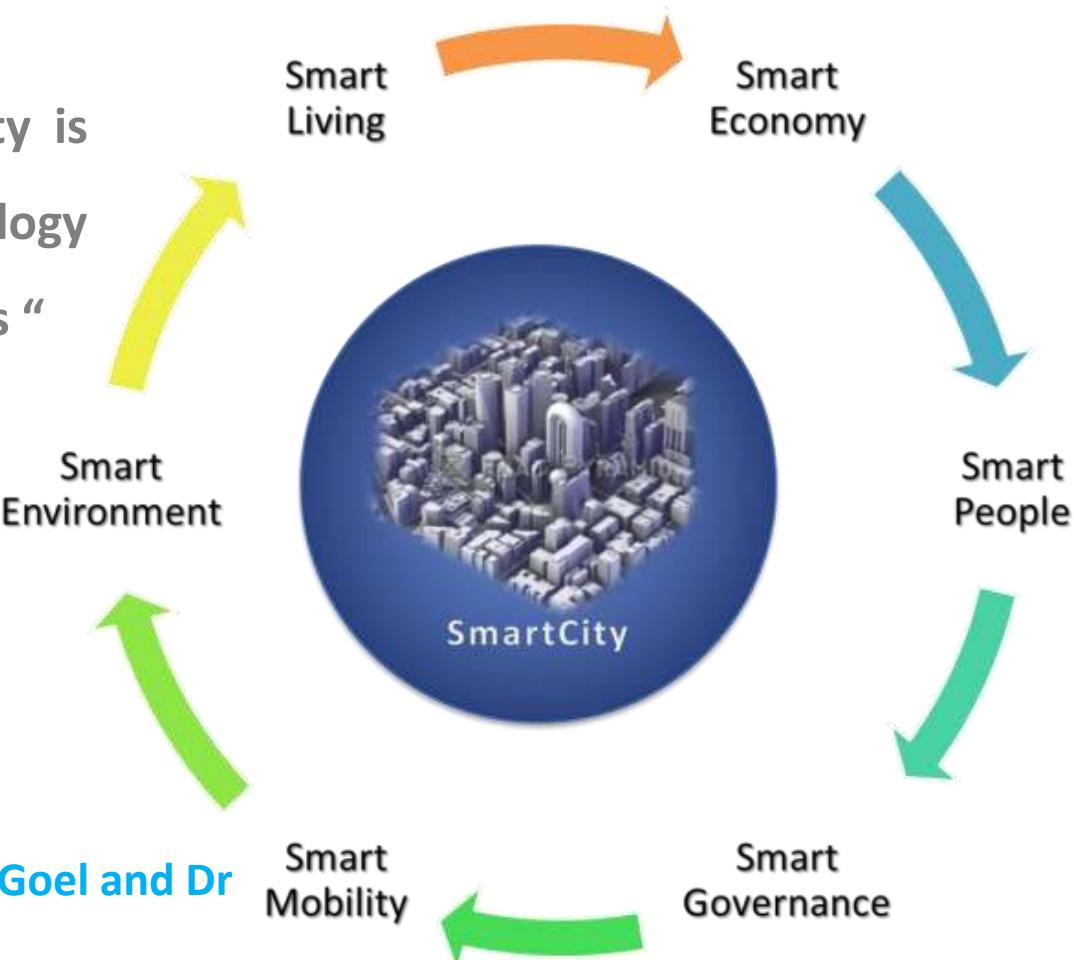
**Source:** Making of a smart city Dr S L Goel and Dr Shalini Rajneesh, IAS



## Smart City Definition

Institute of Electrical and Electronics Engineers: “A smart city brings together technology, government and society to enable the following characteristics: a smart economy, smart mobility, a smart environment , smart people , smart living , smart governance”

Smart City council: “ A smart city is one that has digital technology embedded across all city functions ”



Source: Making of a smart city Dr S L Goel and Dr Shalini Rajneesh, IAS

## Smart people

- Level of qualification, flexibility to get more opportunities, knowledge about the policies and schemes launches by the govt would be the first step of each and every individual, public participation

## Smart economy

- Indicators like entrepreneurship, productivity, self – employment rate, GDP per person, flexibility of labour market, reliability , **smart infrastructure** which directly proportional to the per capita income

## Smart governance

- Efficient govt. services such as e-government portal service, e-learning project, e-passport, public participation in decision making,
- Smart energy: smart grid, energy storage, smart meters

## Smart mobility

- streamlined transportation in order to optimise traffic flow and increase connectivity

## Smart environment

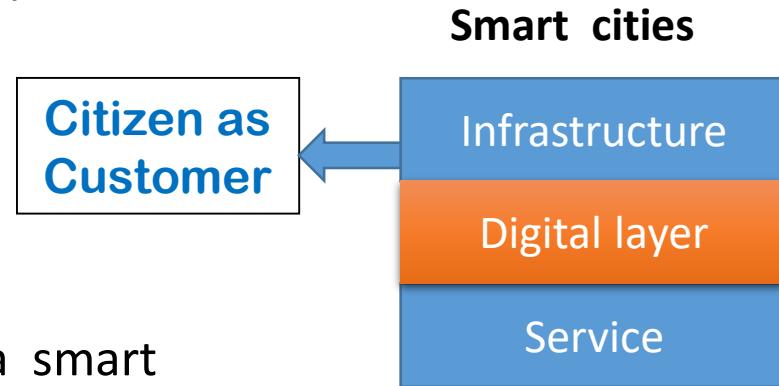
- renewal of energy, waste water management and provide proper sanitation to citizens

## Smart living

- build intelligent building management systems, which will help save up to 30% of water usage, 40% of energy usage and reduction of building maintenance costs by 10 to 30%, smart cooling, smart heating

## Smart City

- Traditionally, Cities are viewed as systems comprising of two main layers:
  - An infrastructure Layer and
  - A service layer.



- The main point that differentiates a smart city is the addition of a third layer in-between the original two:

A digital or data layer, a new layer, which defines smart city

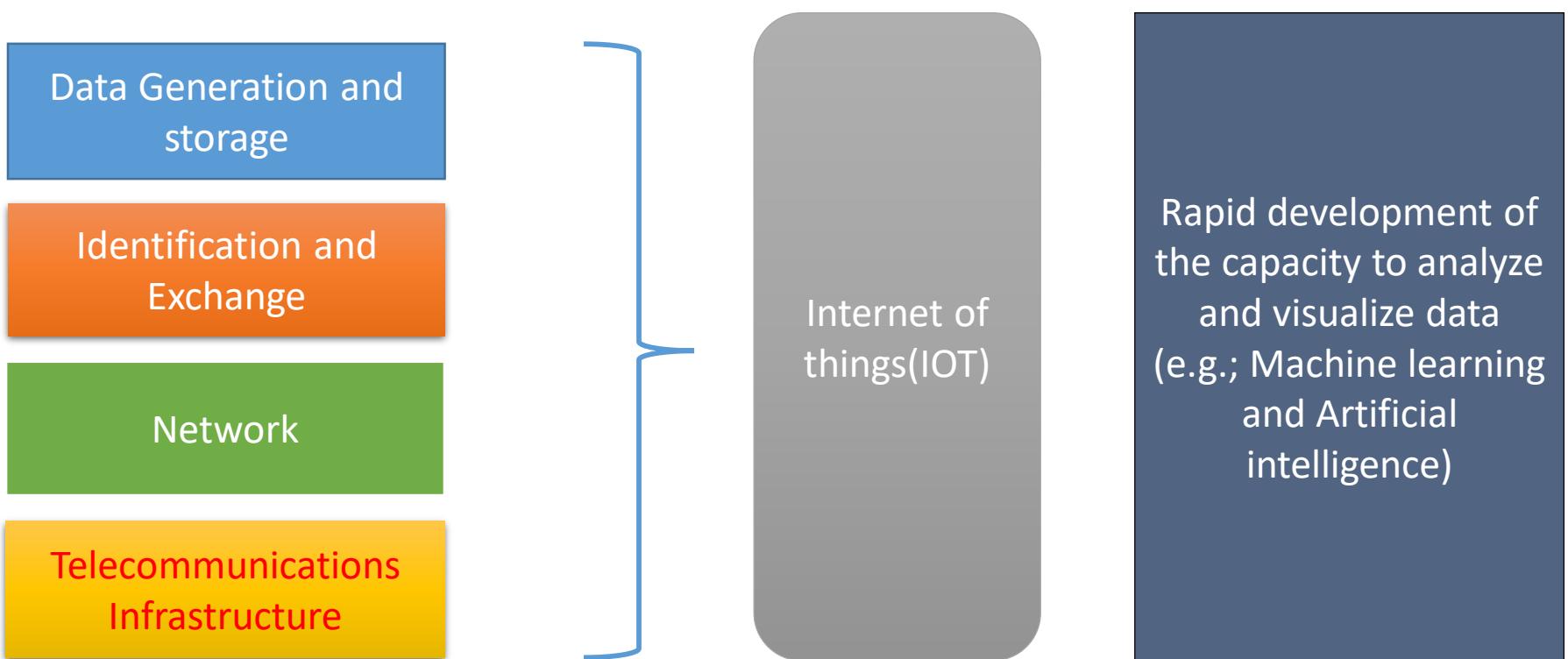
### A digital or data layer.

This layer grows through the increasing number of sources for data generation in cities, such as sensors, cameras, GPS, smart phones, and many others.

These data generation devices can be found at increasingly lower costs and sizes, making their use very convenient.

Additionally, their storage capacity has been growing exponentially, which means that we are generating an unprecedented amount of data. (Source: IGLUS, EPFL)

# Digitalization



## Building blocks of Digitalization

(Source: IGLUS, EPFL)

## Digital / Data Layer

- The base of this data layer is the **telecommunications infrastructure** (both cables and wire-less), which allows for the **physical transmission and storage of information**.
- The second enabler is the **network layer** - connection of all devices through the telecommunications infrastructure. This is done using specific protocols and systems such as the Internet.
- The third aspect is to **identify and exchange the data generated**, which is done through the world-wide web i.e. the communications dimension that connects all data.
- Finally, at the top of this pyramid, you have the individual devices that **generate and store data** (Smart phones, GPS devices, Sensors).
- When you combine all the systems above, you get the **Internet of Things (IoT)**:
- IoT is the connection of different devices through the internet and the WWW  
**(Source: IGLUS, EPFL)**

## Visualization & Analysis of Data

- The data generated must be analyzed for it to be useful.
- This has led to the development of our capacity and ability to not only analyze this data, but also visualize it in a way understandable to humans.
- Some of the tools used to do so are, for instance, **Machine learning** or **Artificial intelligence**.
- This process of analysis of large amounts of data is known as “**Big Data**” or “**Big Data Analytics**”.

(Source: IGLUS, EPFL)

## The core infrastructure elements in a smart city would include:

- Adequate water supply,
- Assured electricity supply,
- Sanitation, including solid waste management,
- Efficient urban mobility and public transport,
- Affordable housing, especially for the poor,
- Robust IT connectivity and digitalization,
- Good governance, especially e-Governance and citizen participation,
- Sustainable environment,
- Safety and security of citizens, particularly women, children and the elderly, and
- Health and education.

**Source: Ministry of Housing and Urban Affairs (Government of India)**

# Artificial Intelligence

- Software algorithms that can perform tasks that normally require human intelligence,
- Visual perception, speech recognition, decision-making, and language translation.
- AI is an “umbrella” concept that is made up of numerous subfields, such as machine learning,
- Focuses on the development of programs that can teach themselves to learn, understand, reason, plan, and act (i.e., become more intelligent) when exposed to new data in the right quantities.

# Applications

## 1. Reduce the time in Planning Stage

- Artificial neural networks can carry out the detection of clashes with utilities in a day without the need for teams of engineers.
- AI can not only detect potential clashes with utilities but can also find solutions for them and change the plans accordingly.

## 2. Efficient and improved Construction Planning and Scheduling

- AI can improve construction execution planning,
- Updating of construction sequences and task management, while keeping all stakeholders always informed.

## **QUIZ 4.2**

**Provide 6 MCQs here based on previous slides you have discussed**

**1**

**2**

**3**

**4**

**5**

**6**

# L5. Smart City Benefits and Challenges

## Learning Objective:

To Identify and ascertain the Benefits and Challenges of smart cities

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Approved by AICTE, New Delhi

# Key features of a “Smart City”



Source: Making of a smart city

# Smart Solutions

## Smart Town Planning

### Smart Security



### Smart Governance



### Smart Building



### Smart Education



## Smart Healthcare



Source: Making of a smart city

# Benefits of smart cities

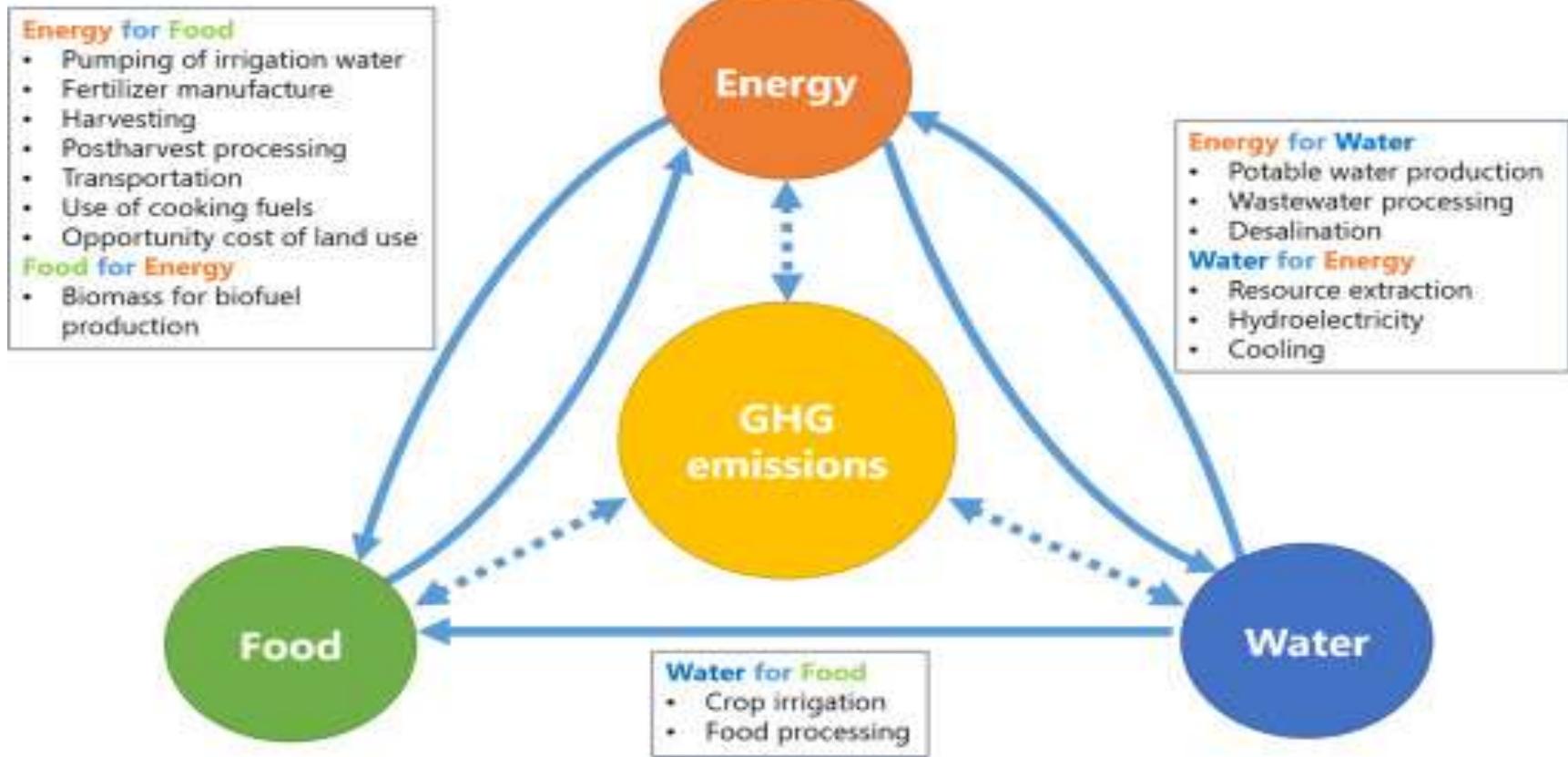


## 1. Environmental impact

Reducing the CO<sub>2</sub> footprint is the main driver behind the development of smart and sustainable cities.

Improving energy efficiency and storage, waste management, traffic conditions are among the greatest advantages.

# Benefits of smart cities



## 2. Optimized energy & water management:

Smart grids and smart water management are recurring themes of smart cities. Energy consumption and potable water monitoring ensure the availability of energy and the quality of tap water across the city.

Source: [solarimpulse.com](http://solarimpulse.com)

# Benefits of smart cities



## 3. Transportation

Clean and efficient transportation of goods, services and people is essential. In the hope of optimizing mobility, many cities are turning to smart technologies to ease traffic congestion and provide users with real-time updates.

Source: [solarimpulse.com](http://solarimpulse.com)

# Benefits of smart cities



## 4. Security

Safety is a priority for all cities. The accelerated development of smart cities should allow municipalities to better monitor their citizens thanks to CCTV cameras with facial recognition.

In addition, state-of-the-art CCTV cameras are also equipped with motion and smoke detectors, as well as fire alarms.

Source: [solarimpulse.com](http://solarimpulse.com)

# The Benefits of a Smart Implementation for Cities

Smart Cities require the use of sensors to provide more granular information about its hard assets, the environment, and the utilization of services. Recent research has shown that adding sensors can provide demonstrable benefits, particularly with transportation issues

## Benefits to the City

- **Reduces traffic and congestion.** Advanced analytics and instrumentation can provide cities with the information they need to minimize congestion. Traffic lights can be synchronized and adjusted for optimal traffic flow.
- **In-vehicle collision-avoidance systems can take action to prevent congestion-causing accidents.** Incident detection and notification systems can analyze information from cameras and vehicles to detect traffic problems, alert drivers and suggest alternative routes

# The Benefits of a Smart Implementation for Cities

## Benefits to Citizens

- Reduces frustrations with inefficiencies in city services.
- Reduces wasted time sitting in traffic

## Benefits to Commerce

- The city becomes more attractive to talent. Professionals, like businesses, consider mobility when deciding where to locate.
- Smart implementations increase cities' competitive advantage. The quality of cities' transportation infrastructure is a major factor in business and industry investment decisions.

## Benefits to the Climate

- Reducing pollution from transportation. Traffic management creates a more efficient road network and reduces travel time, reducing vehicle emissions.

## Benefits of smart cities

- 01 Enhanced citizen experience
- 02 Reduced greenhouse footprint
- 03 Safer and quicker transportation
- 04 Promote safer communities
- 05 Fosters sustainability
- 06 Boosts economy

## QUIZ 5.1

Provide 6 MCQs here based on previous slides you have discussed

1

2

3

4

5

6

[Note: The following message is for faculty members only, for reminder

Please do copy all your quiz questions Quiz 4.1, 4.2 5.1 and 5.2 in word file  
and email me the doc file immediately after completion of both L4 and L5]

# INTELLIGENT ASSETS MAKING CITIES SMARTER BY...

...DECREASED  
EMISSION AND  
POLLUTION  
LEVELS

Vibrant cities  
with more life,  
less stress and  
clearer air

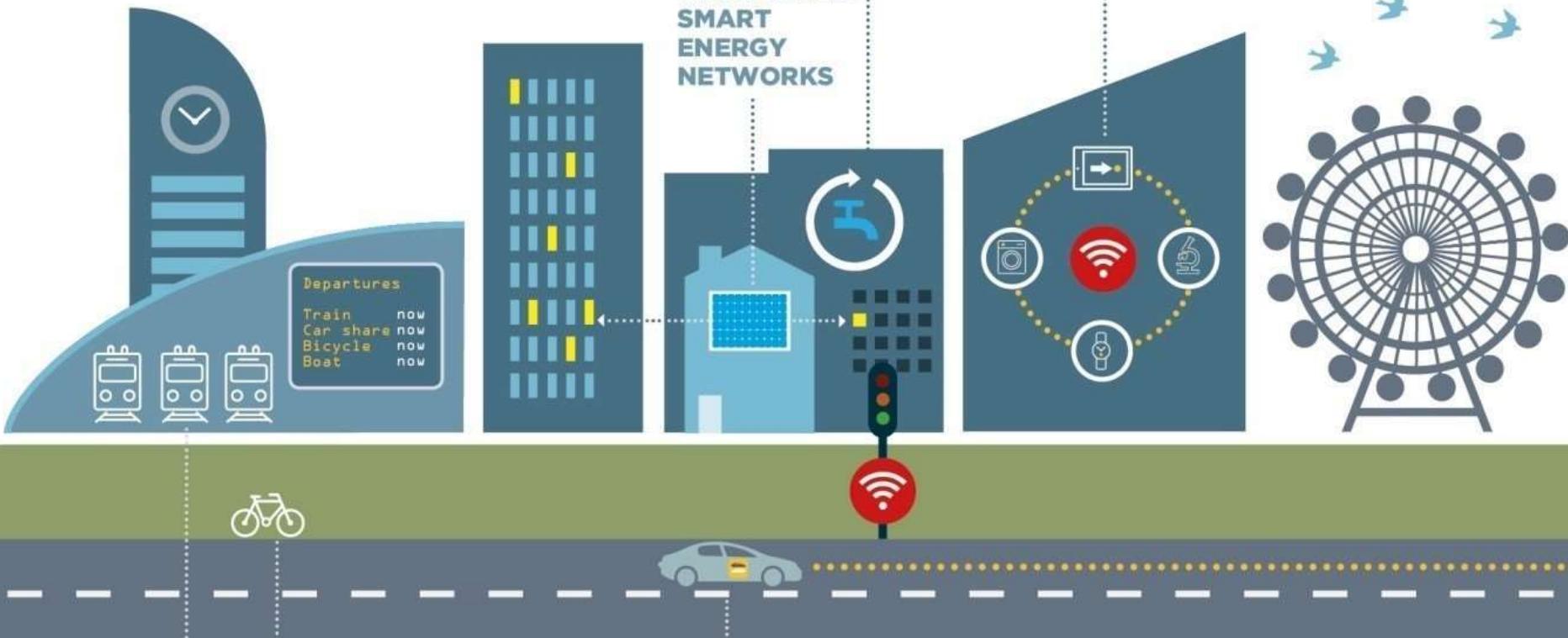
1

...SUSTAINABLE  
DOMESTIC  
WATER USAGE

...LOCALISED  
SMART  
ENERGY  
NETWORKS

...ASSET TRACKING

Precious metals  
'mined' from products  
accumulating in cities,  
and cascaded back into  
different use cycles



(Image source: World Economic Forum)

# Smart Cities: Challenges



## INFRASTRUCTURE AND COSTS

Smart cities use sensor technology to gather and analyse information such as rush hour stats, air quality or crime rates. The implementation of these sensors requires a sophisticated and costly infrastructure.

Source: [solarimpulse.com](http://solarimpulse.com)

# Smart Cities: Challenges



## SECURITY AND PRIVACY CONCERNS

Even though security is part of the benefits, it can also be regarded as a challenge as the use **of IoT and sensor technology increases**. In fact, the threat of cyber attacks is a critical issue for smart cities.

Also, to avoid concerns about data use, smart cities need to involve their citizens. Awareness, education, and transparency on the purpose of data collection are crucial to make the community feel that they are truly taking part in making their city more sustainable.

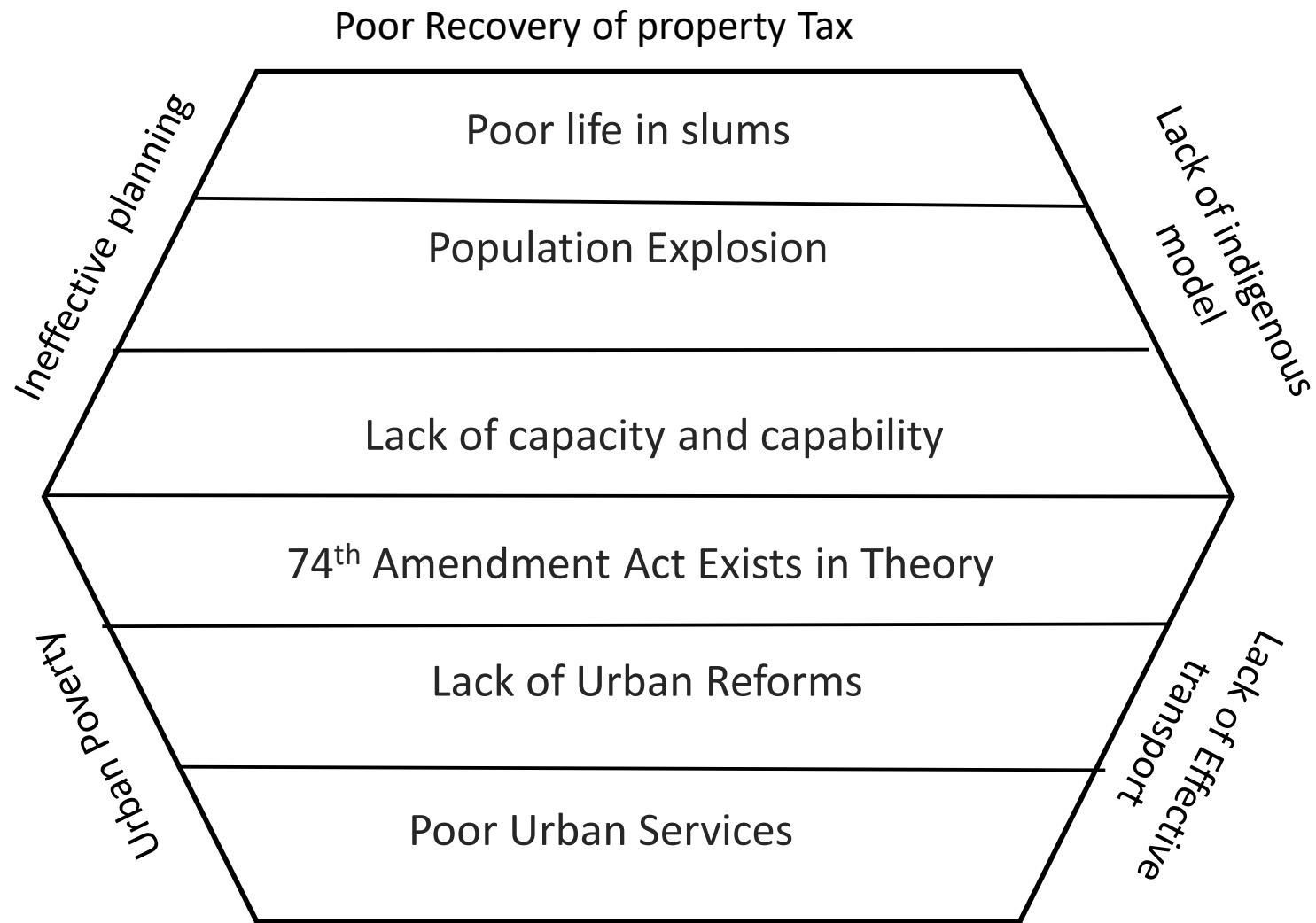
# Smart Cities: Challenges



## SOCIAL RISKS

Inclusive urbanization must be a priority to deal with the increasing vulnerability of poor and slum populations. That is why we need to ensure that no population is excluded from smart city data collection and use.

# Smart Cities Challenges



Source: Making of a smart city Dr S L Goel and Dr Shalini Rajneesh, IAS

## Smart Cities: Challenges and Measures

The concept of smart cities has its challenges, especially in India.

- For instance, the success of such a city depends **on residents, entrepreneurs and visitors** becoming actively involved in **energy saving and implementation of new technologies**.
- There are many ways to make **residential, commercial and public spaces sustainable** by ways of technology, but a high percentage of the total energy use is still in the hands of end users and their behavior.

# Smart Cities: Challenges and Measures

## Key Challenges

- A smart city could take between **8 to 10 years to build from scratch and even more time to attract businesses and people.**
- Such an **initiative requires commitment and persistence on part of the government over a long period of time.**
- The authorities need to be aware of the **latest relevant technologies and the technologies have to be tailor-made and used effectively taking into account the topography, location and natural resources of the area.**

# Smart Cities: Challenges and Measures

## Measures Required

- Setting up of a **central planning authority** that would manage and provide single window clearances, monitor progress of such projects and ensure compliances.
- To **attract businesses to newly developing smart cities**, incentives in the form of long-term tax holidays and other tax sops need to be given.
- In order to develop smart cities at par with global standards, the government needs to involve the private sector as well as global urban planning groups who had implemented the concept of smart city elsewhere in Asia.

## QUIZ 5.2

1) Three important layers of a smart City

a) \_\_\_\_\_ b) \_\_\_\_\_ c) \_\_\_\_\_

2) The theme of National Summit on 100 Smart Cities India 2016

Answer: \_\_\_\_\_

3) Anatomy of a Smart City are

a) \_\_\_\_\_ b) \_\_\_\_\_ c) \_\_\_\_\_ d) \_\_\_\_\_ e) \_\_\_\_\_ f) \_\_\_\_\_

4) The process of analysis of large amounts of data is known as \_\_\_\_\_

5) List any five core infrastructure elements in a smart city

6) List the key features of a smart city

Thank you...

# L6. Evolution of smart cities

## Learning Objective:

To learn about the evolution of smart cities

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# L6. Evolution of smart cities

Presenter

## Learning Objective:

To learn about the evolution of smart cities

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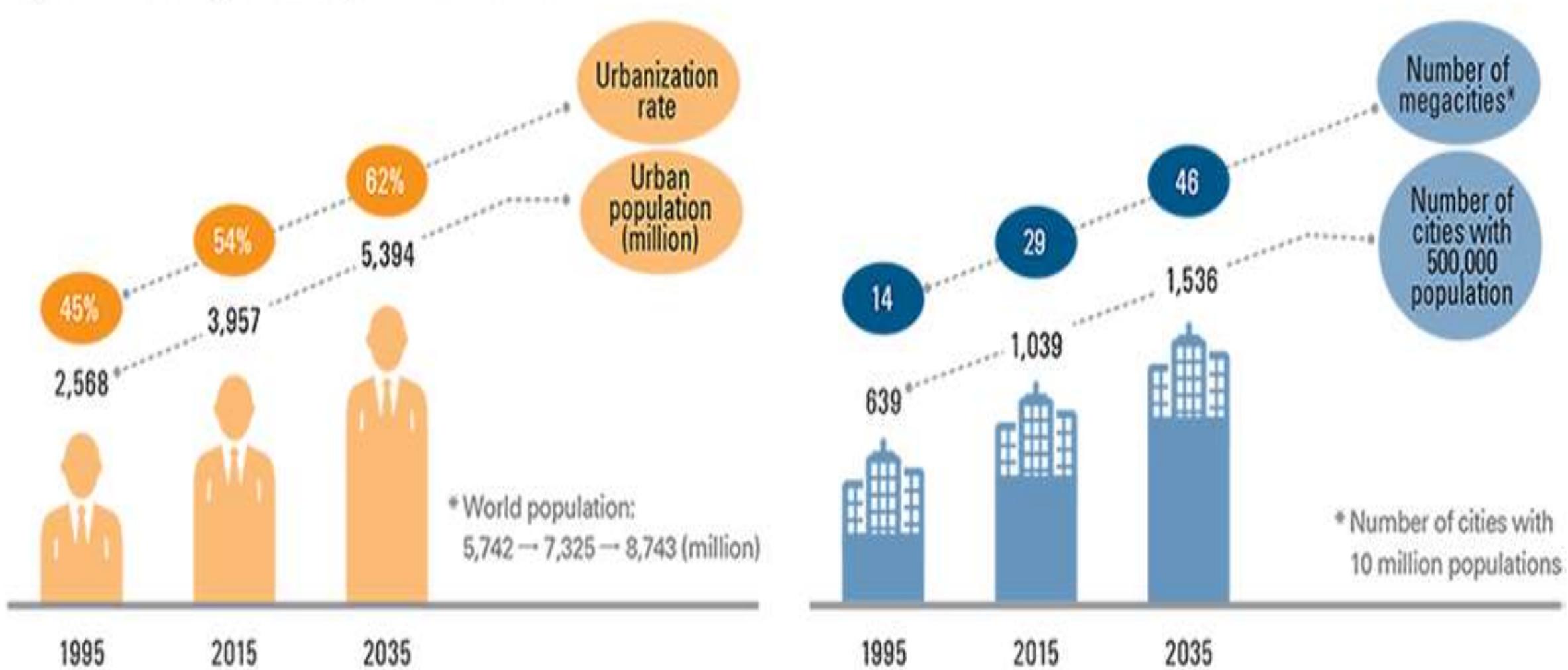
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Approved by AICTE, New Delhi

8.9.2021

## Figure 1. Growing Urban Populations and Cities



Source: UN World Urbanization Prospects, POSRI ('17)

# Evolution of Smart Cities

- The concept of smart cities emerged **in the mid-1990s as the internet and information infrastructure became widespread.**
- **America Online (AOL)** first suggested the concept of a smart city in which services are provided through a network.
- With the advent of the internet, telecommunications companies began offering **new service models** and testing pilot projects.
- The notion was given increasing attention when a series of smart city plans was formulated for megacities, including Amsterdam Digital City in 1993, Helsinki Arena 2000 in 1996, and Tokyo Smart City in 1998.

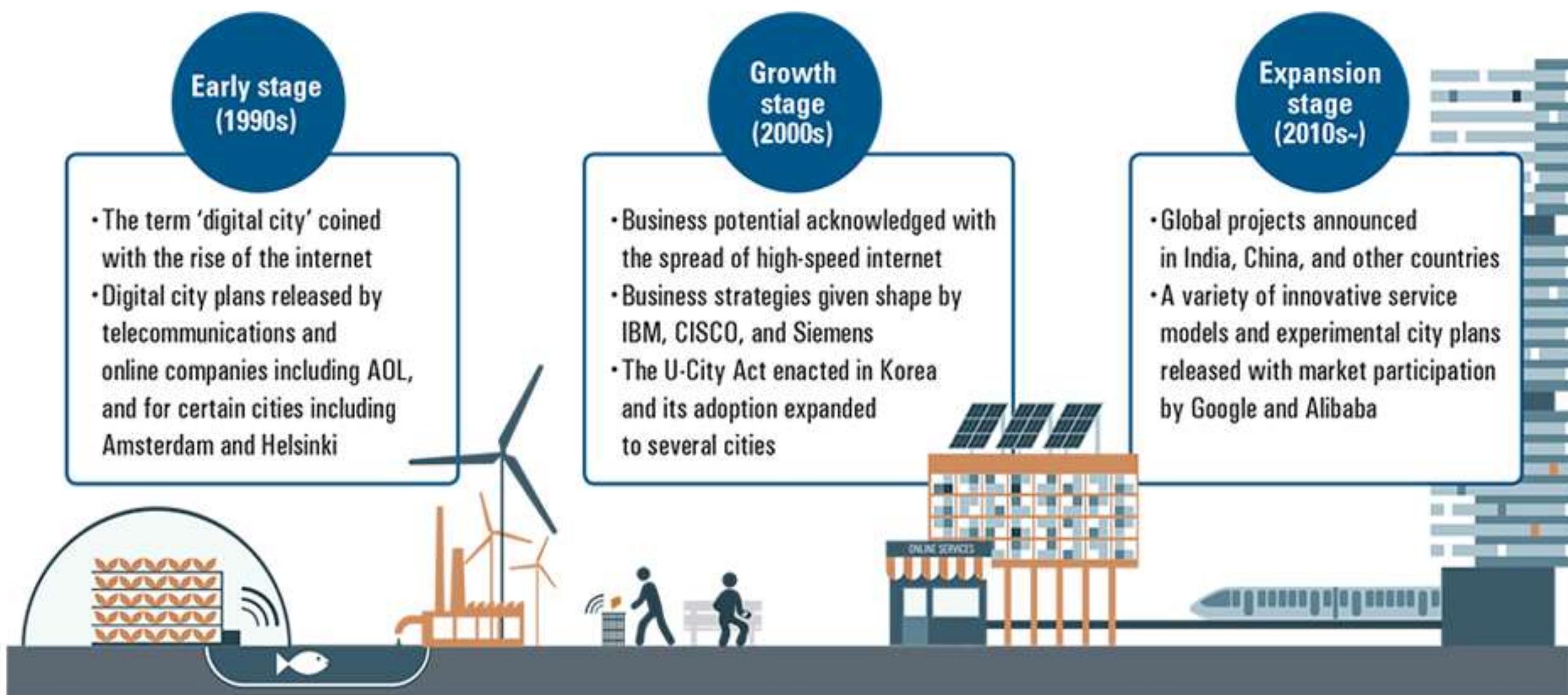
# Evolution of Smart Cities

- Smart cities began to spread during the 2000s when their commercial value was recognized. With the expanding popularity of the internet, various projects were planned in Europe and the US.
- Following the announcement of IBM's Smarter Planet strategy, global companies including Cisco and Siemens actively entered the smart city field, which began to be regarded as an industry.
- In South Korea, the u-City concept was introduced in 2003.
- The Ubiquitous / Global Cities Act was legislated in 2008 and applied to several new cities, including Hwaseong and Dongtan (Dongtan is a township in Hwaseong, South Korea).

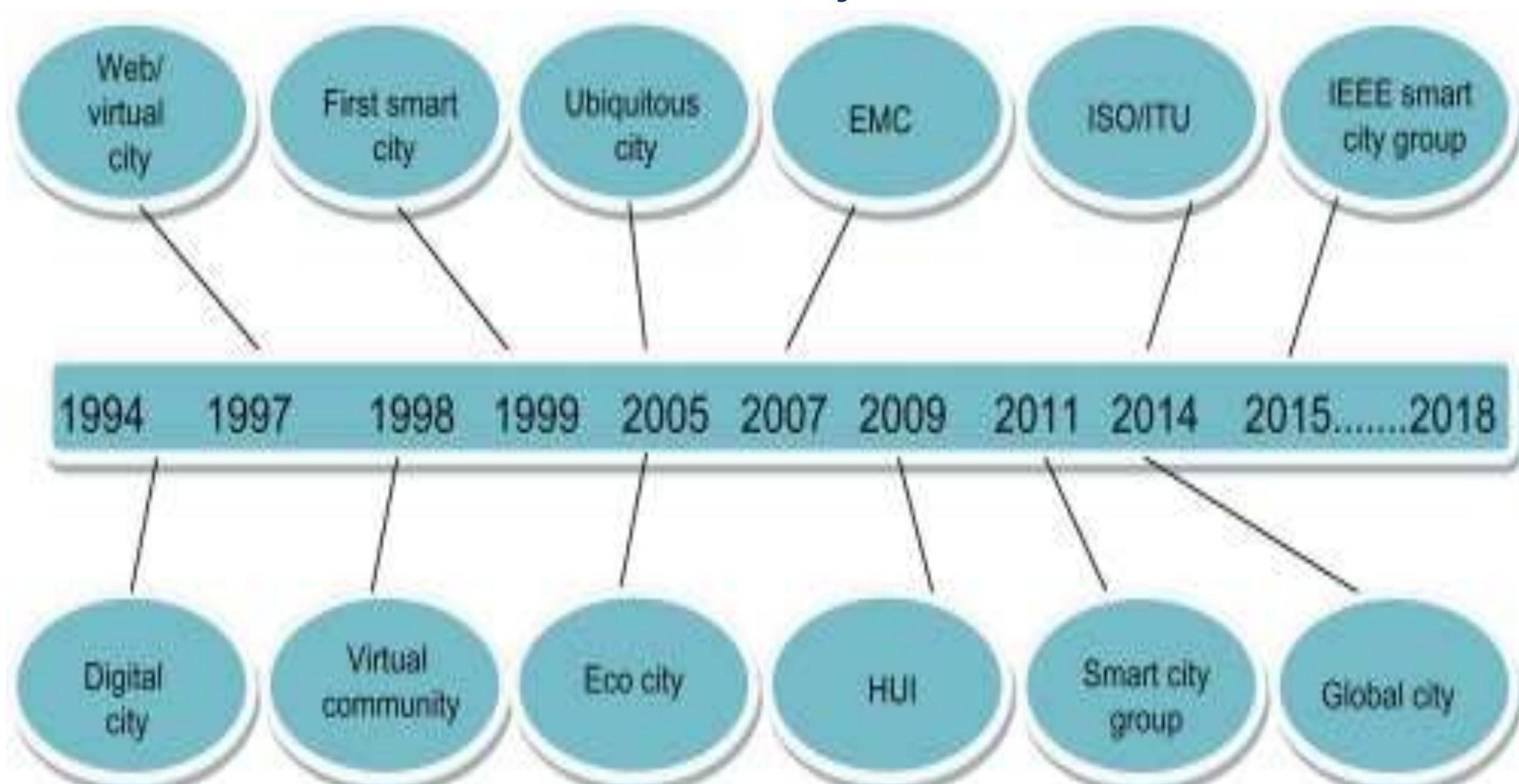
# Evolution of Smart Cities

- After 2010, major Asian cities, including some in China and India, released hundreds of smart city plans and global smart city projects gained momentum.
- With the rise of the Fourth Industrial Revolution and related technologies such as AI, IoT, and big data, bold government policies and corporate innovations are on the rise, exemplified by Google's Sidewalk Labs in Toronto and Alibaba's City Brain model in Hangzhou.

Figure 2. Development Stages of Smart Cities



# Evolution of Smart City - Timeline



# Evolution of Smart Cities

- **Web or Virtual Cities** - This smart city category concerns web environments, which offer local information, online chatting and meeting rooms, and a city's virtual simulation.
- **Knowledge Bases** – A public database with crowd sourcing options for useful local information, which was accessible via the Internet and via text-TV like the Copenhagen Base. The case of Craigmillar –an ex-industrial area capitalized the ICT to structure groups of citizens who shared knowledge and collaborated to deal with unemployment and with other local needs.
- **Broadband City** – Broadband City/Broadband Metropolis, where fiber optic backbones were installed in the city, and enabled the interconnection of households and of local enterprises to ultra-high speed network. Ex: Beijing (China), Antwerp (Belgium), Helsinki, Amsterdam and Geneva

# Evolution of Smart Cities

- **Mobile/Ambient Cities** – Cities which installs wireless broadband networks in the city, accessible (with or without charge) by its inhabitants. Various eservices are offered from local and/or national organizations in the mobile cities. Ex: New York City and Atlanta.
- **Digital City** – It is an ICT based environment whose priorities concern
  - a) the availability of digital means that support local needs and transactions,
  - b) the transformation of the local community to a local information society,
  - c) the direct and indirect, official and unofficial information collection, in order to support the sustainable development of the local community”.
- This approach has been followed by various cities such as Hull (UK), Cape Town (South Africa), Tampere (Finland) and Trikala (Greece).

# Evolution of Smart Cities

- **Ubiquitous / Global City (u-City)** - a result of broadband costs' minimization, commercialization of complex information systems, deployment of cloud services, and ubiquitous computing.
- U-cities are being implemented in South Korea (i.e., in New Songdo)), U.S.A. (Manhattan Harbour, Kentucky), Abu Dhabi (Masdar city) and Japan (Osaka) and deliver information anytime, from anywhere to anybody, via ubiquitous ICT over the cities.
- However, this approach is accompanied with the construction of new urban spaces where the pervasive computing will be included from the scratch in buildings

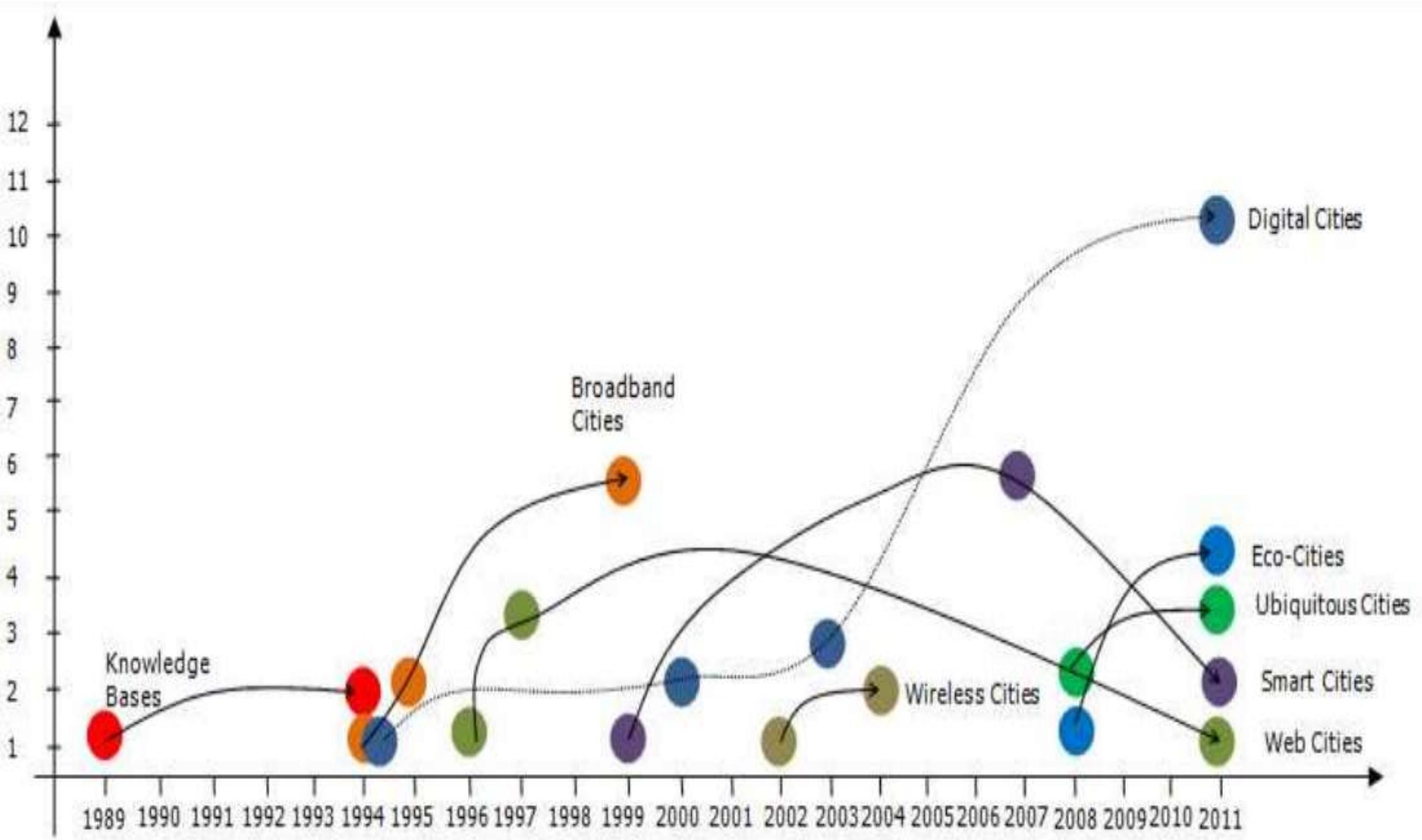
# Evolution of Smart Cities

- **Eco-cities** – This approach capitalizes the ICT for sustainable growth and for ecological protection. These cases install ICT sensors for environmental measurement and for buildings' energy capacity's evaluation; smart grids produce energy for inhabitants' consumption; encourage smart solutions for renewable energy production.

This approach has been followed by various cities (i.e., New Songdo and Dongtan (South Korea), Tianjin (Singapore) and Masdar (Abu Dhabi) and they are being followed by others (i.e., Amsterdam).

# Evolution of Smart Cities

- **Smart cities group** – various cities joined networks of common interests to provide with intelligence their urban spaces or to structure virtual teams of collaborative people.
- The Eurocities network (<http://www.eurocities.org>),
- the Intelligent Communities ([www.intelligentcommunity.org](http://www.intelligentcommunity.org)),
- the World Foundation of Smart Communities (<http://www.smartcommunities.org>) and
- the Community Networks (e.g. the Seattle Community Network (<http://www.scn.org>) are such representative cases.



# Evolution of Smart Cities

- The smart city evolved into a digital city in 1994 in Amsterdam.
- In 1997, it was claimed that there were 2000 virtual urban areas in the world.
- These virtual urban areas were treated as electronic and web-based representations of the real urban areas, and were housed with the help of the world wide web (WWW).
- Virtual cities were treated as the first effort to make use of the Internet to support native democracy, and allowed urban promotion, Internet-based municipal operation, and social development within cities. However, a deficiency of citizen feedback was documented.
- After the introduction of the virtual city, the virtual community came into existence in 1998. The virtual community enables communication between individuals through shared norms.

# Evolution of Smart Cities

- The virtual and digital cities intended to form communities using ICT to socialize residents, to digitalize local government policy, and to make use of virtual space to remove the barrier of public space.
- By this perspective, the Internet, in collaboration with the city system and the WWW, was used to build up city websites that present substitute smart services, including information rescue, and official and general communication.
- These two smart city approaches pretend the metropolitan spaces are either a connected communities, or two/three dimensional virtual spaces.
- The digital city model became identical to an information city, which was understood as a metropolitan location where the ICT is the key driver to deliver innovative online services.

# Evolution of Smart Cities

- The idea of an information city later evolved into the ubiquitous city, where data is available through implanted urban communications.
- The intelligent city focuses on the city performance, which depends on innovation in the following areas (i) intelligence, creativity, and originality; (ii) communal intelligence; and (iii) artificial intelligence.

# Where are Smart City trends going?



Global smart city revenue is expected to grow from \$36.8 billion in 2016 to \$88.7 billion by 2025.

Source: Navigant Research 2016

The research consultancy MarketandMarkets estimates the smart cities component of the Internet of Things market will grow to \$147.5 billion worldwide by 2020

The consultancy McKinsey and Company takes a similar approach, projecting the smart cities component of the IoT market will range between \$930 billion on the low end of the forecast to \$1.7 trillion on the high end by 2025.

Source: Building Smarter Cities by CompTIA

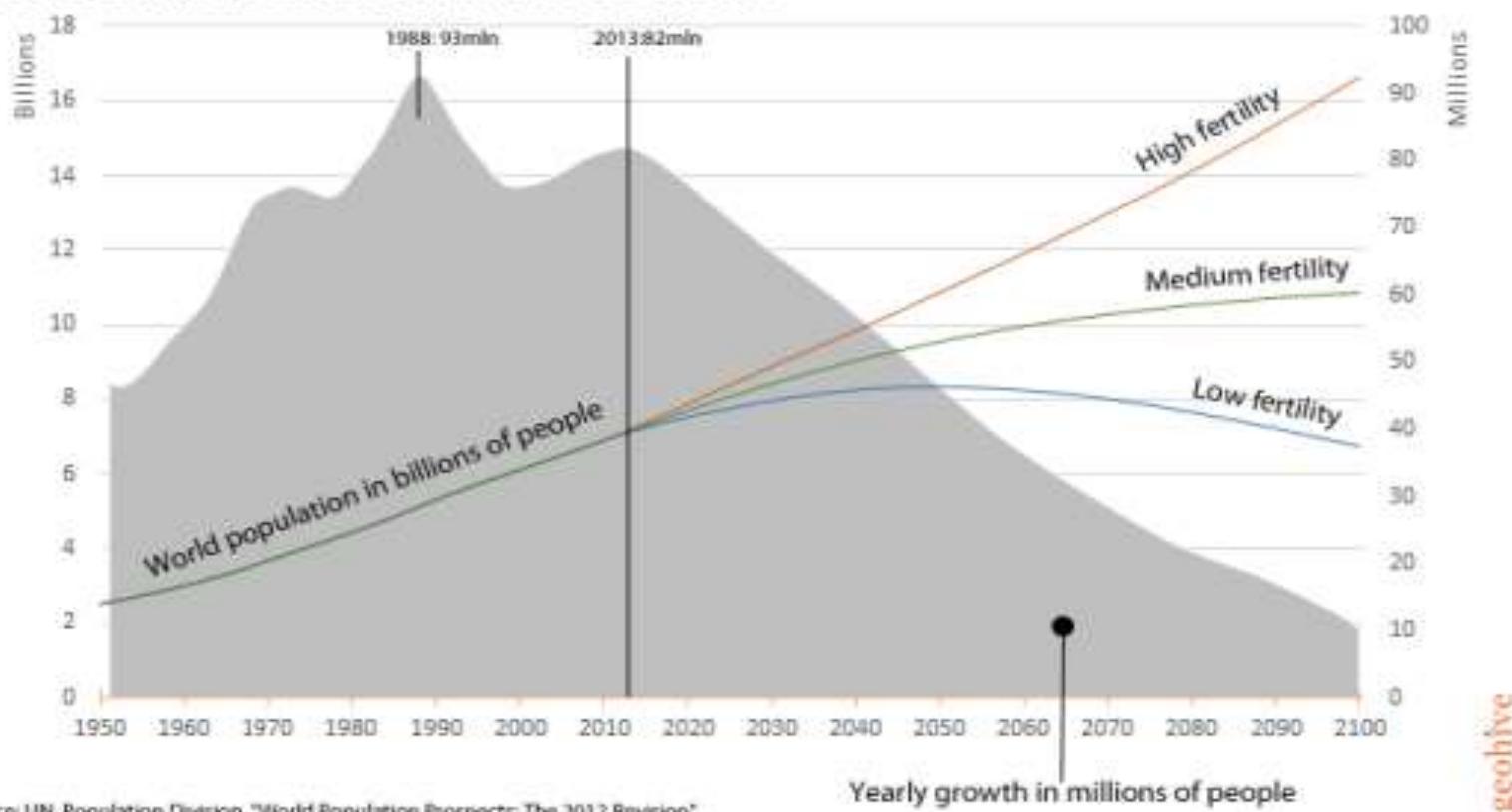


# Trends leading to Smart Cities



Image Source: <https://ijroth.files.wordpress.com>

## POPULATION GROWTH PROJECTIONS



source: UN, Population Division, "World Population Prospects: The 2012 Revision".

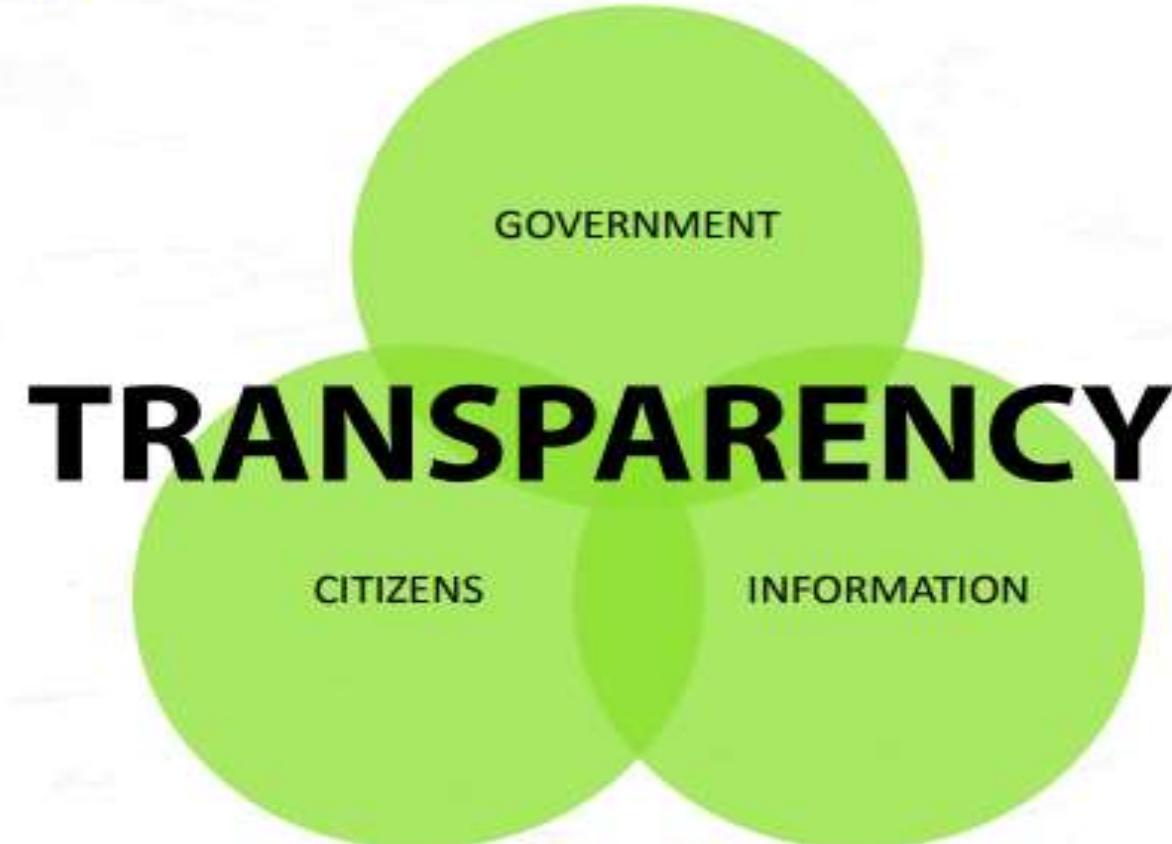
Image Source: <http://www.geohive.com/img/pic2.png>

Source: American Planning Association (APA) APA Texas Chapter State Conference & Short Course for Planning Officials San Antonio, Texas



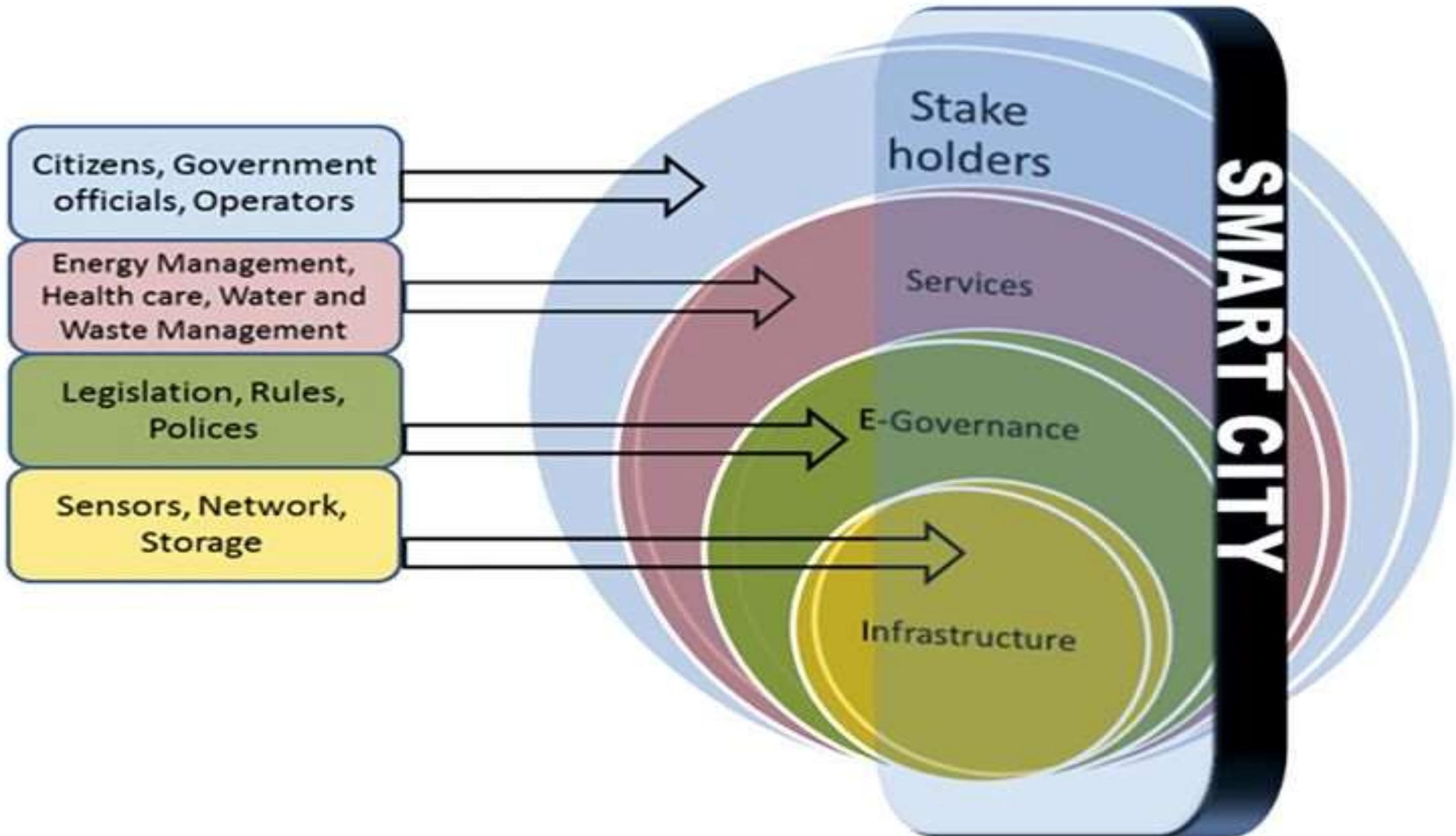
# Trends leading to Smart Cities

## POLITICAL TRENDS



Source: American Planning Association (APA) APA Texas Chapter State Conference & Short Course for Planning Officials San Antonio, Texas





Source: <https://www.thesmartcityjournal.com/en/articles/smart-cities-futuristic-vision>

## **Quiz 6.1**

**1. Name Four U-cities are being implemented in which countries**

i)

ii)

iii)

iv)

**2. \_\_\_\_\_ Online first suggested the concept of a smart city in which services are provided through a network.**

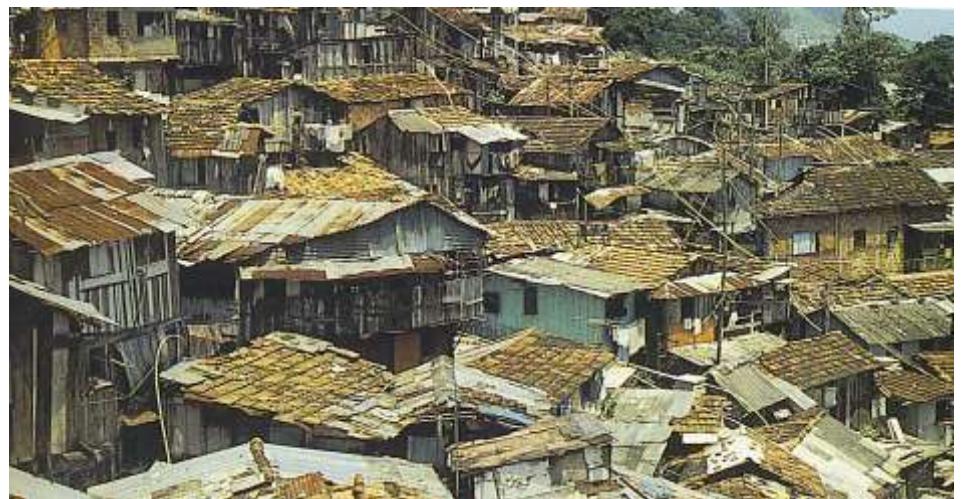
**3. Which Country introduced the u-City concept in 2003.**

**4. \_\_\_\_\_ is an ICT based environment**

**5. Name any two cities which are having ultra-high speed network system**

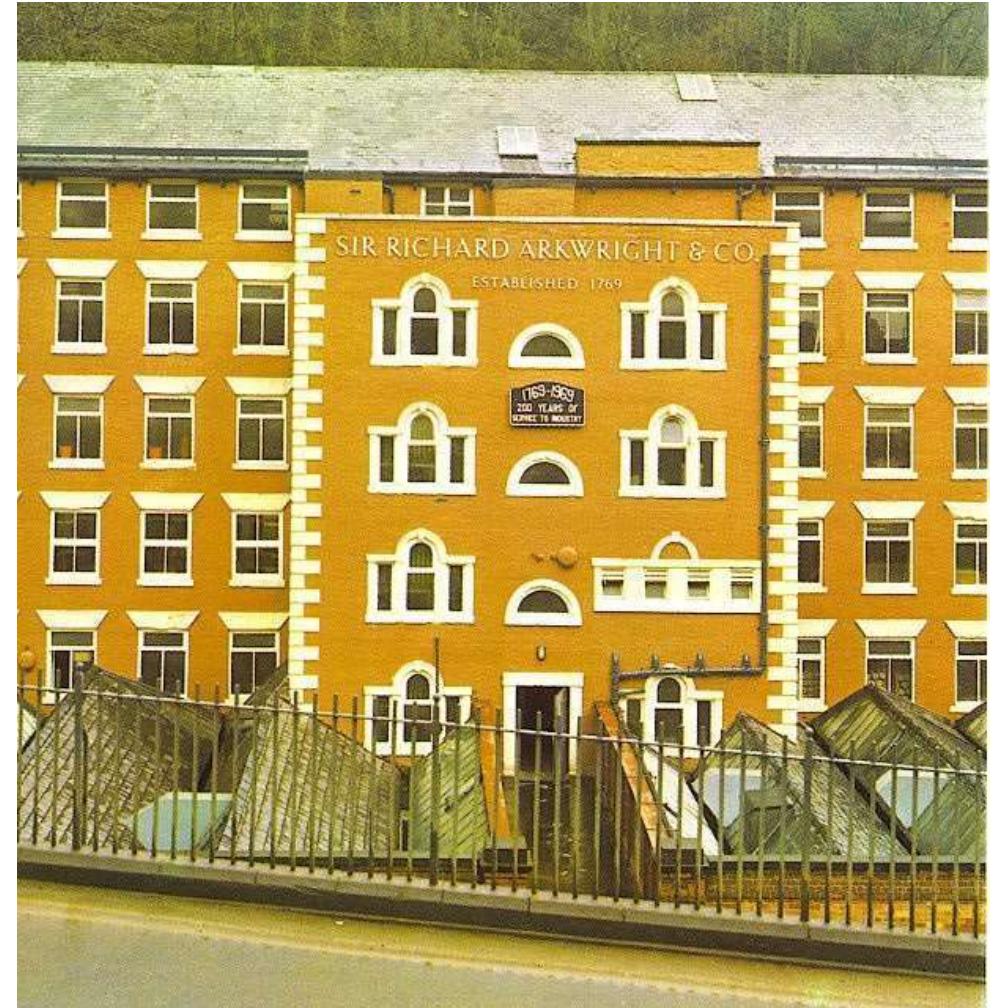
# 21st Century - the Urban Century

- 1900 only 13 cities had 1 million people
- 1999 about 362 cities had 1 million
- By 2025 there will be 650 cities of 1 million population or more
- Sometime in 21<sup>st</sup> cent. The world will become mostly urban
- Western Europe, US & Canada are 80% urban



# Urbanization and Location

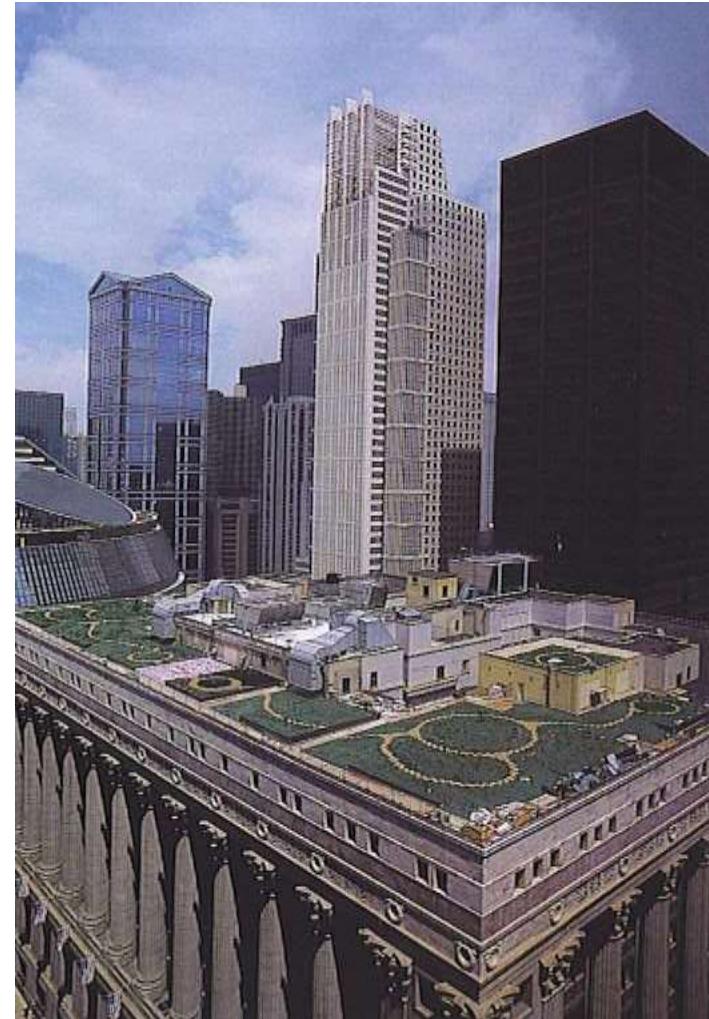
- World today is 50% urban
  - **Agglomeration-** clustering of industries for mutual benefit
  - **Specialization-**certain industries dominate



- **Hinterland:** the surrounding service area of a city that includes smaller villages and hamlets
- **Centrality:** the economic power
- **Hamlet** - small collection of houses-may have services.
- **Village** - several dozen services-stores, gas stations and so forth
- **Town** - larger than a village- higher level of specialization-banks, schools, libraries, specialized stores-furniture, appliances, hardware, etc.
- **City** - more functional specialization - larger hinterland, greater centrality, well defined CBD and suburbs
- **Metropolis or Metropolitan area** - urban area larger than a city

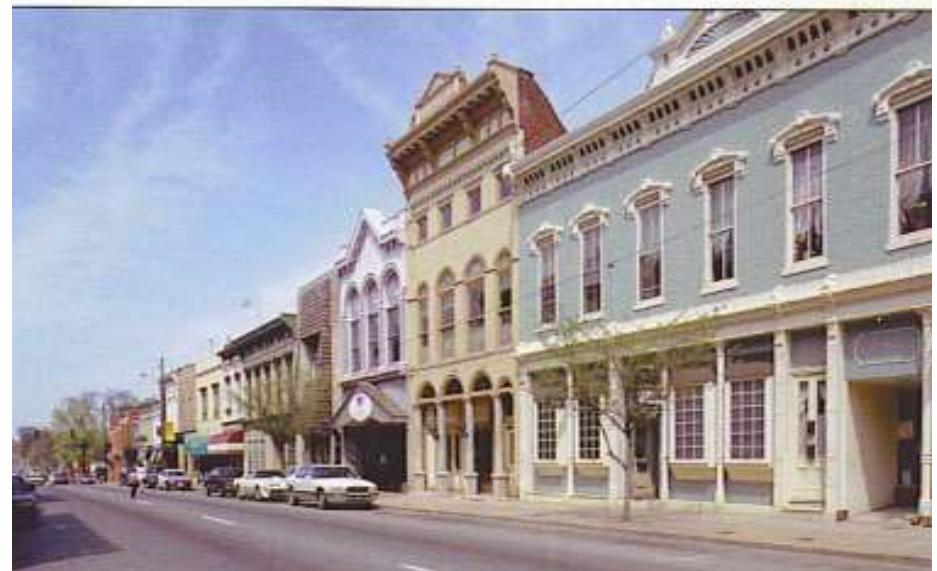
# Urban Definitions

- **Central City** - main city around which suburbs have grown
- **Urbanized area** - continuously built up area with buildings & population density with no reference to political boundaries
- **Metropolitan area** - a large scale functional entity containing several urbanized areas
- **Urban Morphology** - The layout of a city, its physical form and structure.



# Urban Definitions

- **Urban**-The buildup of the central city and the suburban realm – the city and the surrounding environs connected to the city (*a general term for towns, cities and suburban areas*)
- **City**- a conglomeration of people and buildings clustered together to serve as a center of politics, culture, and economics (*nucleated settlement with many functions and a central business district*)



- **Urban Planners look at:**
  - How cities are arranged
  - What cities look like
  - Transport & communications
  - Why people move from place to place within the city

# Attributes of Cities

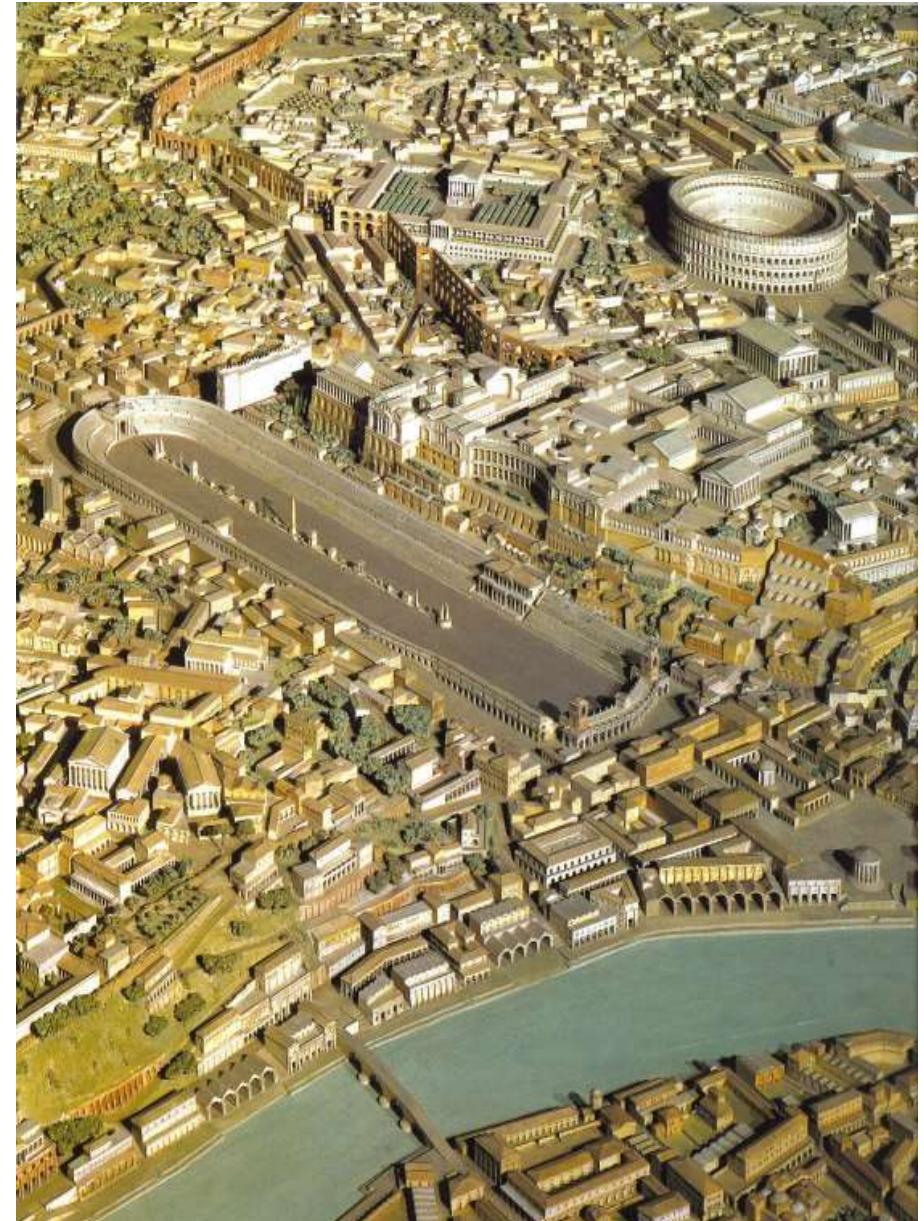
- Centers of political power
- Centers of industrial power
- Centers of technology
- A market place for goods
- Specialization in products and services
- Cultural and Artistic pursuits
- Centers of education and research
- Entertainment of all types
- Sports teams, arenas and parks
- Medical advances

# Function and Location

- Earliest civilizations probably developed with the need for organizations to create irrigation and provide enough food.
- **Availability of water, good farmland and defensible sites** helped certain towns thrive.
- **Positions on travel & trade routes** created urban growth.
- Urban elites or decision makers evolved.

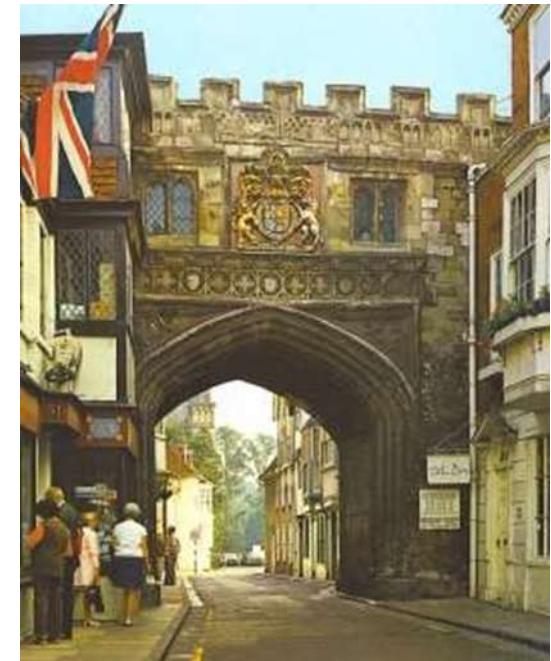
# Roman Urban System

- The Romans created the largest urban system with an excellent transportation system
- The Romans were masters of engineering efficiency creating aqueducts, sewers, roads, bridges and great public



# Pre industrial Europe

- Paris, Amsterdam, Antwerp, Lisbon, Naples and Venice revived and grew.
- By mid-15<sup>th</sup> cent. London had 80,000 and Paris had 120,000 population. By 19<sup>th</sup> cent. London was 1 million while Paris had only 670,000



# Urban Environments

By 17<sup>th</sup> cent.

Europe's cities were:

- Slum ridden
- Unsanitary
- Fire traps
- Plagued by frequent epidemics
- Crime ridden
- Places of social dislocation

# The Modern Western City

- **Medieval city** was bleak and grimy with narrow dangerous streets.
- Unpaved streets provided poor sanitation.
- The tallest buildings were the Church & Castle.
- **Mercantile cities** of the 16<sup>th</sup> and 17<sup>th</sup> cent. were nodes of regional, national and international trade.
- Great cities like London



# The Second Urban Revolution

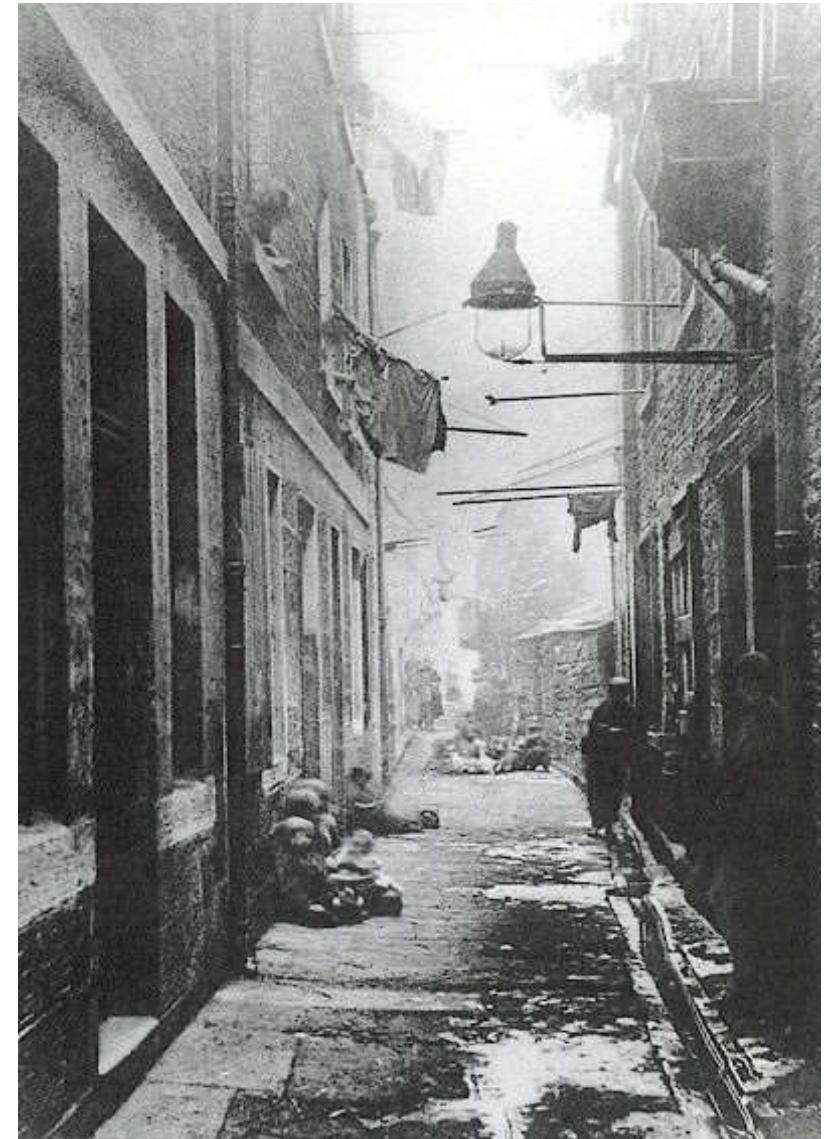
A large scale movement of people to cities  
to work in manufacturing, made possible  
by:

1. second agricultural revolution that improved food production and created a larger surplus
2. industrialization, which encouraged growth of cities near to it.



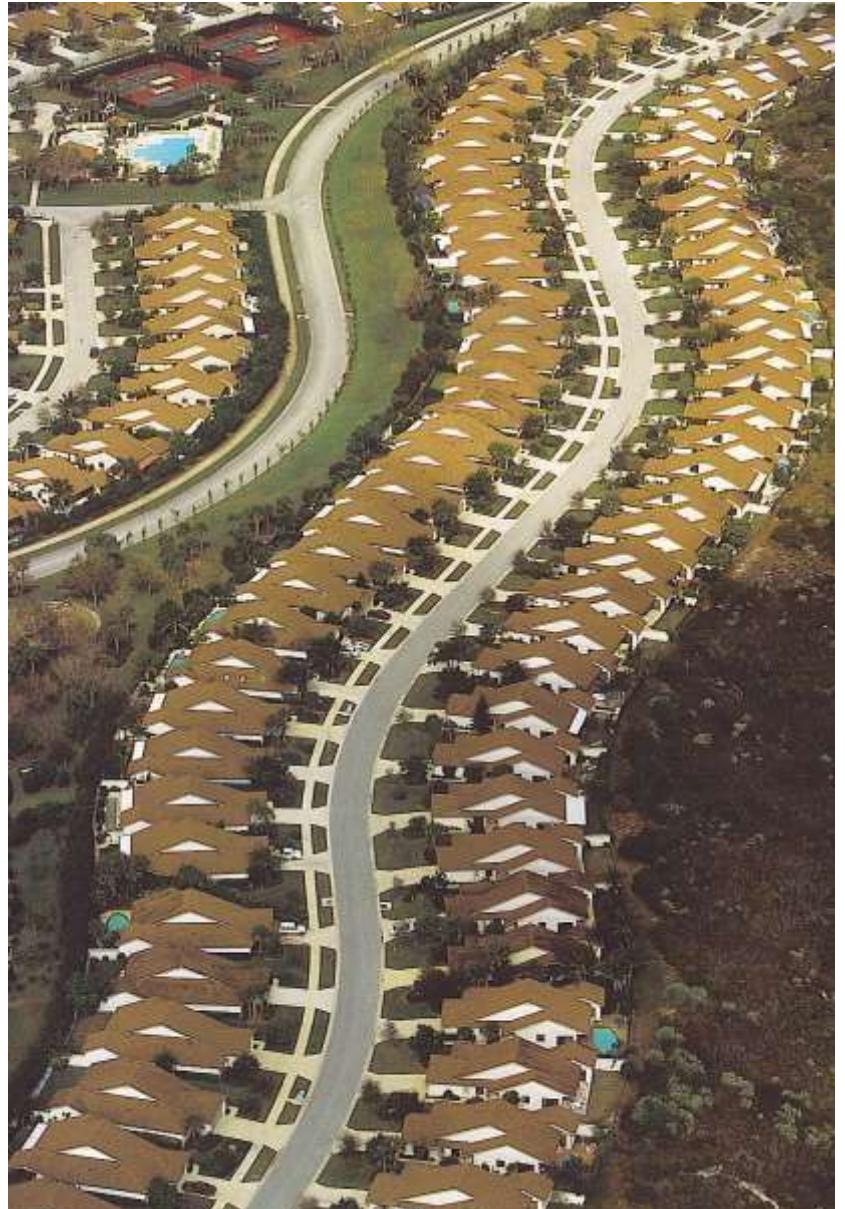
# The Modern Western City

- **Manufacturing city** first developed in Britain, later Western Europe and North America.
- Rapidly growing factory system with railroads and tenement slums.
- Sanitary systems, water supplies and housing were overwhelmed with.



# The Modern Western City

- Modernization of American cities took place in late 19<sup>th</sup> cent.
- Electric trolley and other forms of mass transportation transformed cities-transport systems became circumferential and radial.
- Suburbanization of the city became possible with 1920s revolution of the automobile.
- Modern cities of North America are sprawling



# Modern Urbanization

Highest level of Urbanization-Western Europe, North America, Japan & Australia 70% & higher-Mexico, Cuba, France

**Former Soviet Union**-Russia-73%, Ukraine-70%, Transcaucasus-55%, Central Asia-28%

**South America**-cone of Argentina, Chile & Uruguay- highest urbanization-next Brazil & Venezuela, Paraguay, Bolivia, Guyana, Suriname & French Guiana lag behind.

**Sub-Saharan Africa**-some of the world's lowest urbanization rates-Nigeria-16%, Ethiopia, Rwanda, Burundi & Uganda are even lower. Tropical Africa- only a few nations that are 40% or higher-South

## **Southwest Asia-North Africa-great variety of urbanization.**

Much of Middle East, esp. Arabian Peninsula are highly urbanized due to **nucleation** of the oil industry.

Jordan an exception-no oil wealth-but urban due to long tradition

Southern Arabia is oil poor and rural

Contrast-oil rich Libya is urban, oil poor Afghanistan is rural

## Quiz 6.1

1. List Four Attributes of Cities

i)

ii)

iii)

iv)

2. Nucleated settlement with many functions and a central business district is

called as -----

3. The layout of a city, its physical form and structure is known as -----

4. The main city around which suburbs have grown is known as -----

**South Asia**-low in urbanization, despite huge cities like Mumbai and Kolkata

Most nations in South Asia are under 30% urban India-26% Pakistan-28%

Bangladesh-16% Subsistence farming dominates life here.

**Southeast Asia**- Singapore is the only 100% urban state.

Brunei and Malaysia are the only other nations with over 50% urban

Indonesia- 31%

Myanmar-25%

Vietnam- 20%

Thailand-19%

Subsistence farming  
dominates life here



**East Asia- Averages 36%**

Only Japan, South Korea and Taiwan are highly urbanized in East Asia

China below-25%

Yet Shanghai & Beijing Have 25 million between them, however most of China's 1.2 m. are rural

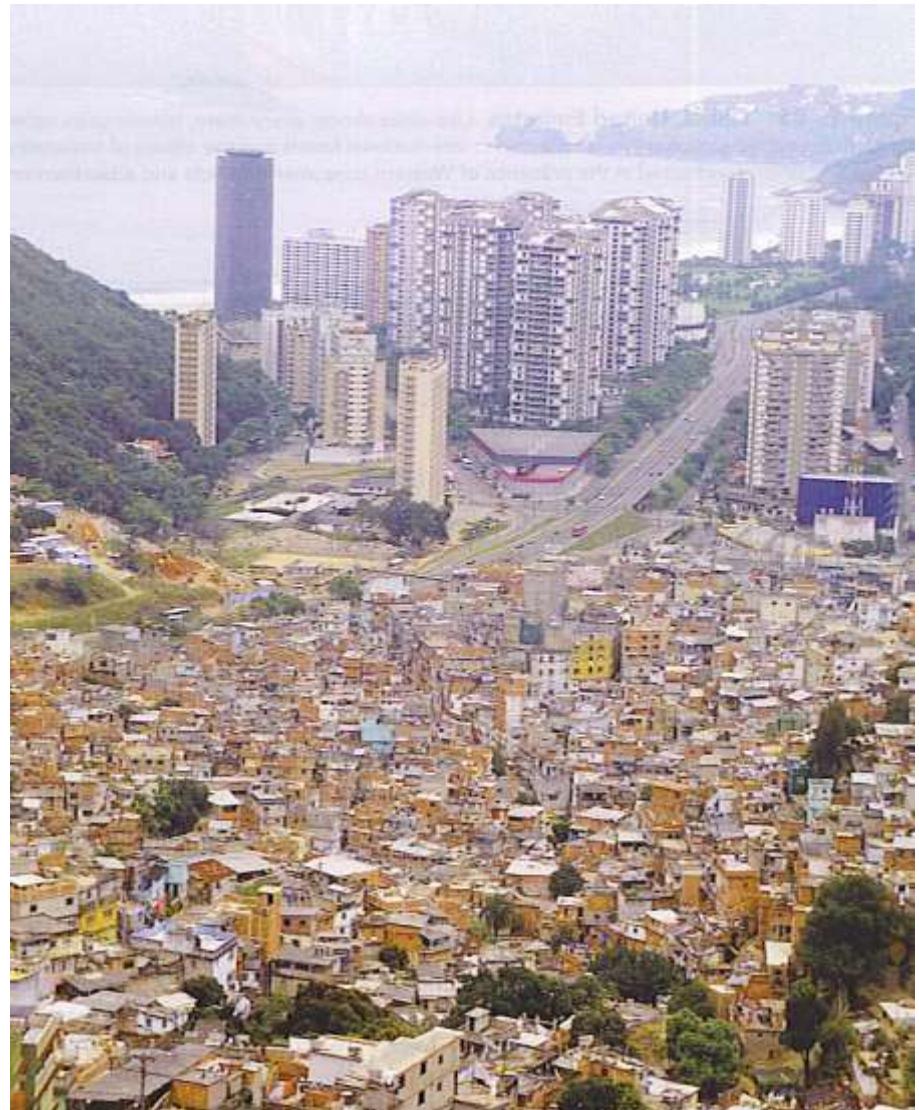
# Great Cities

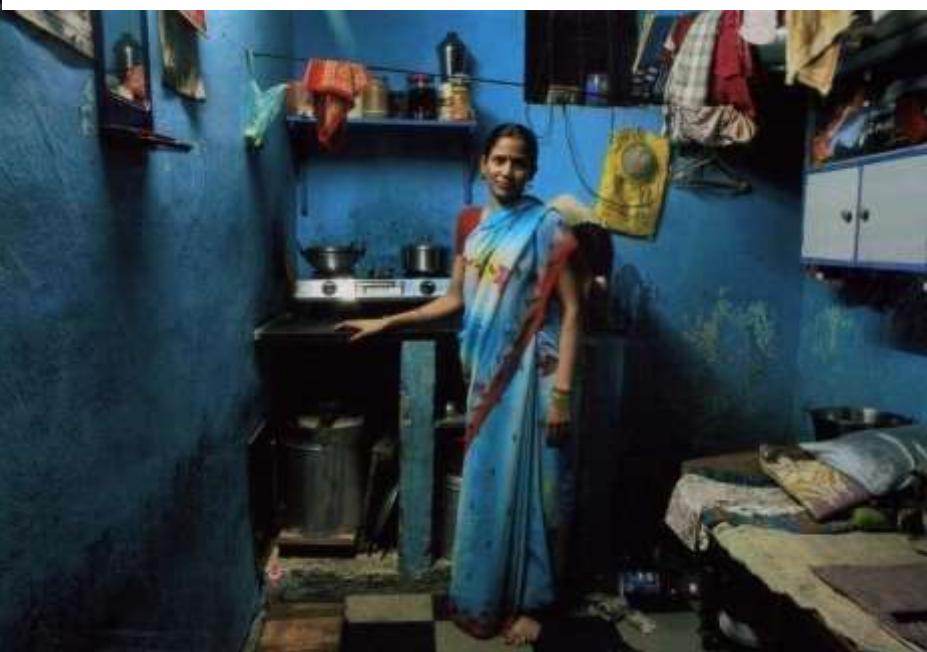
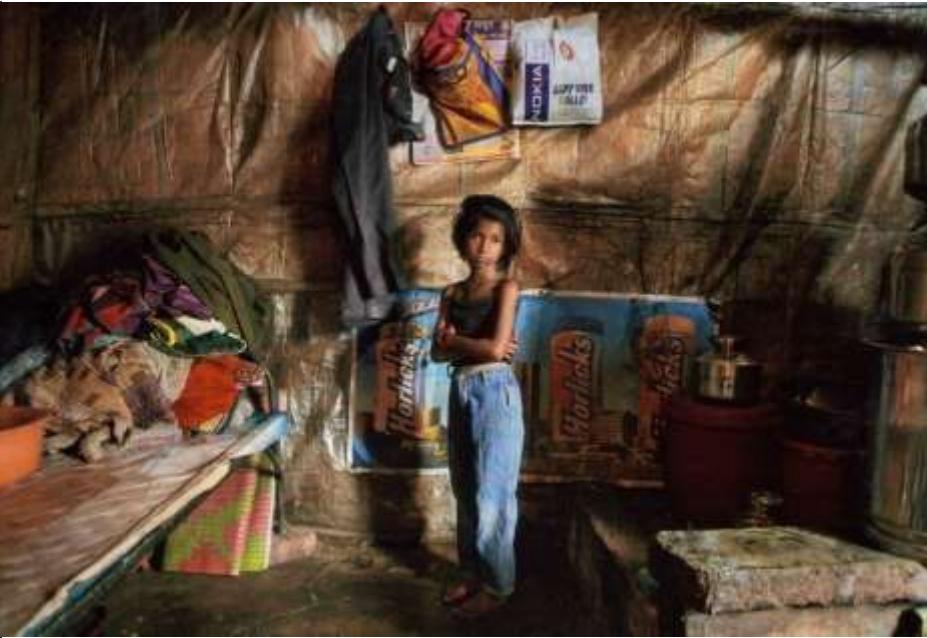
- **North America**-several megalopolitan regions: Boston -Washington, DC
  - Chicago-Detroit-Pittsburgh
  - San Francisco-Los Angeles-San Diego
  - Montreal-Toronto-Windsor
  - Miami-Fort Lauderdale-West Palm Beach
- **Europe:**
  - London-20 m. in Metro area
  - Germany-Ruhr, Rhine zone of Dusseldorf-Essen & Cologne
  - Poland-Saxony & Silesia

- **Asia-Tokyo-Yokohama, Osaka-Kobe-Kyoto**
- **Mega Cities:**
- UN says by 2025 at least 15 cities will be over 20 million
  - Many of the world's most populous cities are found in the poorest nations- Mexico City, Shanghai, Calcutta, Mumbai & Cairo
  - Close are Bangkok, Indonesia; Lima-Callao, Peru; Saigon-Cholon, Vietnam
  - Mexico City, Sao Paulo and Shanghai will have over 30 million by 2025

# Urban Problems

- **Zoning laws** are lacking in many poor countries
- Squatters occupy any open space on the outskirts of the city
- Sharp contrast between fancy hotels of downtown and slums on outskirts





# Urban Function

- Every city or town has an economic base.
- **Basic sector**-workers who produce goods for export or local consumption
- **Non Basic sector or Service sector**-workers who maintain the city, work in offices and provide services for others
- The number of Non basic sector workers is always greater than Basic sector workers-as cities increase in size the ratio increases
- Most large cities have a ratio of 1 to 2
- **Multiplier Effect**-if a business adds 50 manufacturing jobs-another 100 non-basic

# Problems in Urbanization

- 200 years ago only 5% of world was urbanized,
- Today about 50% is urban
- Germany, Spain & Belgium are over 90% urban
- World wide urban problems are:
  - pollution
  - poor sanitation
  - drugs and crime
  - congestion and noise
  - substandard housing & slums

# New Urbanism

- Development, urban revitalization, and suburban reforms that create walkable neighborhoods with a diversity of housing and jobs.
- some are concerned over privatization of public spaces
  - some are concerned that they do nothing to break down the social conditions that create social ills of the cities
  - some believe they work against urban

# L7. Dimensions of Smart City Development

## Learning Objective:

To understand the importance of dimensions of smart city development.

To acquire knowledge on Smart city capability Frame work model for development of smart cities

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Assistant Professor, Civil Engineering**

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# L7. Dimensions of Smart City Development

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To understand the importance of dimensions of smart city development.

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**Presenter**

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Approved by AICTE, New Delhi

9.9.2021

## **Dimensions of smart city development**

More than half the world's population already occupies urban spaces mainly due to the many opportunities.

Cities are estimated to support more than **40% of India's population and more than 75% of the national GDP by 2030.**

Smart city development is required to manage **environmental impact, urban resilience and financing** due to increasing urbanisation.

Different **dimensions of smart city** will help to develop the smart city in right direction.

Six key dimensions that are critical elements in developing an effective Smart City process: **vision, organization, economy, society, technology and communication;**

# The Biggest Economies in the World

Countries with the biggest GDPs (in trillion U.S. dollars) and their growth outlooks

■ 2019 GDP ● Projected 2020 GDP growth

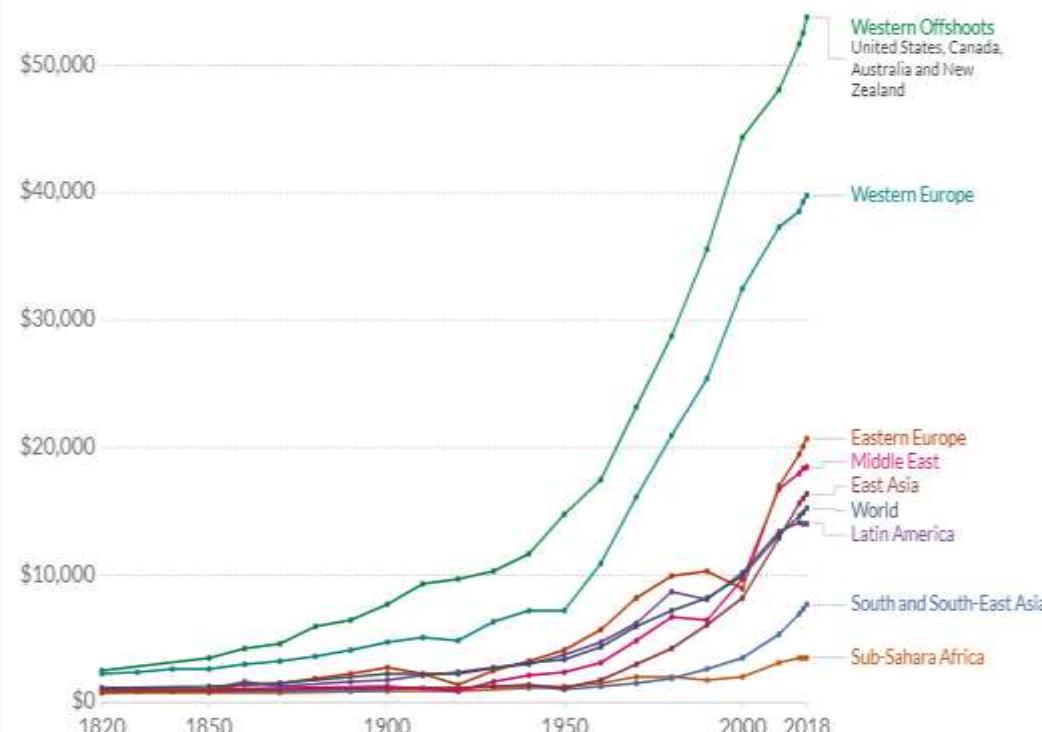


At constant 2017 prices, purchasing power parity/real GDP growth  
Sources: IMF and World Bank

**GDP** - "Gross Domestic Product" and represents the total monetary value of all final goods and services produced (and sold on the market) within a country during a period of time (typically 1 year).

## GDP per capita, 1820 to 2018

GDP per capita adjusted for price changes over time (inflation) and price differences between countries - it is measured in International-\$ in 2011 prices.



Source: Maddison Project Database 2020 (Bolt and van Zanden (2020))

[OurWorldInData.org/economic-growth](https://OurWorldInData.org/economic-growth) • CC BY



# Why Creating Resilient Cities ?

- The increasing urban population creates significant challenges for the city, such as **urbanization, climate change, terrorism, and the increased risk of natural disasters.**
- Cities must learn to adapt in dealing with these challenges and to develop **its resilience in facing the problems of this era of unpredictability and uncertainty.**
- The concept of resilience is a means to deal with these challenges.
- Technological infrastructure will help to respond to above challenges with some innovative solutions.
- A smart City is to be *resilient at any time*, so the concept of resilience is one of the key factors in smart city planning.

Source: Y Arafah et al 2018 IOP Conf. Ser.: Earth Environ

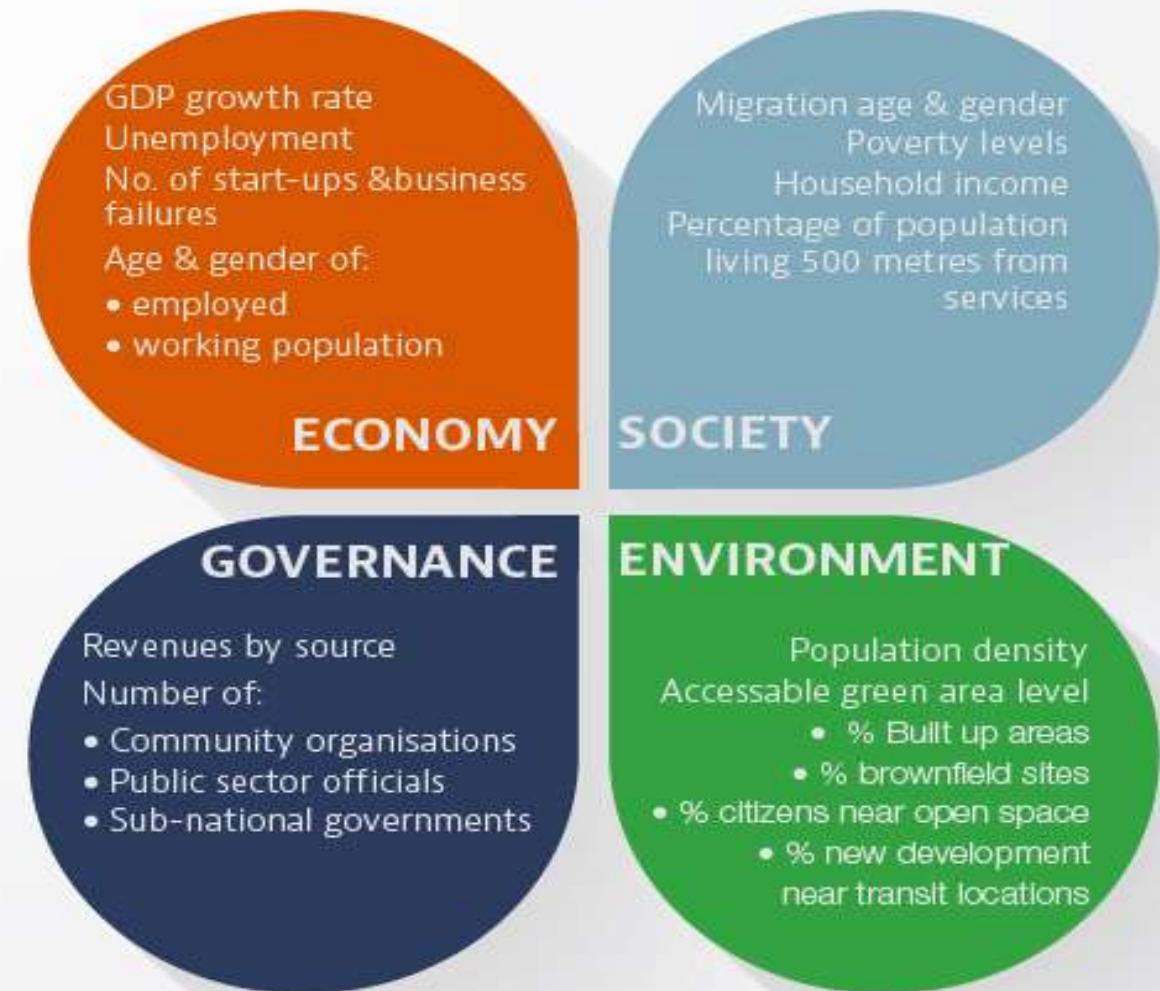


**Resilient cities** are cities that have the ability to absorb, recover and prepare for future shocks (economic, environmental, social & institutional). Resilient cities promote sustainable development, well-being and inclusive growth.

# Urban Resilience

- Urban resilience is the capacity of **individuals, communities, institutions, businesses, and systems** within a city to survive, adapt, and grow no matter what kinds of chronic stresses and acute shocks they experience.  
**(Turnbull et al., 2013)**
- **Chronic stresses** are all type of stresses which weaken the fabric of a city on a day-to-day or cyclical basis.
- Examples -*high unemployment, inefficient public transportation systems, endemic violence, and chronic food and water shortages.*
- **Acute shocks** are sudden, sharp events that threaten a city.
- Examples- *earthquakes, floods, disease outbreaks, and terrorist attacks.*

# Measuring city resilience

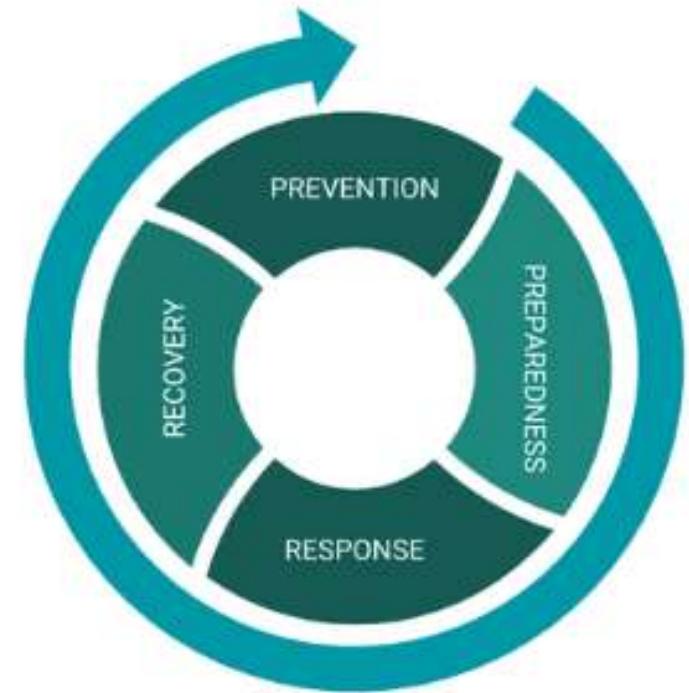


Source: oecd.org

# Smart city with resilience

*Smart city concept based on a resilience approach should comprise some of the following factors:*

- the city's capacity in dealing in dealing with **pressure, shocks and natural hazards**
- to survive, adapt, have determination, and able to transform
- the process of facing changes in the era of uncertainty
- the role of **Information Communication Technology** utilization
- to create a high quality of life as well as improve environmental quality towards sustainability



# Smart city with resilience

## IS YOUR SMART CITY A RESILIENT CITY?

Adding environmental and natural hazard risk data into the smart city mix would add some much-needed context and reality to this brave new technical world.

OASIS HUB

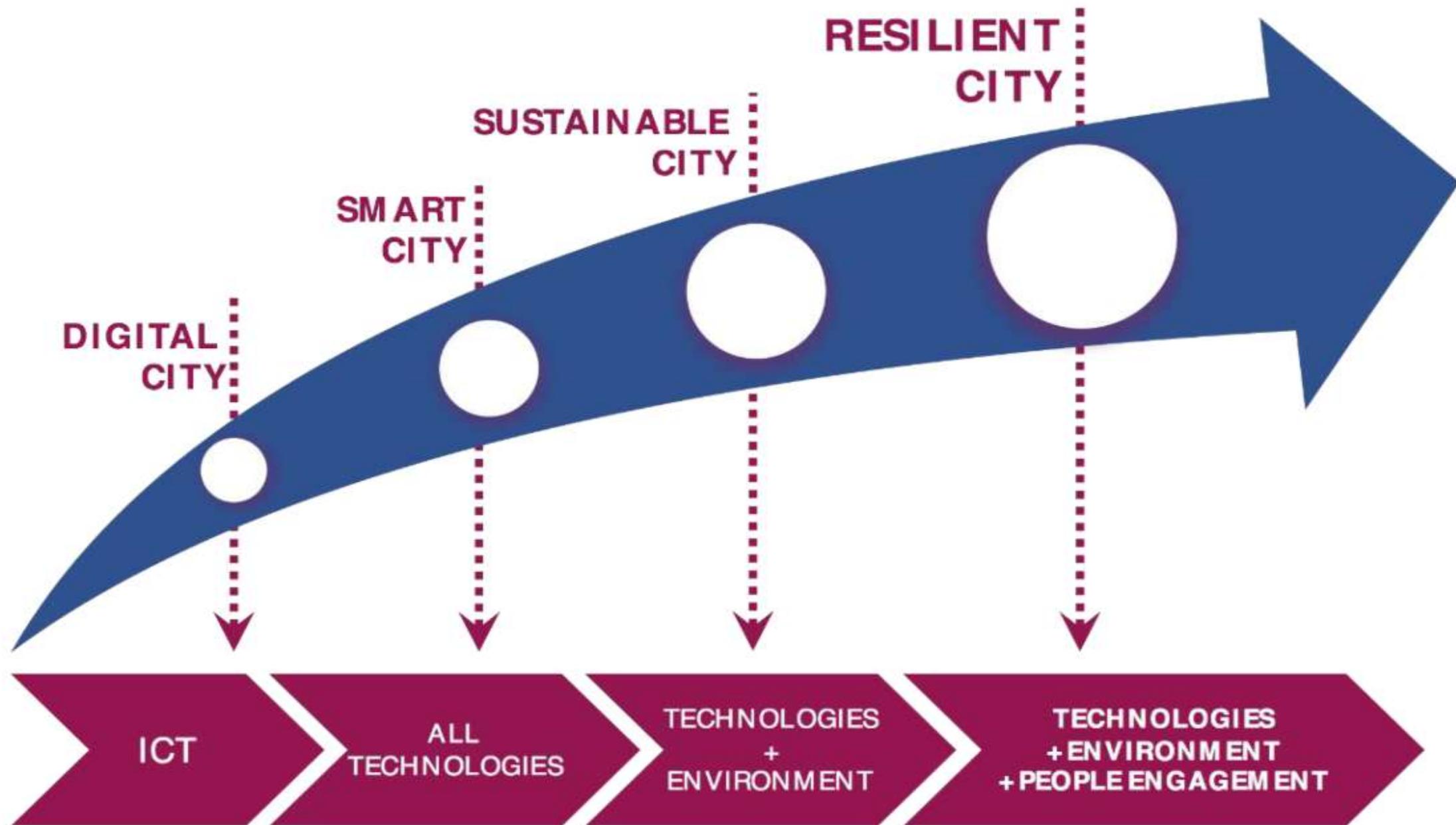


# Role of ICT in building resilience

- To increase citizen's awareness, intelligence, wellbeing as well as community participation
- Stable economic development
- Provide comprehensive public safety
- Establishing Reliable infrastructure
- For Sustainable and affordable housing

*Cities depend on above factors to cope with population growth and urbanization across the globe.*

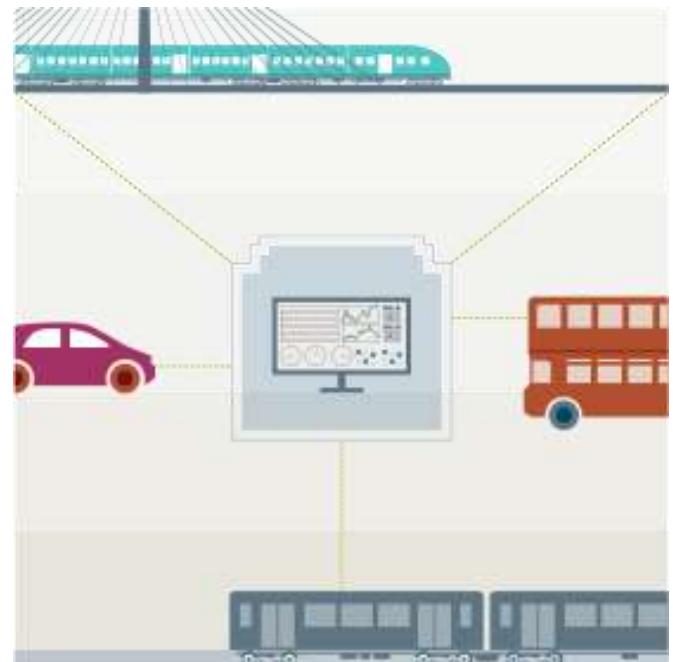
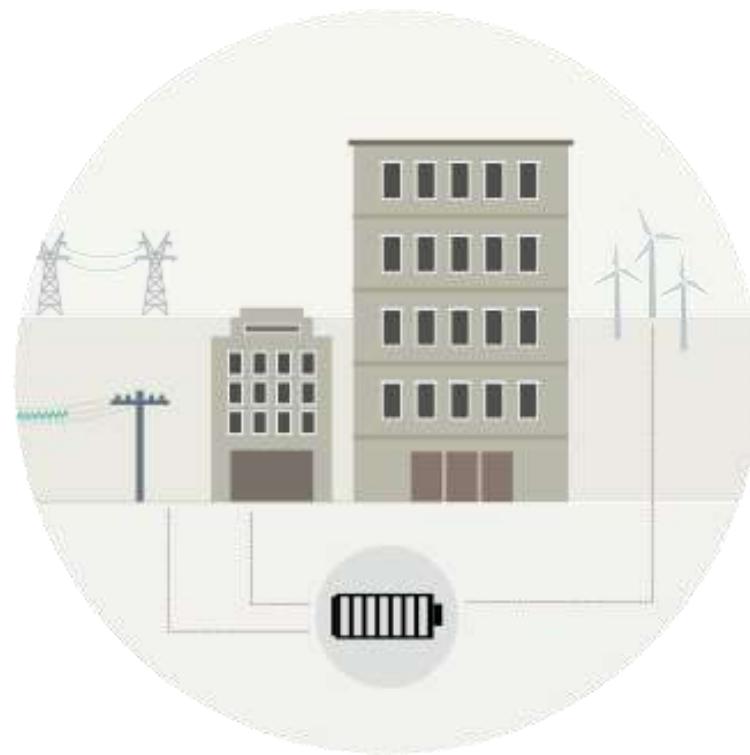
# Role of ICT in building resilience



# Facing the challenges –resilient city

Urban infrastructure systems ensure delivery of the following during unplanned or unforeseeable situations

- Energy – *continuous power supply*
- Mobility – *Intelligent transportation networks*
- Ensure continuous supply of water and Sanitation
- Building Systems
- Constant information flow



## Facing the challenges –

- Smart city governance have to find a new way of thinking about how to **plan, design, build and manage** their cities under more challenging conditions.
- Work with **public as well as private companies** in helping cities, their people, communities and institutions respond to the stresses and acute shocks caused by rapid urbanization, globalization, and climate change.
- *Resilience is not only about surviving – it is also about thriving, regardless of the challenge.*

# Smart Infrastructure

A smart system uses a feedback loop of data, which provides evidence for informed decision-making. The system can monitor, measure, analyse, communicate and act, based on information captured from sensors.

A system may:

- Collect usage and performance data to help future designers to produce the next efficient version
- Collect data, process them and present information to help a human operator to take decisions (for example, traffic systems that detect congestion and inform drivers)
- Use collected data to take action without human intervention

# Principles of smart infrastructure

Data

- It is the basic element required by a smart system to work, and the raw material required by a smart infrastructure for its operation

Analysis

- Systems that are able to process these data and then make appropriate decisions will have to be developed and put in place.

Feedback

- Feedback within a smart system provides opportunities to increase its performance

Adaptability

- Smart systems are those that not only adapt to current demands, but also conform to the needs of the future

**Smart infrastructure collects data, processes information and takes appropriate action completely autonomously (without human intervention) and dynamically, and adapts to changing conditions**

## Smart Network

- efficiently incorporate the behaviour and actions of all users connected
- high-quality and safe supply of network is maintained.

## Smart Buildings

- advanced installation and technological systems
- automation of internal processes, such as heating, ventilation, lighting, security etc.

## Smart public infrastructures

- include electronic devices that transmit information that can then be used to improve their own functioning or the behavior of other related systems

# Conventional Vs Smart Building



# Example: Smart Building- Capital Tower (Singapore)

- This 52-story office building won the Green Mark Platinum Award for its construction design, and for its energy and water efficiency.
- An air-conditioning energy recovery wheel system which allows cool air to be retrieved;
- Motion detectors in the lobby and all bathrooms to conserve energy
- Double-glazed windows that reduce heat penetration and reduce energy consumption the use of condensation from the air-handling unit to reduce water usage, and consta
- nt monitoring for carbon monoxide to ensure optimal air quality.
- This building also features the following amenities: a panoramic view of the Singapore skyline, a fitness center, pool, childcare, and several dining options.



Capital Tower - Singapore

# The Crystal Building (London, England)

- Its annual heating bill is zero.
- It emits 70 percent less carbon dioxide.
- 100 percent of the water in its toilets is recycled.
- It spends 46 percent less on energy than any other building of its size.
- It generates its own energy with the use of solar panels and ground heat pumps.
- It collects rainwater to maintain its bathrooms and irrigation system.



# QUIZ 7

## MCQs here based on previous slides

1. What are the Six key dimensions that are critical elements in developing an effective Smart City process
2. The increasing urban population creates significant challenges for the city, such as.....
3. Give an example of acute shocks are sudden, sharp events that threaten a city?
4. Which city is awarded as Green Mark Platinum Award for its construction design, and for its energy and water efficiency.
5. \_\_\_\_\_ is the basic element required by a smart system to work, and the raw material required by a smart infrastructure for its operation
6. \_\_\_\_\_ is not only about surviving, it is also about thriving, regardless of the challenge.

# L8. SMART CITIES; MISSION STATEMENT AND GUIDELINES

## Learning Objective:

To incorporate and reflect the mission statement and guidelines(MOUD) in the making of a smart city

### Presenter

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Presidency University Act, 2013 of the Karnataka Act No. 41 of 2013 | Established under Section 2(f) of UGC Act, 1956

Approved by AICTE, New Delhi

9.9.2021



# Smart Cities

## Mission Statement and Guidelines



**Government of India**  
**Ministry of Urban Development**  
**(June, 2015)**

# SMART CITY FOR INDIA

DUBIA

## Domain / Area

- urban eco-system
- development-institutional
- physical, social and economic infrastructure

## Mission

- To promote cities that provide **core infrastructure** and give a decent quality of life to its citizens
- A clean and sustainable environment and application of **'Smart' Solutions**
- The focus is on **sustainable and inclusive development** and the idea is to look at compact areas
- create a **replicable model** which will act like a light house to other aspiring cities.



# Objectives

Source :Ministry of Urban development, Government of India

- The Smart Cities Mission of the Government is a **bold, new initiative**. To set examples that can be **replicated** both within and outside the **Smart City**, catalyzing the creation of similar Smart Cities in various regions and parts of the country.
  - Enabling local area development and harnessing technology, especially technology that leads to Smart outcomes.
  - Area-based development will transform existing areas(retrofit and redevelop), including slums, into better planned ones, thereby improving livability of the whole City.
  - New areas(**greenfield**) will be developed around cities in order to accommodate the expanding population in urban areas.
  - Application of Smart Solutions will enable cities to use technology, information and data to improve infrastructure and services
- **Dholera region - India's First Greenfield Smart City**



# Shortlisting of Cities

(Indicative list)

## 1. Economic Criterion

- Cities accounting for 54% of Incremental GDP till 2025\* 69

## 2. Geographic Inclusivity

- All State Capitals (not included above) 12
- Tourist/ Religious – Heritage (not included above) 8
- Hill and Coastal Areas (not included above) 4
- Mid-sized Cities (not included above) 7

---

**100**

# Conditions Precedent

## 1. Municipal Reforms

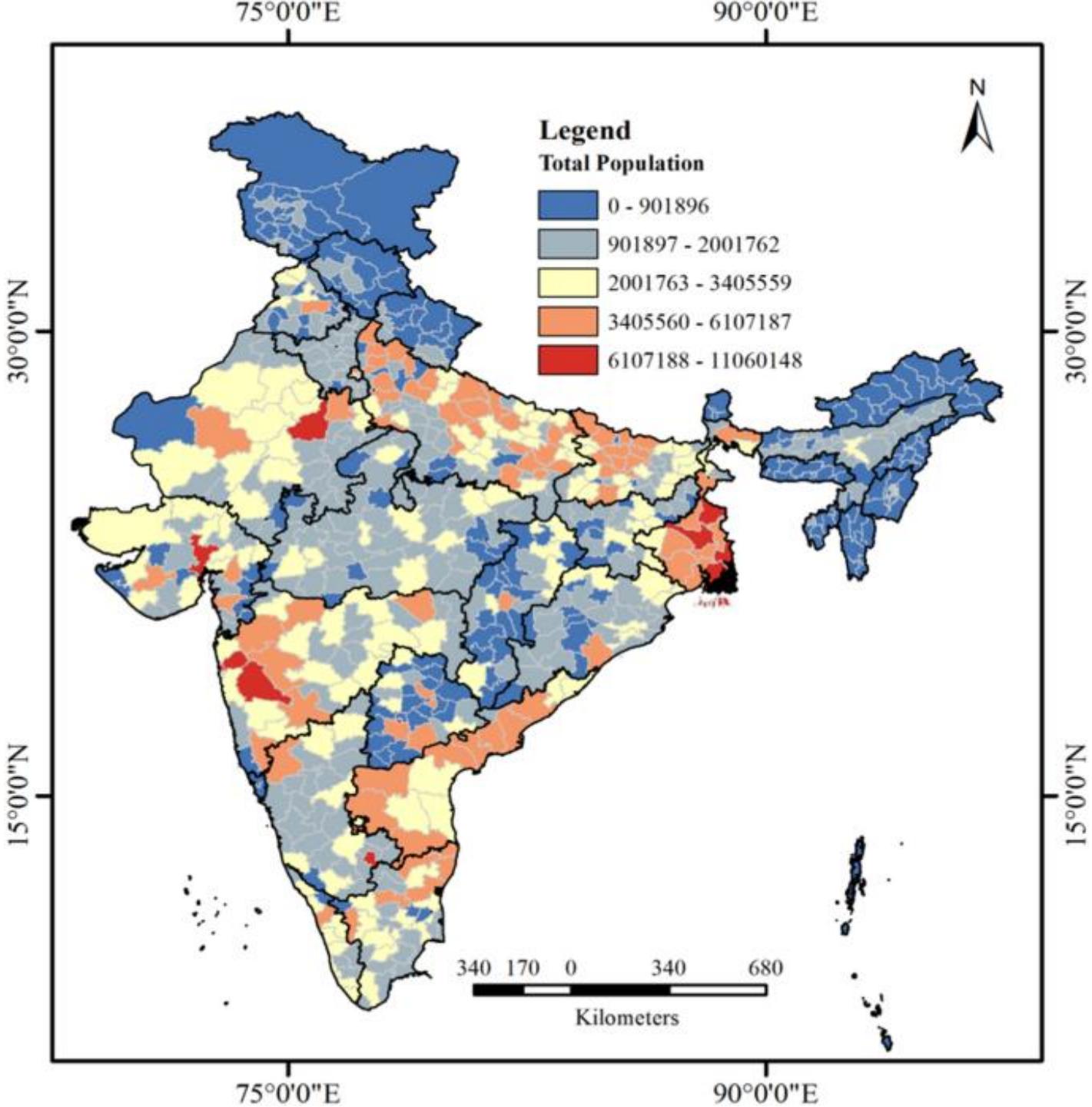
- Double Entry Accounting System
- Minimum 50% collection of Taxes and User Charges
- Creation of Municipal Cadre

## 2. E-Governance

- Electronic Delivery of Public Services
- All Information in Public Domain

## 3. Zero Emissions: Solid & Liquid Waste

## 4. Master Plan based on Spatial Mapping/GIS



## Strategy & Approach

The strategic components of **Area-based development** in the Smart Cities Mission are

### 1. Pan-City Development

Citizen Engagement and Reference Framework

Capacity Building

E-Governance

Zero Emission

City Development Plan based on Spatial/ GIS Mapping, ICT,

Environmental Sustainability

**Pan City:** To upgrade the existing city-wide infrastructure through application of smart solution



NASHIK – Representative Image

### 3. Pan-City 2-3 Major Infrastructural Projects

## Strategic components

Area Based  
Development



Pan City  
Development



**Redevelopment**  
Area: 50 acres



**Retrofitting**  
Area: 500 acres



**Greenfield**  
Area: 250 acres

**100 cities selected**

**5,151 projects  
identified**

**₹ 2,05,018 crore  
investment**

**City-wide Smart Solutions**

## WHAT IS RETROFITTING

- Urban retrofitting is the development or **upgrading of technology** e.g. for **energy distribution and consumption** within **existing** infrastructure.
- Retrofitting is a common strategy at city and regional levels to meet the emerging objectives of rapid reductions of carbon footprints.

Source: Mistra Urban Futures



## Retrofitting in smart cities

- Retrofitting will introduce planning in an **existing built-up area** to achieve **Smart City objectives**, along with other objectives, to make the **existing area** more **efficient and livable**.
- In retrofitting, an area consisting of more than **500 acres** will be identified by the city in consultation with citizens.
- Depending on the existing level of infrastructure services in the identified area and the vision of the residents, the cities will prepare a strategy to become smart.
- Since existing structures are largely to remain intact in this model, it is expected that more intensive infrastructure service levels and a large number of **smart applications** will be packed into the retrofitted **Smart City**.
- This strategy may also be completed in a shorter time frame, leading to **its replication in another part of the city**.

# Retrofitting development

Where?

- Existing Developed Area
- Minimum 500 acres in size

What?

- Zero Emissions- Solid & Liquid Discharge
- Quality Electricity & Water Supply: Smart Metering
- High-Speed, High-Bandwidth Connectivity
- CCTV Surveillance of all public areas
- LED lighting, Intelligent Traffic & Parking Management
- Pavements, Cycle Tracks, Roads

How?

- Implementation in 3 years
- **Urban Local Bodies, State, Centre**
- Selection through Competition – “City Challenge”

## Redevelopment

- Redevelopment is the process of demolishing an existing building altogether and constructing a new one.
- It is a massive undertaking that requires a highly proactive and careful approach on behalf of the housing society.



Source: My gate, <https://mygate.com/blog/redevelopment-of-a-housing-society/>

# Redevelopment

Where?

- Existing Urban Sprawl (including Railway, Bus Stations etc.)
- Minimum 50 acres in size

What?

- In addition to all retrofitting components
- Higher FAR (Floor area ratio) and Lower Ground Coverage
  - Green and Energy-Efficient Buildings
  - Wide Roads; Recreational, Open Spaces

Conditionality's

- Mixed Land Use & Higher FAR
  - Max. 50% ground coverage
  - Max. 40% Commercial, Min. 10% Institutional, Min. 10% for Parking
- MoU with States, ULB, Developers

How?

- Implementation in 5 years
- SPV (Public/Private Developer)
- Equity Participation by GoI, States, ULBs
- Selection through Competition – “City Challenge”

# Greenfield development

- A greenfield development is a real estate construction project on previously undeveloped land.

Examples of typical greenfield development sites are:

- Agricultural fields.
- Forest land.
- Unused land parcels.



# Green-Field Townships

Where?

- Vacant Land
- Minimum 250 acres each Township

What?

- In addition to all Redevelopment components
- Quality infrastructure for Education, Health and Recreation
  - Multimodal Transport
  - Trade Facilitation, Incubation, Skill Development Centres

Conditionality's

- In addition to all redevelopment conditions
- High Speed Rail/Road Connectivity
  - MoU: States, ULB, Developers

How?

- Implementation in 5 years
- SPV (Public/Private developer)
- Equity Participation by GoI, States, ULBs
- Selection through Competition – “City Challenge”

## Proposed “City Challenge” Matrix

	Commitment to National Priorities		
	E-Governance	Swachh Bharat	Make in India
Retrofitting Development			
Redevelopment			
Greenfield Development			

## **Proposed “City Challenge” Process**

- Online applications by States/ULBs/Developers
  - Highlighting Initiatives, innovations and Impact
- Evaluation and Selection by Committee of International and Indian Experts
- Allocation of Funds by Empowered Committee (GoI, States, ULBs)

# MISSION SMART CITIES **2020**

Making  
India  
Smart



WHAT  
MAKES A CITY  
'SMART'?

TODAY  
**5 PM IST**  
ONWARDS



NDTV

MISSION  
SMART CITIES  
2020

A REALITY CHECK ON INDIA'S REALTY SECTOR

## **QUIZ 8**

**MCQs - based on previous slides we have discussed**

1. What is the Smart City project mission of India
2. List any three objectives of smart city plan
3. India's First Greenfield Smart City will be \_\_\_\_\_
4. Define Pan City?
5. What is the difference between retrofitting and redevelopment?
6. What are the aspects of green field township development?

# L 11. Disruptive technologies -I

## Learning Objective:

To explore the most important disruptive technologies in the development of the smart city

## Contributor

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# L 11. Disruptive technologies -I

## Learning Objective:

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UNIVERSITY**



# Why Disruptive technologies?

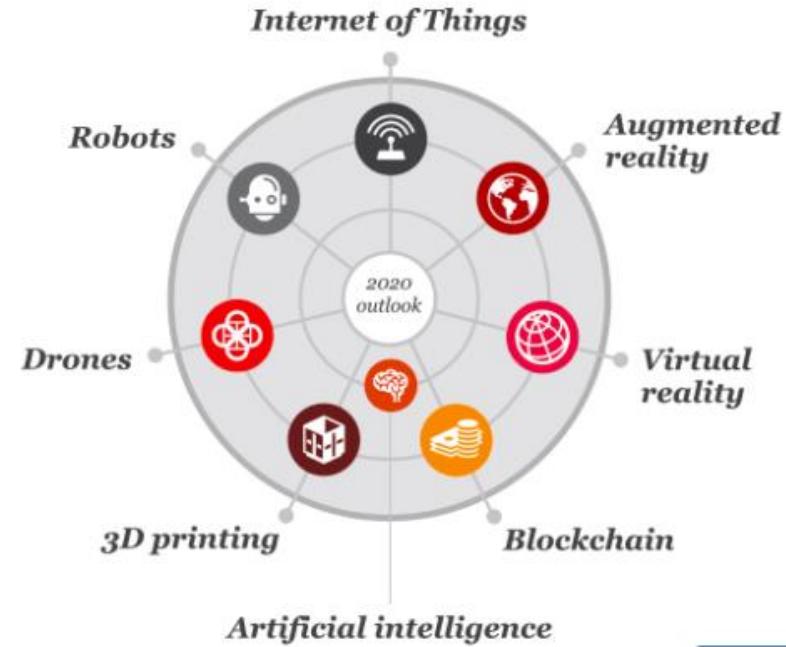
*causing trouble and therefore stopping something from continuing.*

- Every smart city is a dynamic and complex system that attracts an increasing number of people in search of the benefits of urbanisation.
- According to the United Nations, 68% of the world population will be living in cities by 2050. This creates challenges related to limited resources and infrastructure (energy, water, transportation system, etc.).
- To solve these problems, new and emerging technologies are created.
- Internet of Things, big data,
- block chain, artificial intelligence,
- data analytics, machine learning cognitive learning are Just a few exam

**They generate changes in key sectors such as**

- health, energy, transportation,
- education, public safety, etc.

*The essential eight technologies*



# Why Disruptive technologies?

## List of top disruptive technologies

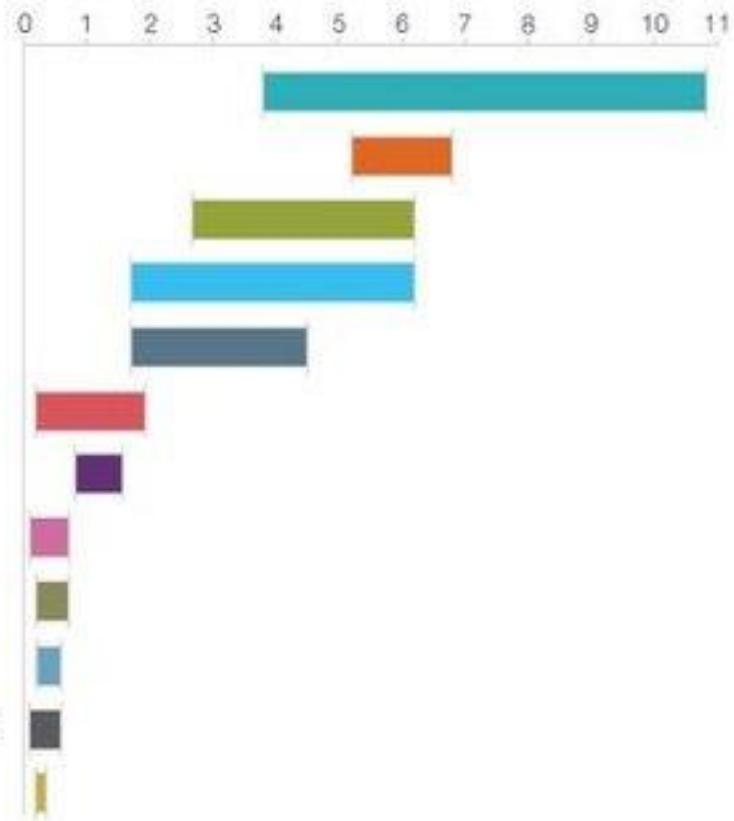
- 3D Printing
- 5G and Improved Connectivity
- Artificial Intelligence and Machine Learning
- Automation and Robotics
- Cyber Security Advances
- Edge Computing
- Virtual and Augmented Reality
- The Rise of “As-a-Service” Computing
- The Work-From-Home Revolution
- Voice-Activated Search

Examples - e-commerce, online news sites, ride-sharing apps, and GPS systems.

## A gallery of disruptive technologies

Estimated potential economic impact of technologies across sized applications in 2025, \$ trillion, annual

1. Mobile internet
2. Automation of knowledge work
3. Internet of Things
4. Cloud
5. Advanced robotics
6. Autonomous and near-autonomous vehicles
7. Next-generation genomics
8. Energy storage
9. 3-D printing
10. Advanced materials
11. Advanced oil and gas exploration and recovery
12. Renewable energy



# Why Disruptive technologies?

- Based on this background, we identified the main disruptive technologies in smart cities. Applications that integrate these technologies help **cities to be smarter** and offer **better living conditions** and easier access to products and services for residents.
- Disruptive technologies are generally considered key drivers in smart city progress.
- We will study these disruptive technologies, their applications in smart cities

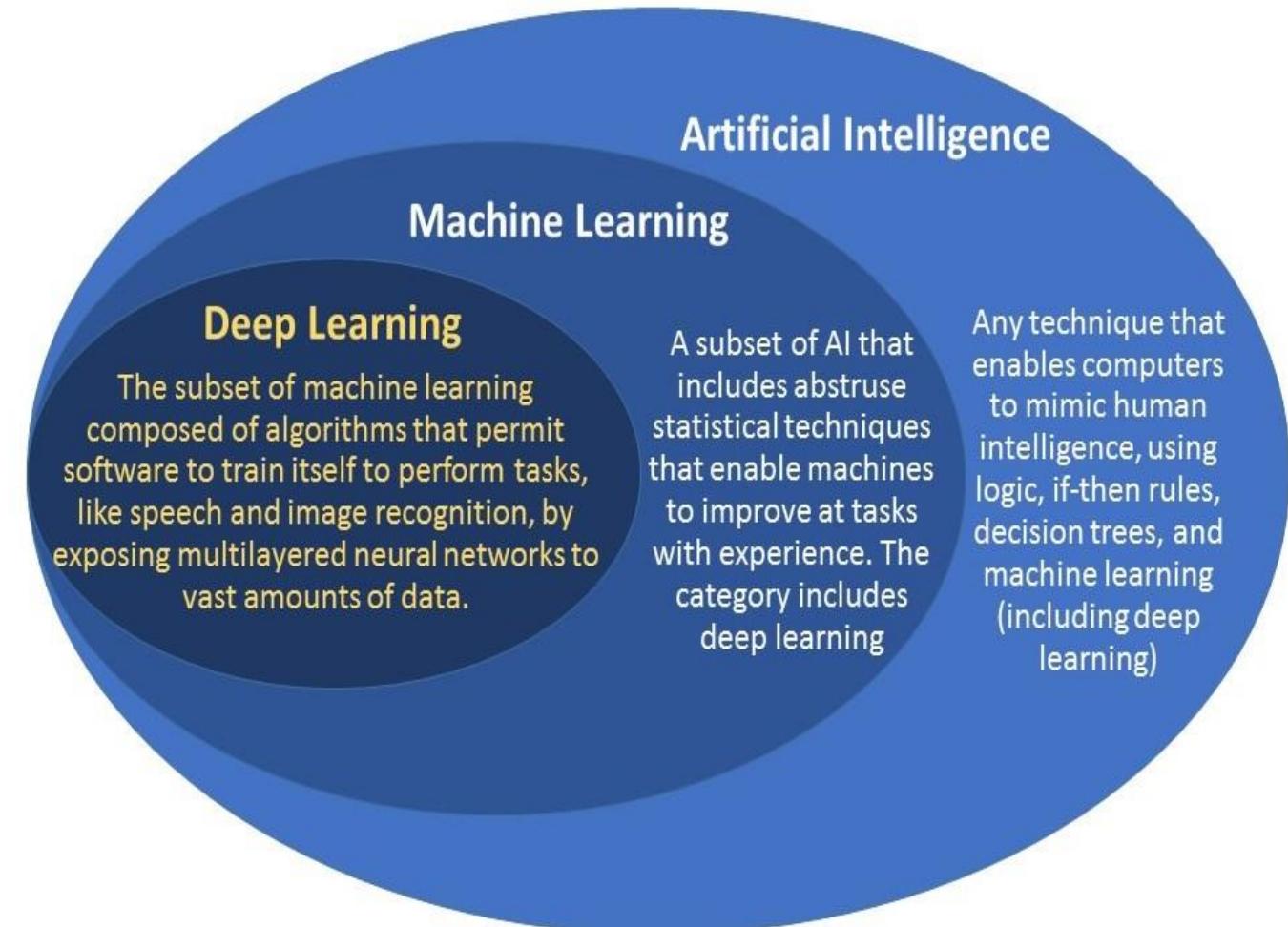
# Disruptive technologies



- Disruptive technology is a technology that affects the way businesses, consumers, or industries function.
- New technology can either be sustaining or disruptive.
- While sustaining technology depends on the incremental improvements in the already existing technology,
- Disruptive technology is a completely new one.
- Practical application of such technologies may not have been proven yet.

# Disruptive technologies

- Disruptive technology is an innovation that significantly alters the way that consumers, industries, or businesses operate. A disruptive technology sweeps away the systems or habits it replaces because it has attributes that are recognizably superior
- Artificial intelligence, virtual/ augmented reality, internet of things, block chain technology, and e-commerce are some of the disruptive technologies significantly influencing the future.



# Smart solutions are fueled by disruptive technologies and social innovations

Most new technologies and social innovations are disruptive on their own. The combination of them is even more powerful and creates a ‘perfect storm’ of disruption.



**Cloud** - on-demand access to rich application functionality and computing power allow for exponential scalable solutions in a “pay-per-use” model



**Mobile** - ubiquitous mobile internet, powerful mobile devices and apps with intuitive interfaces act as front end for many innovative solutions



**Social media & Digital platforms** – use digital technology to connect people in new and powerful ways forming the basis of new collectives and communities



**Big data** - large volumes of highly volatile and rich data (structured data, sensor data, audio, video, social media) form the lifeblood of smart solutions



**Artificial intelligence** - cognitive systems combine machine learning with the ability to interact via natural language and create insight from data



**Internet of things** - physical objects equipped with advanced sensors and connectivity transform into smart objects and generate a plethora of data



**Robotics and drones** – social robots and drones replace human labor on a large scale, not only for routine work but increasingly for providing services



**3D printing** - additive manufacturing allows for efficient production of unique products where and when they are needed



**Blockchain** - algorithm that facilitates registering transactions in an indisputable way without the use of an intermediary or a central administration



**Renewable energy** – New sources of energy like photo voltaic cells and energy from wind and water are an alternative to large scale generation based on fossil fuel.



**Co-creation** - an initiative that brings together parties to jointly create a mutual valued outcome. In the context of smart cities, these are (communities of) citizens, private companies, knowledge institutes and public organizations that form an ecosystem to solve societal problems in a creative way.



**Crowd sourcing** - the process of obtaining needed services, ideas, or content by soliciting contributions from a large group of people, and especially from an online community, rather than from traditional employees or suppliers.



**Sharing economy** - using information technology as an enabler to bring together supply and demand in new ways. Use digital platforms to share and reuse excess capacity in a variety of goods and services.



**Gamification** - the use of game thinking and game design elements (competition, levels, leaderboards, badges, etc.) in non-game contexts. The objective of gamification is to stimulate people to change their behavior. In a desired way.



**Self organization** - a process where overall order and coordination arises out of the local interactions between people in an initially disordered system. It is spontaneous and not necessarily controlled by any auxiliary agent. The resulting organization is wholly distributed and typically robust.



Traditional and digital infrastructure

Technological innovations

Social innovations



Human and social capital

# Mobile – The second wave in the digital revolution

Mobile devices marked the second wave in the Internet revolution and act as the platform for many smartsolutions being the most personal and disruptive of all consumerdevices



## What is it and why is it disruptive?

Mobile devices marked the second wave of the Internet revolution, after the first wave connected fixed devices. Today, smartphones are the most successful consumer device ever. In 2015, 1.4 billion units are expected to be sold of which more than 1 billion are purchased to replace an older smartphone. The total number of smartphones sold will be greater in units and revenues than PC, television, tablet and game consoles combined.

Of all consumer devices, the smartphone is the most personal one. It is the device that people always carry with them, the device that mostly reflects the users personal choice, the device that contains the most personal information and therefore the least likely to be shared, and it is the device the most frequently looked at. The instant-on, always-connected nature, combined with its form factor and intuitive interface caused smartphone to be among the most disruptive devices ever.

Todays smartphones have unparalleled capabilities. The computing power of a single Apple iPhone 6S is 71x faster than the first iPhone and outperforms the Cray-2 supercomputer built in 1985 many times. But computing power alone is not driving the smartphone as one of the most versatile platforms ever, it is the wide array of sensors that is built in. For example, a Galaxy S6 is equipped with the following sensors:

- *Accelerometer* to sense movement of the device
- *Ambient light* to sense the brightness of the light surrounding the device
- *Barometer* to sense pressure
- *Camera* to visualize the environment of the device
- *GPS* to track the geographical location of the device
- *Gyroscope* to sense the orientation of the device
- *Magnetometer* to sense the magnetic field to operate the device's compass
- *Microphone* to sense sound reaching the device
- *Proximity sensor* to sense when someone is close to the device
- *Temperature* to sense the temperature around the device

Source: Deloitte Technology Media and Telecommunications Predictions 2015

## Location Aware Services

Mobile applications that use information about the geographical location of a device to provide location-aware functionality. The trend scores high on the transformational impact on the business and companies will use it for new types of services. However, these new types of services require more than just the use of the technique alone. Genuine innovation will spring from the companies' imaginative power.



## Bring Your Own Device

A strategy that allows users to select and purchase their own mobile devices from which they can use enterprise applications and data. A major driver for BYOD is Consumerization; the trend of innovations starting in consumer technology followed by companies taking advantage of these innovations by embracing them for enterprise use. Most companies introduce BYOD to achieve higher employee satisfaction and higher productivity.



## Context Enriched Services

Context-enriched services are applications and services that combine information about the user with all kinds of situational information to offer context aware experiences. It includes proactively pushing content to the user to suggest products or actions that may be attractive to the user in a particular situation.



# Digital platforms – Business model disruptor



Digital platforms connect supply and demand in ways that were never possible before and disrupt markets

## What is it and why is it disruptive?

The emergence of digital platforms like Booking.com, Uber and Airbnb caused a disruption in each of their respective markets. None of these digital platforms own assets like hotels, planes or taxis, but they connect supply and demand in ways that were never possible before.

- In the first place, digital platforms provide full transparency in supply (quality, price) allowing customers to find the best matching offer without help from an intermediary. In addition, these digital platforms provide mechanisms for rating the service and giving feedback provides valuable information for potential customers.
- Second, digital platforms provide smooth and intuitive booking, fulfilment and payment processes, taking much of the administrative burden from the hands of suppliers. This makes it easier for new suppliers to become active on the market. For example: the presence of a digital platform like Airbnb lowers the threshold for home owners to rent out their house, hereby increasing the supply significantly.

In short, digital platforms disrupt markets in three ways:

- **Lower transaction costs** – Digital platforms automate the entire process between customer and supplier, making all kinds of traditional intermediaries unnecessary. They provide convenience to both customers and suppliers.
- **Augmented supply** – Digital platforms lower the threshold for new suppliers to become active on the market, augmenting the supply side of the market.
- **Exponential scalability** – Digital platforms do not own assets like hotels and taxis, and are therefore exponential scalable. Parties like Uber, Booking.com and Airbnb have been able to gain relatively large market shares in only a couple of years.

### Booking.com

Only ten years ago, people used the services of a travel agency for booking travel arrangements. This market has been totally disrupted by digital platforms like Booking.com, Tripadvisor and Expedia. With only a few clicks, customers book hotel accommodation, plane tickets and rental cars, leaving all administrative handling to the digital platform.



### Airbnb

Airbnb transforms private homes into hotel rooms. Home owners can rent out their house to travelers from all over the world, leaving all administrative handling and payment processing to the digital platform. In The Netherlands, Airbnb was responsible for 4,2 million nights, compared to 28,5 for all traditional hotels combined.

### Uber

Uber provides real time matching of private drivers with citizens looking for a ride. The digital platform and app connect supply with demand and arranges the full payment process and rating process. To balance demand and supply, Uber uses dynamic prices ('surge pricing') that are higher when demand exceeds supply.



Source: ING Economisch Bureau, Hotels en de deeleconomie

# Internet of things (1/4) – The third wave in the digital revolution



A city with a digital overlay generates massive amounts of data to fuel all kinds of smart solutions

## What is it and why is it disruptive?

The Internet of Things (IoT) refers to the massive use of advanced sensors and wireless communication in all kinds of physical objects. The wide scale use of sensor technology creates massive volumes of data providing a fine grained digital view on the physical world. This data can be used by smart systems that optimize the use of infrastructure and resources.

The IoT marks the third wave in the development of the Internet. The first wave provided fixed connections to the Internet, the second wave connected a much larger number of mobile devices to the Internet. The third wave connects a plethora of things to the Internet, creating a situation where the vast majority of all IP addresses in the world belongs to objects instead of persons.

## Why now?

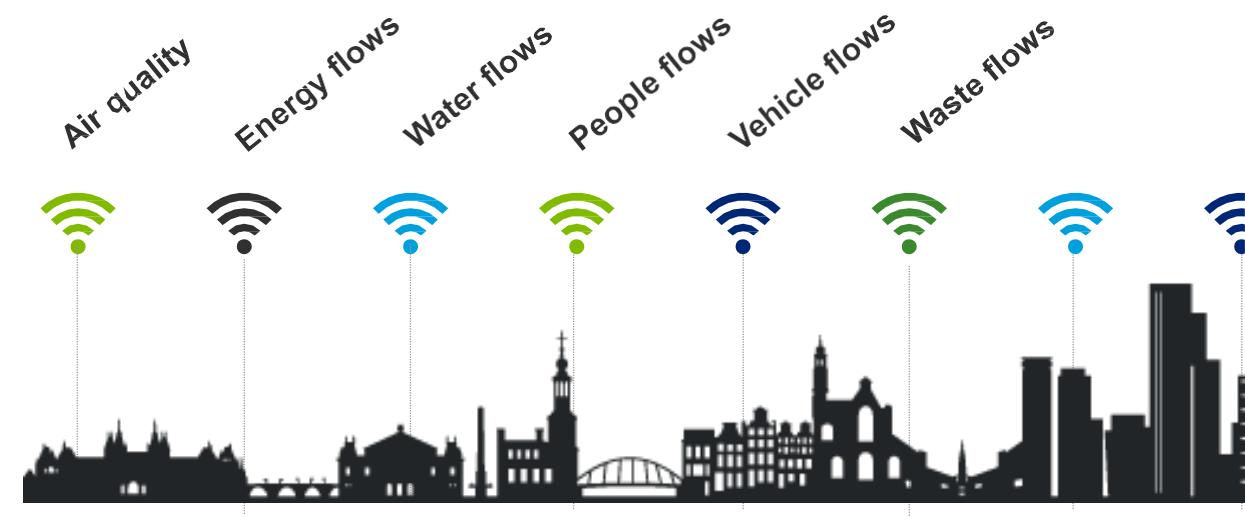
The concept of connected objects is not new, but a number of developments have come together to enable an exponential rise of IoT. These are:

- **Price erosion** – The price of sensors has been dropping in the past five years and is expected to remain decreasing with 5% per year in the next years. This allows large scale use of sensors in an economically feasible way.
- **Ubiquitous wireless coverage** – Sensors require access to wireless networks to make the data available for processing. Ubiquitous wireless coverage is now available, even through different types of networks (WiFi, 3G/4G and LoRa).
- **Abundant processing and storage** – The big data that is generated by billions of sensors needs to be stored and processed. The capacity of processing power and bandwidth has increased and keeps increasing in an exponential way. Due to this, the capacity required for the back end solutions is in place.
- **IPV6** – The newest version of the Internet Protocol allows for an almost unlimited number of unique IP-addresses that can be assigned to identify any conceivable IoT device.

### Example: smart lampposts

The lamppost is the most valuable real estate asset in the city for the purpose of installing sensors that form a city wide IoT backbone. Of all objects, lampposts are best distributed across the entire city and they already are connected to power networks.

There are **116.000** lampposts in Amsterdam.



# Internet of things (2/4) – A multitude of sensortypes



“Anything that can be connected, will be connected”; 22 examples of sensor use

1. **Air** – Sensors that detect the level of **air pollution** in urban areas to take appropriate measures that protect people's health.
2. **Athletes** – Sensors that use an **accelerometer** and **gyroscope** are used to detect the severity of a hit to the head, which can be used by the coach to decide to pull athletes off the field to check for concussions.
3. **Buildings** – Sensors that monitor **vibrations** and **material conditions** in buildings, bridges and historical monuments provide ‘early warnings’ in case of damages.
4. **Distribution vehicles** – Sensors that detect the **geographical location** of each vehicle in a fleet are used to optimize routes and create accurate estimates for delivery times.
5. **Energy usage** – Sensors that monitor **energy usage** can be used to verify the energy efficiency of “green building” and gain insight in further improving this efficiency.
6. **Green houses** – Sensors that detect the micro-climate in terms of **temperature**, **humidity** and **CO<sub>2</sub> level** are used to maximize the production of fruits and vegetables.
7. **Gunshots** – Sensors that detect the **sound** of a gunshot are used to pinpoint the location with an accuracy of 10 meters in real time and dispatch police to that location immediately.
8. **Hazardous gases** – Sensors that detect levels of **explosive or toxic gases** in industrial environments and indoor locations allow immediate action to secure the safety of people.
9. **Health** – Sensors that measure vital metrics such as **blood pressure** and **heart rate**, are used to monitor patients as they live their lives. The data is used to decide when the next visit to the doctor is necessary and to improve patient adherence to prescribed therapies.
10. **Item location** – Sensors that detect the **geographical location** of an object are used to track objects to save valuable time searching for them.
11. **Machines** – Sensors that monitor the state of machine parts, e.g. by measuring **temperature**, **pressure**, **vibration** and **wear** generate detailed data that can be used for condition based maintenance; applying maintenance when it is needed instead of in regular intervals independently from the status of the machine.
12. **Noise** – Sensors that monitor **noise levels** generated by entertainment venues in real-time allow rapid interventions when permissions are violated.
13. **Parking spaces** – Sensors that detect variations in **magnetic fields** generated by parked cars are used to detect whether a parking space is free. The information is used to guide people looking for a car space to the nearest free space.
14. **Perimeter access** – Sensors that detect **people in non-authorized areas** are more efficient than human security guards and can trigger immediate action on the right location.
15. **Public lighting** – Sensors that detect **motion** of people and vehicles in a street and adjust the public lighting to the required level.
16. **Rivers** – Sensors that detect river **pollution** e.g. caused by leakages of chemical plants in real-time allow for immediate actions that confine the damage to the environment.
17. **Roads** – Sensors that detect the **temperature** of a road to provide early warnings to drivers in case of slippery road due to e.g. ice.
18. **Storage conditions** – Sensors that monitor storage conditions of perishable goods such as vaccines and medicines measure **temperature** and **humidity** to secure the quality of products.
19. **Storage incompatibility** – Sensors that detect objects (e.g. **dangerous goods**) that are not allowed to be stored together. e.g. inflammable goods and explosives. Or in hospitals, the presence of blood for patient X in the operating room where patient Y is having surgery.
20. **Traffic** – Sensors that detect the **speed** and the number of vehicles using public roads are used to detect traffic congestion and suggest drivers to take an alternative route.
21. **Waste** – Sensors that detect to what extent a **rubbish container** is filled, to optimize the trash collection routes and to prevent trash being deposited on the street if a container is full.
22. **Water** – Sensors that detect **water leakages** in the water distribution network are used to align the maintenance schedule to the actual loss of water.

# Internet of things (3/4) – Example

“The most connected office space in the world” - Bloomberg



- The Edge, in Amsterdam, is not only the greenest office building in the world, but also the most connected one. It is a living lab for innovative applications of the Internet Of Things in office environments.
- The building has a floor space of 40.000 m<sup>2</sup>, houses 2500 people and is equipped with **30.000 sensors**. The majority of these are integrated in a revolutionary new lighting system consisting of 6.000 luminaires. The LED lighting is connected via Ethernet cables only, providing both Power over Ethernet and IP network connection. Each luminaire has its unique IP-address and is equipped with sensors for infrared, ambient light, temperature and humidity. Smart apps can be used to define personal preferences for temperature and lighting. When the sensors detect a user, the lighting and cooling at that spot is automatically adjusted.
- During the day the sensors detect the intensity with which each part of the building is used. At the end of the day, this data is visualized in a heat map used by the cleaning staff to focus on areas that have been used most.



- Next to the thousands of sensors in the smart ceiling, sensors are used in all kind of objects, such as coffee machines and towel dispensers. The data that is generated by these objects is used by facility services to refill just in time. All smart solutions contribute to energy efficiency, security and convenience.



# Internet of things (4/4) – IoT at home: smart devices

Sensors and wireless connectivity are installed in all kinds of devices to make them adaptive, responsive and intelligent

## What is it and why is it disruptive?

The combination of all kinds of devices with intelligent sensors and wireless communication creates 'smart objects' with new functionality that adapt their behavior to the context they are used in. Complex networks of smart objects, communicating with each other and with intelligent cloud systems, emerge. These new possibilities are the source of a plethora of new products. Furthermore, suppliers will try to change their business model to generate new income streams from subscriptions to value added services, provided through intelligent cloud systems (apps) connected to the smart object.

One of the disruptive effects of the Internet of Things is the fusion of information technology with other technologies, like consumer technology, medical devices or vehicles. A self driving car is both car technology as information technology.

## First examples - Nest

Nest, acquired by Google, produces common household objects, like thermostats, that have been made 'smart' by a Wi-Fi connection and apps to visualize sensor data and to control the object.



## Results of a CIO survey

In a Technology Trends survey among leading CIO's, Deloitte and CIO Magazine (NL) asked the CIO's to respond to the thesis "*In the future, the Internet of Things will impact our products and services significantly*".

71% of all respondents answered positively (22%: strongly agree, 49%: agree)

**"By 2022, a family home in an affluent, mature market will contain over 500 smart devices." - Gartner**

## Gartner predictions:

- By 2022, the falling cost of adding sensing and communications to consumer products will mean that a family home in a mature, affluent market could contain several hundred smart objects. These will enable a wide range of new digital business opportunities.
- The number of smart objects in the average home will grow slowly for at least a decade. However, although a mature smart home won't exist until 2020 to 2025, smart domestic products are now being manufactured. The first digital business opportunities they enable have already emerged.
- Any organization manufacturing a domestic product for home use costing more than \$20 should brainstorm how it could be differentiated or made more valuable by becoming smart and networked.

Source: Gartner, The Future Smart Home: 500 Smart Objects Will Enable New Business Opportunities

## QUIZ 11

Provide 6 MCQs here based on previous slides you have discussed

1

2

3

4

5

6

# L 12. Disruptive technologies -II

## Learning Objective:

To explore the most important disruptive technologies in the development of the smart city

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# L 11. Disruptive technologies -I

## Learning Objective:

To explore the most important disruptive technologies in the development of the smart city

Presenter

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# Big data

Large volumes of rich data (structured data, sensor data, audio, video) form the lifeblood of smart solutions

## What is it and why is it disruptive?

One of the most heard buzz-words is 'big data'. In contrast to the name, this does not simply refer to large data sets. We define Big Data as data too large to be processed by traditional database management and analysis tools. Three characteristics are:

- **Volume** - Too large for traditional databases, data warehouses and analysis tools. Typical examples are: click-stream data, sensor data, location data of mobile devices, surveillance camera data, medical images data, etc. In general, big data requires a distributed approach with parallel software running on large numbers of servers.
- **Velocity** - Rapidly changing data, for example a stream of online sales transactions or real-time data of clicking behavior on websites.
- **Variety** - Heterogeneous content, for example a combination of structured data from enterprise systems, data captured from social media, sensor data and video data from surveillance camera's. In general, big data is assembled from multiple sources: data that is generated by the own organization, data that is provided by partners and data that is harvested from the public Internet.

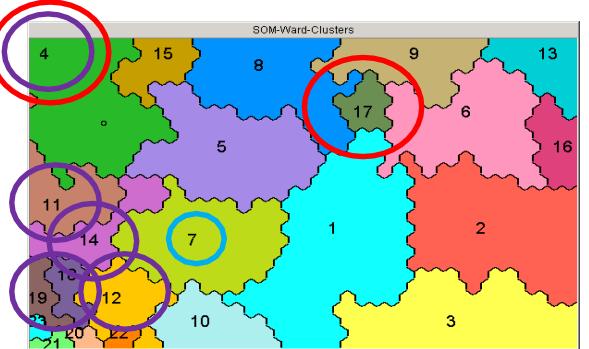
## Results of a CIO survey

In a Technology Trends survey among leading CIO's, Deloitte and CIO Magazine (NL) asked the CIO's to respond to the thesis "*Big Data and Analytics have much more potential for my organization than currently realized*".

86% of all respondents answered positively (34%: strongly agree, 52%: agree)

## Advanced analytics

Advanced analytics on enterprise data is applying statistical techniques on complex data sets to find patterns and correlations between variables. Typical examples are: outlier detection, clustering, pattern recognition and link analysis.



Source: [www.flowingcity.com](http://www.flowingcity.com)

## Advanced visualization

Visualization techniques extending beyond traditional graphs and charts and with interactive features. It combines information technology, psychology, graphic design and art. The approach builds on human qualities like pattern recognition and interpretation of color, brightness, size and motion. Fine grained sensor data of a city can be visualized as an overlay on geographical maps to be interpreted by humans easily. If done in real time, sensor data can be used to identify early warning signals and take the necessary interventions.

# Open data

Large volumes of rich data (structured data, sensor data, audio, video) form the lifeblood of smart solutions



## What is it and why is it disruptive?

Open data is machine-readable digital data, freely available for everyone to use and republish. The objectives of the 'open data' movement are similar to movements like 'open source'. Major open data initiatives are taken by governments to boost economic growth, for example in the UK ([data.gov.uk](http://data.gov.uk)) and the Netherlands ([data.overheid.nl](http://data.overheid.nl)).

The idea is for companies to improve the quality of their existing services and look for opportunities to develop new services. The trend is not, however, limited to 'open' government data. Businesses, too, will open up their data to innovate the way they compete. By releasing parts of their data, companies expect to ignite the creativity of the crowd, to ultimately generate new revenues. This represents a paradigm shift compared to the current practice of keeping all data proprietary.

## Data Infrastructure

In a smart city, data is as important as the physical infrastructure. In the past centuries, cities developed carefully thought our mechanisms to manage the physical infrastructure. For data, such mechanisms are either lacking or in its infancy. A data infrastructure is required to maintain data and share data and has the following features:

- **Authority** – The data infrastructure is a credible, authoritative source of data.
- **Transparency** – The data infrastructure is transparent about where the data comes from, how it has been collected and how it has been processed.
- **Openness** – The data infrastructure is open for all users, making the data as accessible as possible.
- **Real-time** – The value of data decreases with its age. The use of IoT generates massive volumes of real-time data which can be made available through the data infrastructure.
- **Agility** – In addition to the previous aspect, agility to update data quickly, the data infrastructure should also be agile to encompass new data sets.

The screenshot shows the homepage of the London Data Store. At the top, there are links for 'GREATER LONDON AUTHORITY', 'MAYOR OF LONDON', and 'LONDON ASSEMBLY'. Below that is the 'LONDON DATASTORE' logo. The main navigation menu includes 'Blog', 'Data', 'Topics', 'Community', 'Developers', 'Boroughs', 'GLA Analysis', and 'More'. A search bar at the top right says 'Search all datasets...'. The background image is a scenic view of the London skyline, featuring the London Eye and St. Paul's Cathedral.

The screenshot shows the homepage of the Amsterdam Open Data portal. The header is red with the text 'amsterdam open data' and 'Home' (which is underlined). Other menu items include 'Data', 'Apps', 'Ideeën', 'Documenten', and 'Over Open'. Below the header is a photo of a canal in Amsterdam at night. To the right of the photo is a section titled 'Amsterdam Open Data' with a welcome message in Dutch. At the bottom left, there are stats: '18 Thema's', '172 Onderwerpen', and '416 Datasets'. At the bottom right, there is a link 'Meer lezen >'. A search bar at the very bottom says 'Zoek op Data'.



# Cognitive computing

Cognitive systems combine machine learning with the ability to interact via natural language and create insight from massive amounts of data

## What is it and why is it disruptive?

Cognitive computing systems interact with humans via natural language. They understand questions from humans and can ask for additional information by asking questions themselves. This allows a whole new type of engagement between man and machine.

- They have *learning and reasoning abilities*, that resemble the capabilities of the human brain. They move beyond calculation based on preconfigured rules and programs.
- With these abilities, cognitive computing systems are able to *deal with ambiguity and uncertainty*.
- They are able to *provide confidence scores*, a quantitative value that represents the merit of an answer. This helps users to make the best possible choice.
- They have the ability to *process massive amounts of data*, which cannot be handled by humans any more. A medical doctor for example is not able to read all medical articles that are published.

## Replace or empower humans?

The rise of cognitive systems caused a debate about the impact of these systems on employment. A widely cited article of the University of Oxford estimates that 47% of US jobs is susceptible to being computerized in the next 20 years. However, automating entire jobs or processes is not likely in the near term. More likely is a scenario where parts of jobs are computerized and people will be interacting with cognitive systems, as airline pilots already do today.

## The complex decision what to automate

History shows that automation of work is undeniable valuable, but can has unexpected consequences too. Leaving humans with the tasks that could not be automated may create its own problems. People tend to loose their skills if they do not practice them. Here is an analogy with the use of an autopilot in airplanes. If human pilots do not practice flying without the autopilot, they are ill prepared to take over command when the autopilot fails.

## The value of human skills changes

As routine tasks will increasingly be automated, the skills required for those tasks will tend to become less valuable and less needed in the workforce. On the other hand, skills that are required for the type of work that can not be automated becomes more valuable. These are the skills to perform loosely defined jobs (common sense, general intelligence, flexibility and creativity) and the skills for successful interpersonal interactions (emotional intelligence and empathy).

Finally, as cognitive systems become able to mimic human skills and automate parts of jobs and processes, the ability of critical thinking becomes more important. Insight always starts with asking the right questions and that is typically a skill that is hard to automate.

### IBM Watson

A well known example of cognitive computing is IBM Watson. In 2011, Watson competed on Jeopardy! against former winners Brad Rutter and Ken Jennings. Watson received the first place prize of \$1 million.



Source: Redesigning work in an era of cognitive technologies, D. Schatsky and J. Schwartz, Deloitte Review 17

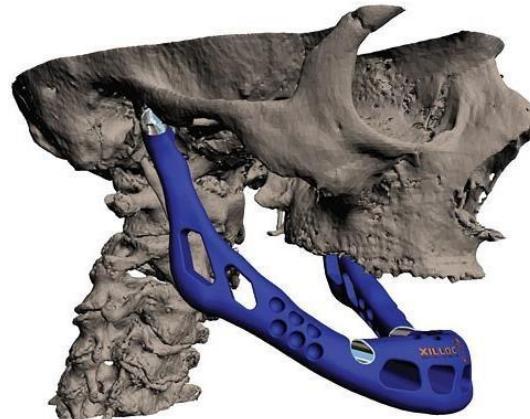
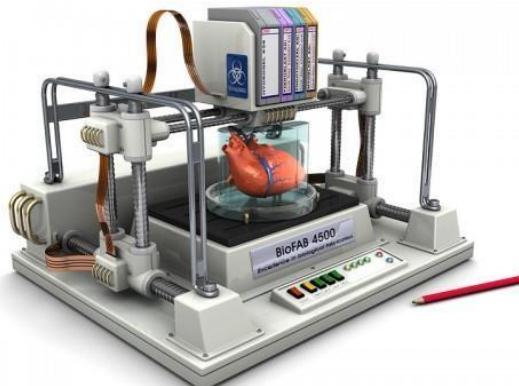


# 3D Printing

Additive manufacturing allows for efficient production of unique products where and when they are needed

## What is it and why is it disruptive?

- A 3D printer uses a digital model to create a physical product through additive manufacturing techniques.
- The traditional production paradigm is based on large batches of identical products. 3D printing makes it possible to economically create one-of-a-kind products and changes the traditional paradigm.
- This allows rapid prototyping, through which research and development cycles can be shortened.
- In the same way, 3D printing makes it possible to create personalized products that are highly tailored to the needs and preferences of customers.
- 3D printing can be used to create spare parts at the time when it is needed and in the location where it is needed, without having to keep large inventories of spare parts and the logistics to distribute them.



3D printing is a revolution: just not the revolution you think

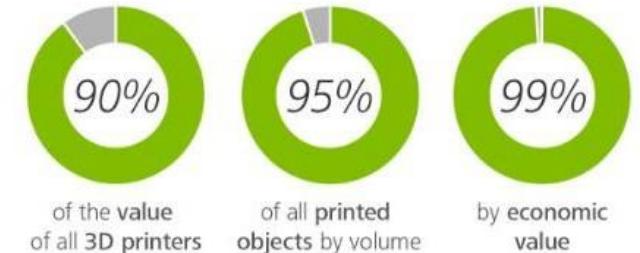
In 2015 nearly  
**220,000**  
3D printers will be sold worldwide



The real revolution is for the  
**enterprise market**  
not the consumer.



ENTERPRISES WILL ACCOUNT FOR ABOUT



Source: Deloitte TMT predictions



# Social Robots

Robots transcend industrial environments as they become more flexible and acquire social skills. Increasingly, they will appear in our daily life environment

## Traditional use of robots

Industrial robots have been used for decades already. They are used for assembling products, handling dangerous materials, welding, spray-painting, etc. The total number of industrial robots is estimated at 1,500,000 and is growing with over 200,000 units per year. About 40% of all robots is used in the car manufacturing industry, which has been completely robotized. China currently shows the largest growth and is expected to have more industrial robots than Europe or the United States by 2017.

In their current environments, robots have been successful because they allow lower production costs compared to human labor. They work 24x7, do not get tired and can work more precise and with less errors than humans.

## Innovations and relevance for smart cities

The successful use of robots in industrial environments does not make them relevant from a smart cities perspective. There is however a number of innovations that do make robotics interesting from a smart cities point of view. The common denominator of these innovations is that robots become more flexible and acquire social abilities that make them suited for entering the arena of our daily lives with the potential to increase quality of life.

**Machine vision** - One of the first relevant innovations is 3D-vision and the ability to recognize 3D objects. Traditionally, industrial robots have a fixed position and require the object they work on and the parts they assemble to be in a fixed position too. Robots with 3D vision are fundamentally different as they are able to operate in semi-structured environments which they interpret through visual abilities. As an example: the US postal service installed some 1,000 robots last year to sort parcels. In July 2015, Amazon organized the 'Amazon Picking Challenge' where teams from universities and research institutions competed with robots that use 3D vision to pick the right consumer items from Amazon warehouse storage facilities.

**Cognitive and Social abilities** – The second major innovation in robotics is robots acquiring cognitive and social abilities. They use artificial intelligence and speech recognition to interact with people through natural language. Even more, they recognize and respond to human emotions and express their own emotions too.

## Potential

Next to the traditional class of industrial robots, a new class of social / service robots emerges. These robots are designed to operate in the same environment as we live in and to assist humans performing all kind of tasks that increase quality of life. Social robots are only in a premature phase. Unleashing the full potential of social robots will probably take decades of research and development. However, the first real life examples are already there.

### F.R.O.G. robot guide

The Fun Robotic Outdoor Guide is developed by the University of Twente and designed to operate in semi-controlled environments like heritage sites and zoos. It is an autonomous robot that spots and approaches people, shows them around, answers questions and then moves on to the next group. The challenge of FROG is to understand social clues: which people form a group, are people having a good time, are people lost and looking for direction? In worst case scenario's, FROG can alert security for assistance.



### ZORA care robot

The ZORA ('Zorg Ouderent Revalidatie Animatie') robot is based on the generic NAO robot and has been programmed to perform tasks in environments where care is provided to e.g. elderly and autistic children. For example by demonstrating physical exercises, playing games and quizzes and being a companion in walking around. The robot is intended to augment the work of human staff and not to replace them. In 2015, ZORA was the first humanoid robot that has been used in the interaction with real people. It won the Health & IT Startup-awards in 2015.



# Self driving vehicles

Transforming the way we transport ourselves, potentially eliminating casualties and traffic jams, while freeing up locations currently used as parking space

## What is it and why is it disruptive?

A specific type of robotics is a self driving car. This concept goes far beyond the driver assistance tools that are currently added to existing cars (e.g. adaptive cruise control, automated parking). Self driving cars have the disruptive potential to reduce the number of casualties and damages to virtually zero, to eliminate traffic jams and reduce commuting time and to eliminate the need for parking spaces from the city.

## How does it work?

Self driving cars are equipped with a range of sensors and intelligent software. At any moment, the car knows its position using maps and sensor data. The sensors are also used to detect objects around the car, it recognizes other vehicles, cyclists, pedestrians, but also unexpected objects on the road. The software uses this information to predict what all objects will be doing next. For example, it will anticipate on another vehicle to slow down speed and on a pedestrian to cross the street. The software then determines a safe speed and trajectory, e.g. by slowing down to yield the pedestrian. Self driving cars will follow traffic rules themselves, but anticipate on other objects not following traffic rules.

## Disruptive type of use

Self driving cars do not just replace the current generation of cars, but require a fundamental different type of use, that differs from the current use where everyone owns a car that is not used – and hence occupying parking space - for 90% of the time. This fundamental change will take time as it needs phasing out traditional cars and changing human behavior. However, the advantages seem too large for not realizing this dream eventually.

If the technology of self driving cars is matched with a shift from possession to use, a pool of self driving cars can be envisaged that constantly roam throughout the city and match demand for transportation with mathematical precision. This would reduce the total number of cars with large numbers. Furthermore, as the fleet of self driving cars find parking spaces outside the city when they are not in use, existing parking spaces in cities will be freed up for other purposes.

### Google car

Starting in 2008, Google is working on a fully self driving car. They experimented with existing cars modified to become self driving and with a new car designed from the ground up. These prototypes have already driven over 1 million miles on the road.



### Volvo Drive Me

Volvo plans a large scale autonomous driving pilot project in which 100 self driving cars will use 50 kilometers of selected roads in and around Gothenburg (Sweden). The project is endorsed by the Swedish Government and aims at establishing insight in technological challenges and feedback from real users.

**“Self driving cars do have benefits, but these are relatively weakly linked to the objectives of most cities. It requires government policies to shape the market to achieve the desired outcomes.”**



# Drones

## Aerial inspection and transportation

### What is it and why is it disruptive?

Drones are unmanned aerial vehicles that are available as entry-level hobbyist model, but also as enterprise model. The latter usually have six or more rotors, large blades and multiple motors. They can be designed to maximize either payload or weight, being able to carry up to three kilograms or flying over one hour time.

The drone market has benefitted from a number of advances in consumer electronics. The rapid increase in quality of high-definition video enabled its primary use for aerial inspection. The accelerometer and gyroscopes used in drones are bulk-produced for smartphones. The availability of smartphones and tablets to control a drone removed the costs of a separate controller.

### Examples

Typical examples of professional use of drones are:

- Energy companies can use drones to inspect wind turbines, which reach tens of meters in the air, removing the need for someone to climb up a structure.
- Building owners can use drones to inspect their buildings, especially the parts of the construction that are difficult to reach by humans, such as the roof.
- Livestock owners can undertake aerial searches for lost animals or even herd them.
- Police forces and rescue units can use drones to complement search and rescue missions, especially by using infrared camera's.
- Geologists can use drones to map uncharted territories, or to survey for oil.
- Off-shore oil rigs can be similarly inspected.
- Archeologists can use drones to make a 3D model of sites and to patrol for looters.
- Television stations can use drones to film footage that would otherwise be hard to reach.
- Finally, drones can be used to distribute medicines in the absence of viable roads.

### Inspection of water ways

In The Netherlands, all water ways are under the responsibility of the Water Board. This Water Board started to use drones for aerial inspection of water ways and nature reserves. These areas are in general difficult to access. Before the use of drones, a team of three experts walked for days in an area to make notes and take photos. With a drone, an inspection can be done in an hour and the video material remains available for later use.



### First drone delivery

On July 17, 2015, the first drone delivery authorized by the FAA took place in the United States. It was operated by Flirtey, a startup based in Nevada. The delivery took place during the annual free clinic run in a remote area, serving 1,500 patients. Medical supplies were delivered to an airport nearby, then broken up in smaller packages and taken by the drones to the Wise County Fairgrounds where the supplies were needed.

## **QUIZ 12**

**Provide 6 MCQs here based on previous slides you have discussed**

**1**

**2**

**3**

**4**

**5**

**6**