SUSTAINABLE HABITAT

A sustainable habitat is an ecosystem that produces food and shelter for people and other organisms, without resource depletion and in such a way that no external waste is produced (which minimizes energy footprint). Thus sustainable home is one that is environmentally friendly, built from recycled materials and runs on renewable energy sources. Such a sustainable habitat may evolve naturally or be produced under the influence of man. The term sustainable habitat often refers to sustainable human habitats, which typically involves some form of green building or environmental planning. In creating such sustainable habitats, environmental scientist, designers, engineers and architects must consider no element as a waste product is to be disposed of somewhere off site, but as a nutrient stream for another process to feed on. Designing a sustainable habitat is a matter of keeping two goals in mind.

- One is to incorporate design concepts and materials that minimize resource use, maximize energy and water efficiency, eliminate exposure to toxic chemicals, and prioritize human health and safety throughout the construction process.
- The second is to identify ways and means such that the building and the living can actually help protect the environment through practices that restore nature in specific and meaningful ways.

GREEN BUILDING

- Construction uses large quantity of energy, water and other natural resources. The increase in population and corresponding increase in construction cause more waste generation. Improper planning causes huge losses in terms of utilization of facilities at a particular site.
- Green Building or Green Construction or Sustainable Building refers to a structure that uses process which is environmentally responsible and resource efficient throughout a buildings lifecycle (i.e., from design, construction, maintenance, renovation to demolition)

Green building are those which use optimum resources and energy, conserve the natural resources, generate less waste and provide a healthy environment for occupants. Green building design aims at achieving a balance between sustainability needs and housing requirements.

Objectives of Green Building Concept:

1. Reduced energy consumption without sacrificing the comfort levels
2. Reduced destruction of natural areas, habitats, biodiversity and reduced soil loss from erosion etc
3. Reduced air and water pollution.

4. Reduced water consumption
5. Limited waste generation due to recycling and reuse
6. Reduced pollution loads
7. Increased user productivity
8. Enhanced image and marketability.

Characteristics of green buildings

1. Efficient use of energy, water and other resources
2. Protecting occupant health and improving employee productivity
3. Reducing waste, pollution and environmental degradation.

The key features of green building are:

1. **Proper site selection:** the selection of site is very important due to many reasons .accessibility to roads, school and other amenities reduce the cost of living as well as unnecessary utilization of resources. The selection of site should take into account the environmental concern, i.e. whether there is any destruction of forest, wetlands, agricultural land etc. proper orientation of a house facilities natural ventilation, heating or cooling and thus energy consumption for these processes can be reduced. Also the possibilities for harnessing sunlight must also be utilized in order to use it for natural lighting, heating or electrification.
2. **Structural design efficiency:** At the time of design it is very important to consider the life-cycle of the materials used. Each building material and its effect on the occupants, resources and the environment must be checked properly. Materials harmful to the environment must be avoided and alternative must be used creatively. The design of the building should provide natural means of ventilation, maximum natural lighting, utilization of solar energy, etc.
3. **Energy efficiency:** The quest for energy efficiency must start from installation and continue through each step of operation. Building techniques used must be suitable for conditions at the site. A design suitable for a dry, hot region might not produce the desired results at a site where the climate is tropical. Thus the energy management solution adopted must be on the basis of thorough study of such factors. At the time of construction, building materials and processes must have low energy consumption. During the operation, if windows and ventilations are properly placed, the energy required for Heating, Ventilation and Air conditioning (HVAC) can be minimized. The utilization of day light, solar energy for heating, right placement and maintenance of trees for creating shadows, etc. are some of the

methods to achieve energy efficiency in a green building.

4. **Water efficiency:** Reduction in consumption of water and protecting water quality are equally important. In a green building, both these requirements must be addressed. Facilities for water collection, treatment recycling and reuse are the important factors in the implementation of green buildings. Water harvesting must be done properly to collect fresh water available from nature. Ultra low flesh toilets which use as little as 6 liters of water per flush as opposed to 13-15 liters in conventional flush tanks and low flow shower heads are examples of water conserving devices in green building.
5. **Material efficiency:** Construction materials for green buildings include lumber, bamboo and straw, recycled stone and recycled metals. It is expected building materials for green buildings are non- toxic, reusable, renewable and recyclable. Industrial wastes like combustion products or foundry sand are also used as building materials.
6. **Indoor environmental quality enhancement:** The three important parameters coming under this objective are indoor air quality, thermal quality and lighting quality. In indoor air quality, the main issues include the reduction of volatile organic components and moisture. Volatile organic component will cause bad odour and toxic emissions, whereas moisture helps the presence of bacteria and mould. The HAVC system should mainly depend on passive system related to the surfaces of the rooms and envelope of the building. Occupants should not be affected by any health problems like asthma and allergy which are related to air quality.
7. **Operation and maintenance optimization:** Even if the design of a building is sustainable, it is the operation and maintenance that keeps up the tag. Trained personnel can do optimum operation and maintenance.

Waste reduction: Waste reduction is an essential requirement during many phases of the building's life-cycle. During the maintenance or demolishing of a building, it should not have much waste other than those suitable for recycling. This part is crucial because in many countries the major component of landfills is construction materials. Waste water, bio-degradable wastes and other must efficiently treated, and energy must be generated from this. There are projects in which waste water, human waste and other organic materials are taken to centralized biogas plants for the production of energy.

GREEN MATERIALS FOR BUILDING CONSTRUCTION

The green building materials are materials which are locally produced and sourced and include recycled materials which have low CO_2 emissions, reduced transportation cost, lower environmental impact, thermal efficiency, less energy, and financial viability. Following are the major criteria for selecting the materials:

1. Locally produced and locally available materials.
2. Transportation cost.
3. Environmental impact
4. Occupant needs and health considerations
5. Thermal efficiency for maintaining comfort depending on the climate.
6. Financial viability.
7. Recycling and re-usability of building materials and demolished buildings.
8. Pollution generated during manufacturing, construction and usage.
9. Treating the wasted part of construction materials.
10. Energy required in manufacturing process.
11. Use of alternative and renewable sources of energy in production.
12. Maintenance cost.

For example:

i. Use of fly ash, which is a by-product of coal burning power plants, as a substitute for Portland cement in the construction of foundations.
ii. Use of concrete and rubble for drainage and back fill purposes.
iii. Use of polystyrene for insulation of foundation to minimize heat loss.
iv. Use of engineered lumber instead of wood to reduce deforestation. This can be achieved by replacing solid swan lumber with wooden I-Joints. Another strategy is to replace wooden structures as much as possible with steel structures which are 95% reusable.
v. Use of insulated pipes and heaters will reduce heat loss and thus energy can be saved.
vi. Replacement of toilets with ultra low flush models and fix chlorine filter on shower head. Brown cellulose insulation is a type of insulation used in green buildings.
vii. Use of LED light instead of incandescent lamps and CFLs for energy saving.
viii. Use rapidly renewable flooring option such as bamboo, cork, sorghum, eucalyptus and palm. Use wool, sisal, sea grass, etc. for carpets. Recycled ceramic tiles and stone tiles are also used for flooring.

ix. Use of low Volatile Organic Compound (VOC) paints, lime paint, milk paint and natural plaster for wall painting to reduce health problems to the occupants and also for reduction of toxic emission.

GREEN BUILDING CERTIFICATION

Energy efficient green building concept is followed by many construction firms. In order to fix the standards, several criteria are considered important, and based on these, rating are provided for green buildings. The primary rating systems in India are:

1. GRIHA (Green Rating for Integrated Habitat Assessment)
2. LEED (Leadership in Energy and Environmental Design)

GRIHA Rating

GRIHA rating system has 34 criteria out of which eight (Criteria 8,9,13,27,28,30,32,33) are mandatory, four (Criteria 1,5,14,18) are partly mandatory and others are optional. Based on compliance to these criteria, points are fixed. The maximum obtainable score is hundred. Based on the points obtained there will be star rating ranging from one to five. The steps for rating procedure are:

1. Submission of online application
2. Submission of details regarding the building. Documents to substantiate the claims must be submitted alongside.

The project is evaluated using three-tier system.

1. A preliminary inspection by a GRIHA team will be conducted, and they will validate the details. GRIHA will study the evaluation report, and same will be sent to the experts in relevant field.
2. These experts will evaluate the criteria independently and assign points. Based on the suggestions, the client will be given extra time of one month for making necessary modifications.
3. After modifications are carried out, the above procedure is repeated. The final points are fixed and based on the score obtained the rating will be awarded.

GRIHA Rating: Score will be out of 100.

i. One star - for score obtained between 50-60
ii. Two star - for score obtained between 61-70
iii. Three star - for score obtained between 71-80
iv. Four star - for score obtained between 81-90
v. Five star - for score obtained between 91-100

GRIHA Criteria

Criterion 1	Sire selection
Criterion 2	Preserve and protect landscape during construction/compensatory depository forestation
Criterion 3	Soil conservation(post construction)
Criterion 4	Design to include existing site features
Criterion 5	Reduce hard paving on site
Criterion 6	Enhance outdoor lighting system efficiency
Criterion 7	Plan utilities efficiently and optimize on-site circulation efficiency
Criterion 8	Provide minimum level of sanitation/safety Facilities for construction workers
Criterion 9	Reduce air pollution during construction
Criterion 10	Reduce landscape water demand
Criterion 11	Reduce building water use
Criterion 12	Efficient water use during construction
Criterion 13	Optimise building design to reduce conventional energy demand
Criterion 14	Optimise energy performance of building within specified comfort limits
Criterion 15	Utilisation of flyash or equivalent industrial/agricultural waste as recommended by BIS in building structures
Criterion 16	Reduce embodied energy of construction by adopting material efficient technologies and/or low-energy materials
Criterion 17	Use of low energy materials in interiors

Criterion 18	Renewable energy utilisation
Criterion 19	Renewable energy based hot water system
Criterion 20	Waste water treatment
Criterion 21	Water recycle and reuse (including rain water)

Criterion 22	Reduction in waste during construction
Criterion 23	Efficient waste segregation
Criterion 24	Storage and disposal of wastes
Criterion 25	Resource recovery from waste
Criterion 26	Use of low-VOC paints/adhesives/sealants
Criterion 27	Minimize Ozone Depleting Substance
Criterion 28	Ensure water quality
Criterion 29	Acceptable outdoor and indoor noise levels
Criterion 30	Tobacco and smoke control
Criterion 31	Provide at least the minimum level of accessibility for persons with disabilities
Criterion 32	Energy audit and validation
Criterion 33	Operation and maintenance
Criterion 34	Innovation points

LEED Rating

The Confederation of Indian Industries (CII) formed an Indian Green Building Council (IGBC) in 2001. IGBC has its office in CII-Sohrabji Godrej Green Business Center which itself is a LEED certified green building. Now, IGBC is the licensed authority for LEED certified green building in India.

The five properties of LEED India are:

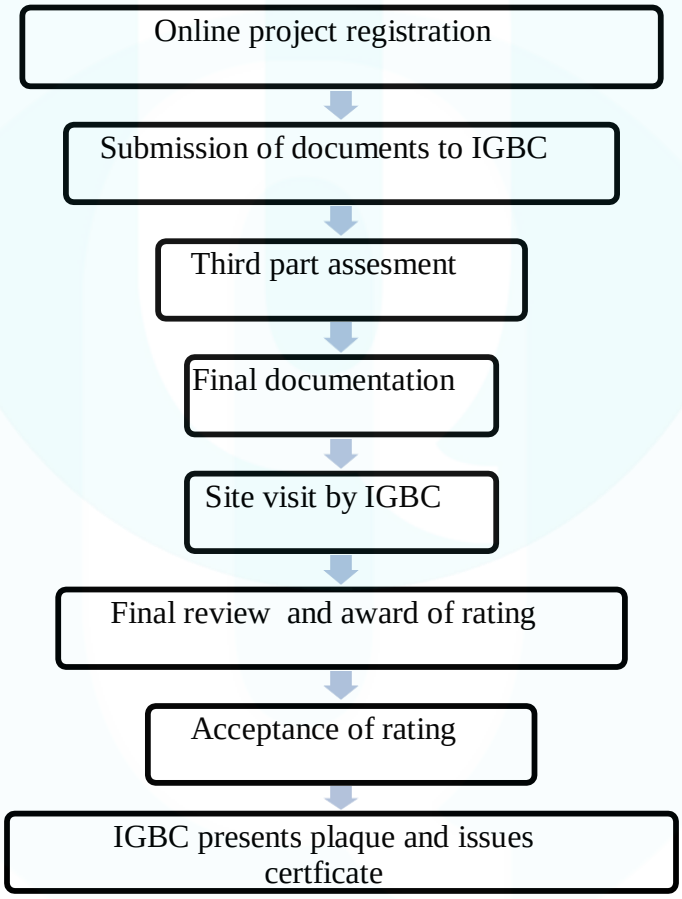
i. Sustainable site development
ii. Water savings
iii. Energy savings
iv. Material selection
v. Indoor environmental quality

The rating of the building is shown in table given below:

Rating	Recognition
Certified	Good practices
Silver	Best practices
Gold	Outstanding performances
Platinum	National excellence
Super platinum	Global leader ship

Organizations seeking certification should register through the IGBC website. This provides access to the required documents, templates, important communications and other necessary information. After the preliminary submission, a third party assessment will take place. Within 30 days, reviewer 'comments will be provided. The firm must provide whatever clarifications are sought, and another review followed by a site visit is conducted within 30days. The rating will be awarded on this basis.

LEED Procedure



ENERGY IN BUILDING

Energy in buildings can be categorized into two:

- Energy for the maintenance / servicing of a building during its life
- Energy capital that goes into production of a building using various building materials.

ENERGY EFFICIENT BUILDINGS

Concept of energy efficient buildings

To reduce the overall environmental impact by efficiently using energy, water and other recourses, new technologies are relied in making the structures green or buildings sustainable. Energy efficient buildings protect the health of occupants and improve the employee productivity. Green buildings often include measures to reduce energy consumption both the energy required to extract, process, transport and install building material and operating energy to provide services.

Energy efficient buildings consume less energy and the costs of operations in such buildings are low. With the development of green buildings and their ratings based on GRIHA or LEED, methods for energy efficiency are incorporated in different ways.

Methods to make a building energy efficient

1) **Passive solar energy utilization:**

   The consumption of gas or electricity for heating and lighting can be partly offset by utilizing solar energy. Photovoltaic system attached to the roof top of a building produces electricity for different uses. Since low energy LED lights are available, the energy collected during the day time itself will be sufficient for night-time as well. The proper orientation of rooms for capturing sufficient day light will reduce the use of electricity lighting during the day time.

2) **Thermal storage:**

   Strategic window placement helps to collect heat and light from the sun during the day time. Glazing of windows with appropriate shading to prevent undesirable heat again, use of light-coloured materials or paint for building envelopes and roofs, careful siting, orientation and appropriate landscaping help in temperature management. Shading strategy includes overhangs and porches, trees and other vegetation, roll down shades or shutters, etc. The walls with thick bricks absorb more heat and release it when required.

3) **Cooling strategies:** The vapour absorption type air conditioners are used for cooling during summer by connecting it with solar heaters. Evaporative cooling systems are used in connection with solar systems.

4) **Reducing electricity usage:**

   Sensors can be used which will switch off lights, fans and other electrical equipment by sensing the absence of occupants. Sensors of this nature are known as occupancy sensors.

There are also light sensors which will dim electric lights according to the luminance of other lights available in the room. So the average luminance of the room will always be the same. Automatic shutters or doors in air conditioned rooms reduce losses due to opening and closing.

5) **High performance insulation:**

Insulating panels made of rigid plastics are used to cover walls. Insulation is done not only for the walls but also for roofs and floors. These panels are generally less expensive compared to wooden panels. Labour cost associated with them is also less.

These latest techniques in modern building include computerized control of building parts with occupancy sensors, lighting sensors and thermostats. The energy efficient buildings are economic and sustainable by ensuring that only minimum resources are consumed during construction and operation.

SUSTAINABLE CITIES

A sustainable city (Eco City) is a city designed with consideration of environmental impact, inhabitants by people dedicated to minimization of required inputs of energy, water and food, and waste output of heat, air pollution, CO_2, methane and water pollution.

Sustainable city can be also defined as a city which should meet their "inhabitants' development needs without imposing unsustainable demands on local or global natural resources and systems".

From 2007 onwards 50 percent of the world population is living in urban areas. The extrapolated living in cities may reach 70 percent by2050. The concentration of large number of people is expected produce economic growth and social development as the accessibility to all amenities will be more compared to rural areas. Also necessities like electricity, water supply, educational institutions and other services are more available in cities. But the most difficult part is the expansion of these facilities in tune with the population increase. Also, population rates and waste disposal issues are more serious in cities. So, sustainable cities are the need of the hour. The concept of sustainable city is necessary for the future, since urbanization is a growing trend in the world. There are three pillars of sustainability

1. Social development
2. Economic development
3. Environmental management

Social development supports the major concerns of education and health for all. Food and nutrition with good recreation facilities and community support is necessary for sustainable city. Green buildings should be the trade mark of sustainable cities to reduce energy losses and avoiding resources degradation. Effective and sustainable solutions for water and sanitation are required for the community to be sustainable. Access to green energy should be attained by proper planning.

Economic development, which is a main factor, is the second pillar. It deals with green productive growth, creation of decent employment, production and distribution of renewable energy and research and development. All these will contribute to economic growth which in turn will produce more opportunities. The people moving to the cities by

urbanization can be satisfied only by the second pillar.

Environmental management is an important pillar which forms the basis of sustainability. Waste management, forest and soil conservation, energy efficiency systems, air and quality management, reduction in factors contributing to climate change, etc. must be practiced.

High density of population necessitates efficient urban governance. Planning and decentralization is imperative to the establishment and maintenance of a sustainable city. Civil and political rights must be strengthened to develop a community with a hearty self-esteem. The reduction of inequities is very essential to maintain harmony in a society which is the backbone of the sustainable cities.

Basic features of sustainable city

1. Sustainable city should be in harmony with nature
2. More natural open spaces
3. Predominant transport mode to be walking, cycling and public transport
4. Minimise the required inputs such as water, energy, and other resources
5. Conservation of existing water bodies and rain water harvesting
6. Tap more renewable energy sources and reduce relying more on non renewable energy sources
7. Maximise recovery, reuse and recycling of waste materials
8. Maintenance of law and order reduces the crime rates
9. Create jobs for the local population and implementation of poverty elimination programmes
10. Improved waste management

SUSTAINABLE TRANSPORT

According to Black, the definition of sustainable transport is “transport that meets current transport and mobility needs without compromising the ability of future generations to meet these needs” D.W Pearce and E.Daly have given the definition as “transport and mobility with non-declining capital, where capital includes human capital, monetary capital and natural capital.”

Transportation systems give rise to the following issues:

1. The combustion of fossil fuels cause air pollution and GHG emissions which exacerbates environmental ills like climate changes and global warming.
2. If the fuels and energy sources used are non-renewable, there is the possibility that they will get exhausted.
3. Unsustainable transportation methodologies cause traffic bottle necks due to the unforeseen increase in motorized vehicles plying the roads.
4. Safety of pedestrians physically challenged and users of non-motorized vehicles cannot be ensured.
5. The development of roads is not at par with the huge increase in vehicle population.
6. Increase in private individual transport system like cars by the middle class reduces the significance and efficiency of public transport system. This also increases traffic problems due to excess vehicles.

In order to address the above issues, the following solutions must be taken into consideration:

1. Needed of good planning for sustainability. On the roads, priority must be given to pedestrians, cyclists, public transport usage, specialist service vehicles for emergency and waste disposal and other motor traffic in that order.
2. The streets also must be provided with car free zones giving priority to pedestrians and non- motorized vehicles. Cars must be used only when there is sufficient number of travelers. Public transport system should provide maximum connectivity to schools and residential areas. Other motor vehicles must be limited to designated roads.
3. The vehicles which use alternatives energy sources are to be promoted for the sake of

environment. This will reduce GHG emissions considerably.

4. Congestion on roads can be minimized by promoting the use of rails and other public transport systems
5. The public transport system must be efficient. There should be well-designed vehicles which use hybrid energy principles. The public transport vehicles should be maintained properly. Good personnel management is also essential for providing better services. Metro rail and mono rail projects in cities will reduce the congestion
6. On the roads there must be facilities like bus bays, bus lines and special priority for public transport vehicles at signals.
7. Walking and cycling for short distances are to be made attractive by providing prioritized paths in streets and cities.
8. Walking and cycling will reduce the GCG emissions. Moreover it is healthy as well. Subways must be provided for the safety of pedestrians.
9. Taxes and charges must be imposed on private motor vehicles in order to promote public transport system
10. Routing and scheduling of the public transport system are to be modified in accordance with public opinion. There must be easy access to the public by providing online facilities for ticket booking and awareness about the time schedules and routes. Modern communication systems are also to be used for assisting the public to access the transport facilities.
11. Offices and other institutions must be located as close to each other as possible and thus movements of people can be optimized.

GREEN ENGINEERING

Green engineering approaches the design of products and processes by applying financially and technologically feasible processes and products in a manner that simultaneously decreases the amount of pollution that is generated by a source, minimizes exposures to potential hazards (including reducing toxicity and improved uses of matter and energy throughout the life cycle of the product and processes). In so doing, the overall health and ecological stress and risk are reduced.

As such, green engineering is not actually an engineering discipline in itself, but an overarching engineering framework for all design disciplines.

Green Engineering Principles:

1. Engineer processes and products holistically, use systems analysis, and integrate environmental impact assessment tools.
2. Conserve and improve natural ecosystems while protecting human health and well-being.
3. Use life-cycle thinking in all engineering activities.
4. Ensure that all material and energy inputs and outputs are as inherently safe and benign as possible.
5. Minimize depletion of natural resources.
6. Strive to prevent waste.
7. Develop and apply engineering solutions, while being cognizant of local geography, aspirations, and cultures.
8. Create engineering solutions beyond current or dominant technologies; improve, innovate, and invent (technologies) to achieve sustainability.
9. Actively engage communities and stakeholders in development of engineering solutions.

Green engineering involves four basic approaches to improve processes and products to make them more efficient from an environmental standpoint

1. Waste reduction;
2. Materials management;
3. Pollution prevention; and,
4. Product enhancement

SUSTAINABLE URBANIZATION

Urbanization may be defined as the movement of population from rural to urban areas, the growth of cities in number and size and the increase of the share of urban population in total population.

Sustainability adds new dimensions to urbanization. Conversely, urbanization, depending upon its pace, nature and patterns, may create numerous problems or opportunities that will need special treatment. Therefore, sustainable urbanization is the maximization of economic efficiency in the use of resources including air, water and soil, maintaining natural resource stocks at or above their present level, ensuring social equity in the distribution of development benefits and costs, and avoidance of unnecessary foreclosure of future development options.

Rapid urbanisation is arguably the most complex and important socio-economic phenomenon of the 20th and 21st centuries. Generally understood as a shift from a predominantly rural to a predominantly urban society, it also represents major and irreversible changes in production and consumption and the way people interact with nature.

For sustainable urbanisation the following points should be kept in mind

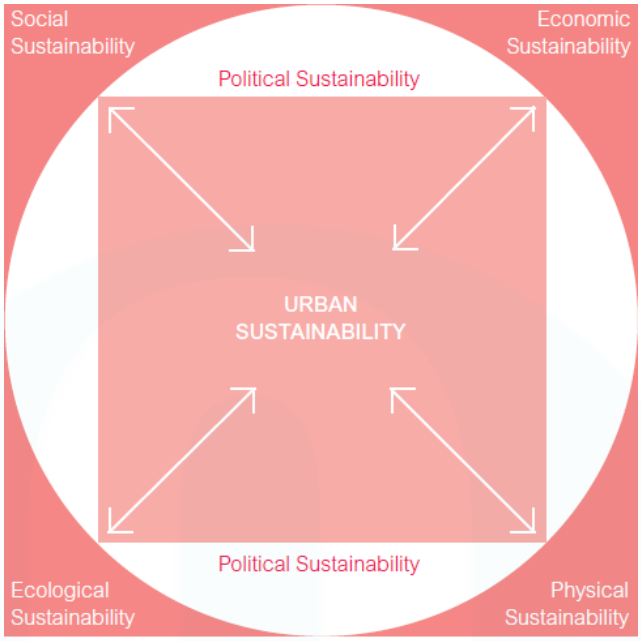
ECONOMIC SUSTAINABILITY is understood as the capacity and ability of a practice to be able to put local/regional resources to productive use for the long-term benefit of the community, without damaging or depleting the natural resource base on which it depends and without increasing the city's ecological footprint. This implies taking into consideration the full impact of the production cycle.

SOCIAL SUSTAINABILITY refers to the fairness, inclusiveness and cultural adequacy of an intervention to promote equal rights over the natural, physical and economic capital that supports the livelihoods and lives of local communities, with particular emphasis on the poor and traditionally marginalized groups. Cultural adequacy means, in this context, the extent to which a practice respects cultural heritage and cultural diversity.

ECOLOGICAL SUSTAINABILITY pertains to the impact of urban production and consumption on the integrity and health of the city region and global carrying capacity. This demands the long term consideration of the relation between the state and dynamics of environmental resources and services and the demands exerted over them.

The SUSTAINABILITY OF THE BUILT ENVIRONMENT concerns the capacity of an intervention to enhance the livability of buildings and urban infrastructures for 'all' city dwellers without damaging or disrupting the urban region environment. It also includes a concern for the efficiency of the built environment to support the local economy.

Last, but not least, POLITICAL SUSTAINABILITY is concerned with the quality of governance systems guiding the relationship and actions of different actors among the previous four dimensions. Thereby, it implies the democratization and participation



The outer most rectangle shows the original ecological capacity which consists of all the resources based on which the sustainability of economy, society, built environment and ecology can be achieved. The circle connects all these through the political sustainability to govern the resources and other capacities. If all these are balanced without pulling each other in different directions, sustainable urbanization cab be obtained.