

**GREEN AIRPORT: AN INNOVATION IN AIR  
TRANSPORTATION**

A  
THESIS

*Submitted in partial fulfilment of the requirements for the award of the  
degree of*

**MASTER OF TECHNOLOGY**

**IN**

**CIVIL ENGINEERING**

*With specialization in*

**CONSTRUCTION MANAGEMENT**

*Under the supervision*

*of*

**Mr. Aakash Gupta**

**(Assistant Professor)**

*by*

**Rajat Thakur (172609)**

*to*



**JAYPEE UNIVERSITY OF INFORMATION TECHNOLOGY**

**WAKNAGHAT, SOLAN – 173234**

**HIMACHAL PRADESH, INDIA**

**May – 2019**

## **STUDENT'S DECLARATION**

I hereby declare that the work presented in the Project report entitled “**Green Airport : An Innovation in Green Transportation**” submitted for partial fulfilment of the requirements for the degree of Master of Technology in Civil Engineering at **Jaypee University of Information Technology, Wagnaghat** is an authentic record of my work carried out under the supervision of **MR. AAKASH GUPTA** (Assistant Professor). This work has not been submitted elsewhere for the reward of any other degree/diploma. I am fully responsible for the contents of my project report.

Signature of Student

Rajat Thakur

172609

Department of Civil Engineering

Jaypee University of Information Technology, Wagnaghat, India

... May 2019

## CERTIFICATE

This is to certify that the work which is being presented in the project report titled **Green Airport : An Innovation in Green Transportation** in partial fulfilment of the requirements for the award of the degree of Master of Technology in Civil Engineering submitted to the Department of Civil Engineering, **Jaypee University of Information Technology, Wagnaghat** is an authentic record of work carried out by **Rajat Thakur (172609)** during a period from July, 2018 to May, 2019 under the supervision of **Mr. Aakash Gupta** Department of Civil Engineering, Jaypee University of Information Technology, Wagnaghat.

The above statement made is correct to the best of my knowledge.

Date: .....

Signature of Supervisor

Mr. Aakash Gupta

Assistant Professor

Department of Civil Engineering

JUIT, Wagnaghat

Signature of HOD

Dr. Ashok Kumar Gupta

Professor and Head

Department of Civil Engineering

JUIT, Wagnaghat

External Examiner

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**Rajat Thakur**

**(172609)**

## ABSTRACT

Aviation assumes a critical job in present day socio-economies, giving availability and openness, and encouraging trade. Airplane terminals are basic hubs noticeable all around transport framework and of the domain network also. Airplane terminals are an incredible place to advance economical living and bringing down the carbon impression. Airplane terminals would go for the stringent 'Economical Guidelines' guaranteeing utilization of least common assets viz. vitality and water, profoundly proficient waste administration and by and large less carbon impression. This could likewise be clarified with "Triple Bottom Line" viz. Monetary Growth, Social Responsibility and Environment Stewardship. A vital and incorporated way to deal with characterize the airplane terminal framework configuration consenting to the particular maintainability prerequisites is required. The point of the paper is to show the concentrated on the improvement of a system for the manageability execution based assessment of airplane terminal undertaking plan and mechanical techniques to upgrade the ecological limit of the foundation amid its life cycle. Natural and operational limit can be expanded through a long haul arranging guaranteeing a viable ecological administration that makes up for development through the presentation of eco-proficient foundation, mechanical, and working techniques. The proposed research characterizes particular techniques and instruments empowering both plan venture control and maintainability examination. The destinations are accomplished through the definition, investigation and evaluation of the answers for ecological limit and maintainable air terminal system advancement through inside and out investigation of the effects emerging from airplane terminal activities and framework. In this particular research , Shimla Airport is considered under study to compare the cost efficiency between conventional and green airport components using various recent eco-friendly techniques such as smart runway, waste water treatment and solar panel etc.

**Keywords:** Sustainable mobility; Service operations; Cost efficiency; Solar panels.

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# CHAPTER 1

## INTRODUCTION

### 1.1 GENERAL

Aviation industry is developing quickly and air terminals are making a positive effect on social and financial prosperity of the network they are situated in. In any case, it is likewise causing negative effect on condition and nature with basic issues, for example, vitality, contamination (air, water, and sound) and abuse of regular assets. Airplane terminal super structures have a greater obligation on them. Being monster assets chugging framework, Airports can never again bear the cost of not to make strides toward environmental friendliness and be economical. In future, every one of the Airports would go for the stringent 'Feasible Guidelines' guaranteeing utilization of least common assets viz. vitality and water, very effective waste administration and by and large less carbon impression. Air terminal Authorities are step by step receiving these worldwide models which incorporate various imaginative methods, for example, high-productive coating framework, effective and computerized lighting frameworks, green materials and synthetic compounds, water collecting, water reusing, squander the board and so forth. In a more drawn out run, we would see cutting edge air terminals designers focusing past green building affirmation. At the appropriate time, air terminals administrators will go for self-upgrading procedures to enhance the manageability file past the customized arrangements.

By sustainable improvement, we try to address the issues of the present without trading off the capacity of future ages to address their very own issues. This could likewise be clarified with "Triple Bottom Line" viz. Monetary Growth, Social Responsibility and Environment Stewardship. In the present time, there is noteworthy mindfulness about making strides toward environmental friendliness. When an intricate language 'Supportability' has now turned into a need of our time. In future, Airports will go past the green tag and will endeavour to be maintainable supported by in general execution and effectiveness. Summing it up, cutting edge airplane terminals will be structured, developed and worked so as to not have any negative effect on nature. Distinctive fronts of a constructed situation maintainability incorporate. vitality, water, indoor environment and operations.

On the vitality front, most airplane terminals will be net-zero vitality shoppers, i.e. they will act naturally dependent as far as their vitality needs and won't expend any power from the network. Give us a chance to comprehend this dependent on interest side and supply side vitality utilization. On the interest side, air terminals will be structured in a way by which there is no lighting utilization amid daytime task. Furthermore, compositional structure highlights to get in ideal, sans glare light. New innovations like light pipes, light catcher arches, characteristic lighting with fiber optics, and so forth will guarantee nil counterfeit light utilization amid daytime activity. This, upheld by appropriate plan of supply side of vitality, utilizing heap inexhaustible innovation and fuel alternatives, will prompt net zero or even a net positive vitality foundation. Mapping of all conceivable vitality sources be it sun powered, wind, geothermal, fuel, and so forth ought to be done, their all out site potential investigated and techniques to outfit them to the greatest, investigated. Much legitimacy is there for such assessment as much land is accessible for an air terminal considering the airside arrive accessibility to effectively focus on this accomplishment. In India, Kochi air terminal has just accomplished the accomplishment of first net zero vitality airplane terminal in the planet through sun powered power.

## **1.2 Indoor environment quality is a must for any airport**

Peoples of various countries, districts, organizations, restorative patients, and so on merge on an airplane terminal consistently, consistently. The issue of tainting of indoor air and to guarantee that it generally remains sound for all is in reality a test. Sufficient natural air ventilation, filtration to trap even wheeze beads of H1N1 contamination, adequate oxygen levels at various traffic levels, and so forth are to be sure a test. The parity of natural air prerequisite alongside advancement of vitality utilization to treat this outside air makes this test considerably trickier. Modern airplane terminals will make their very own natural air without taking any outside air for this issue. This will guarantee a solid indoor condition with nil vitality utilization in cooling outside natural air.

Modern air terminals will most likely be touchy to squander age and reusing. With legitimate isolated accumulation of waste, one could without much of a stretch accomplish 100% reusing of all waste created. Most forward looking association, natural ways of life, hoteliers and retailers can all things considered social gathering and accomplish zero utilization of

virgin crude materials for every one of their necessities. Advanced air terminals will be structured and worked in a way by which they will initially outline assets that nature have accommodated them and consistently screen the amount of these assets are being used by them. This will to be sure be a definitive proportion of maintainable and green execution of a future air terminal.

### **1.3 Characteristics of Green Airport**

- i.** Airport vehicles will be taken as electric charged vehicles for using low emission of carbon footprint.
- ii.** Energy efficient cooling or heating system has to used in terminal building and adjacent spaces.
- iii.** High performance glazing is to be used for reduce the interior glare and solar heat build up in the concourse.
- iv.** Electric charging refuelling stations are provided in parking.
- v.** 100% Rain water harvesting.
- vi.** 100% Grey water treatment.
- vii.** Fresh air openings has to be maintain good indoor air quality.
- viii.** Green house keeping chemicals are used.

### **1.4 Green airport parameters**

A green airport has been defined in many ways. The most acceptable description in most of the literature and sustainable dictionaries is - 'Green airport (also known as sustainable airport or green construction) refers to both a structure and the discrimination of processes that area unit environmentally liable and there is less recourse used in the whole life of building from siting to style, maintenance, renovation, construction, operation and demolition. Another popular approach to define a green building highlights the enhanced efficiency in buildings due to sustainable parameters. "The observe of skyrocketing the potency of buildings and their use of energy, water, and materials, and reducing building impacts on human health and the environment, through better siting, design, construction, operation, maintenance, and removal of the structure at the tip of use, the whole building life

cycle".

The Indian Green Building Council defines it as 'A green building is one which provide optimize energy efficiency, generates less waste, uses less water, save natural resources and provide healthier environment for occupants, as compared to a conventional building. 'IGBC was one of the pioneers to initiate the Green building movement in our country with CII Sohrabji Godrej Green Business Centre as the first Platinum rated green building in India. (www.igbc.in)

GRIHA – Green Rating for Integrated Habitat Assessment (GRIHA) describes a green building with the fact that it impacts the natural resources to a minimum during its construction and operation. A green building is designed with the aim to minimize the demand on non renewable resources, use resources efficiently and imbibe reuse, reduce and recycle attitude with integration of renewable. (GRIHA Vol. 1) The definitions and descriptions show similar intent to include good practices towards the environment taking into account the holistic approach towards the building life cycle.

The green buildings characterized by various parameters that are defined by the certification programs majorly under common major heads as follows:

- 1. Efficiency of site selection and planning:** Includes surrounding environment, ecology, amenities in site vicinity, stages of construction with site development, landscape design and green cover along with labourer's health and well being.
- 2. Water Management:** It includes water and waste water management with reduce recycle-reuse concept enhancing water savings, water resource optimization and water use for various other utilities including irrigation of the designed landscape.
- 3. Energy Efficiency:** Optimization of building design with elements as per solar passive options is included with renewable resource optimization and energy saving options with various electrical and mechanical utilities.
- 4. Materials:** Includes selection of sustainable materials and the technologies with material waste management.
- 5. Indoor Environmental Quality:** Includes optimized comfort parameters along with day to day measures to practice sustainability and control pollution.
- 6. Innovation:** Exemplary achievements along with sustainable innovations are included.
- 7. Audit & Maintenance:** It includes optimization of operation and maintenance for

efficiency in day to day life.

## **1.5 Sustainable Aspects of Green Buildings**

The most significant impact of a green building is related to the social well being improving the overall quality of life and health. In view of environment and economic benefits of green building, the social benefits are often ignored and taken a back foot. For every construction activity it is utmost important that the end user should be comfortable and lead a good life in the space designed and created as his dwelling. It is equally important to create a space that is no harm to the surrounding eco system and enhances the regional biodiversity retaining the natural balance

Further these aspects are often compromised on economic grounds as the need for a dwelling is at a much higher position than the need for a comfortable and quality space that is not harming the environment.

### **A) Social Impacts**

The social impacts of economical structure are dependably in the positive mode except if confused. They are identified with the enhancements in the personal satisfaction, wellbeing, and prosperity of the tenants. According to the LEED rating, these advantages can be fathomed at different dimensions – structures, the network, and society on the loose. At a structure level, investigate on a maintainable development has three essential fundamental angles: wellbeing, solace, and delight. In spite of the fact that these results are obviously interrelated, they have diverse scholarly extraction and use various strategies.

Medical problems are the circle of general wellbeing experts while comfort is examined by specialists with mastery in structure science and physiology and the prosperity and psychosocial forms are considered by ecological and test clinicians.

The structure setting will have each negative and positive effects on the tenant's personal satisfaction. Negative effects incorporate sickness, non-appearance, weakness, inconvenience, stress, and diversions coming about because of poor indoor air quality, warm molding, lighting, and explicit parts of inside space structure that are horrifying resultants of unseemly materials choices and human densities. Reducing these problems through sustainable design with green buildings often improves health, performance and creates positive psychological and social experiences.

There are various studies that prove the social benefits of the green approach that can help change the outlook for a city or a region improving upon the air, water and noise environment lessening the issues like traffic and landfills (Frank, 2000).

### **B) Environmental Impact**

All the green certification ratings have confirmed that green buildings reduce the impact on the surrounding environment at all phases of construction enhancing the micro ecosystem. Green certification norms establish a solid set of benchmarks with regards to the built environment (Megaron, 2016). With the phenomenal growth for the residential construction and the concepts of green building penetrating in the industry ensuring good savings and good benefits, Joel Makower, Chairman, Green biz group stimulates a question for all in the market as -How good is '**good enough**'? With the Green Building Impact Report 2016 of LEED in the Watson summarizes a few observations as mentioned below:

- a) Approximately 400 million vehicle miles travelled have been avoided by the occupants of LEED buildings.
- b) LEED buildings consume approximately 25% less energy that amounts to more than 1.3 million tons of coal equivalent each year, representing approximately 78 million tons of avoided carbon dioxide emissions.
- c) Certified projects to date have specified a total of more than \$10 billion of green materials.
- d) Annual productivity gains exceeding \$170 million resulting from improved indoor environmental quality

The above numbers defiantly add interest retaining the question whether travel reduction, material advantage or improvement in annual productivity with reducing energy by 25% is sufficient to address climate change and other global issues. (USGBC report, 2016) The need for ideal green emerges with the question with the thought for improvement in our own base lines. (USGBC report 2016) Every green building will relate the savings either tangibly or intangibly. The estimations and the numbers are always at the prime when the benefits are published. All energy numbers and savings are always associated to the costing some or the other ways (Langdon,2007).

### **C) Economic Impact**

Economic impacts has to be considered in jobs, gross domestic product (GDP), labour earnings, individual state tax contributions and environmental asset indicators at both the

state and national levels. Impacts realized at individual level though are not much significant in numbers but have a say to the major batch causing important contribution. Many studies have projected economic circumstances with green construction practices impacting the regional or national economy in a positive manner.

Sustainable structures give budgetary prizes to building proprietors, administrators, and tenant. They have lower yearly expenses for energy, water, support, fix and other working costs. It is additionally noted with numerous models that these diminished expenses don't generally need to come to the expense of higher first expenses.

Through incorporated style and creative utilization of property materials and instrumentality, the principal cost of a manageable structure can be equivalent to, or lower than, that of a customary or regular structure. Hardly any feasible structure highlights have higher first expenses, yet the recompense time frame for the steady speculation regularly is short and the existence cycle cost lower than the expense of progressively customary structures. Notwithstanding immediate esteem funds, property structures will offer aberrant financial points of interest to each the structure proprietor and society.

A green structure can propose fiscal focal points with lesser threats, longer structure lifetime, improved ability to attract new specialists, decreased expenses for overseeing complaints, less time and lower costs for venture permitting coming about as a result of system affirmation and sponsorship for reasonable undertakings, and extended asset regard. Sensible structures in like manner offer society generally speaking financial points of interest, for instance, diminished costs from air tainting damage and lower establishment costs, e.g., for avoided landfills, wastewater treatment plants, control plants, and transmission/transport lines.

It is noted that green buildings do not only prove beneficial in terms of savings and costs but as per the Green Building Economic Impact Study report of 2015 by Booz Allen Hamilton for USGBC, by 2018 green constructions will contribute 1.1 million jobs out of which LEED will contribute 386000 jobs. Thus going green also enhances the employment, improves financial conditions with defined income sources. The overall green building or sustainable, impacts if studied for social, environment and economic point of view, prove to be interrelated and linked with the similar aspect for improving the overall quality of human life and enhancing the unlimited resource benefit with the alternatives available in nature.



## **1.6 Green Certification Programs**

As per the Green Building Alliance (GBA) resources (April 2011), '3<sup>rd</sup> party certification is not technique to achieve a healthy and high performance space, but it is definitely one of the most capable ways to guarantee you to come in and get one'. The detailed process of accomplishing a certification appends a layer of responsibility and integrity for the structure project team.

While an area will definitely be inexperienced and high-performing if it's not certified, there square measure many tangible edges that accompany certification that can't be as simply earned while not it (LEED, USGBC). The global movement for green certification gained momentum with US Green Building Council that cited the benefits of green building and certification on global level. They further introduced various national councils for many countries and helped them set up the green building organizations. With landmark certified buildings in countries other than US, they made their presence in other nationals and promoted green buildings with benefits realized at micro national level (LEED, USGBC).

### **1.6.1 Green Building Movement in India:**

The Green Building development in India was activated off when sustainable business center structure in Hyderabad was granted with the 1<sup>st</sup> and the lofty Platinum evaluated green structure rating in India from US Green Building Council. In the same premise IGBC was born which itself is now a robust certification body under Confederation of Indian Industry. Sustainable structure movement in India has achieved fabulous thrust over the years since 2003 with approximately 3,738. Green Buildings projects coming up with a path of over 3.84 Billion sq. ft registered with the Indian Green Building Council, out of which 853 Green Building projects are certified and fully functional in India (CII - IGBC, India). The movement is simultaneously taken forward by GRIHA that evolved with support of Government bodies and has made a steady hold in many cities. Certification programs by Eco Housing, ECBC, USGBC – EDGE, WELL, etc have also been a contributor to add to the green footprint in the country, well supported by incentives and promotional support. All types of buildings are going for the certification program including- Government projects, Semi Government projects, IT Parks, Offices, Residential projects, Banks, Airports, Convention Centre, Institutions, Hospitals, Hotels, Factories, SEZs, Townships, Schools, Metros, etc., IGBC has been evolving since then and stands as the most popular rating in the

country today. ( CII - IGBC, India)

### **1.6.2 Overview of rating systems**

A green rating is a voluntary activity and initiative but unless few benefits are realized for the same, usually developers are reluctant to go with the certifications. The overall purpose of 'Green' or environment friendly construction is that it is in tune with the local requirements and the development should not prove negatively imp active to the region. Globally the ratings have made their presence felt and many countries have made a compulsion to follow the green certification with local permissions for construction as per the Asia green buildings report on government incentives and regulations (2016).

### **1.6.3 Green Rating Systems in India**

In India prevalent rating systems are LEED, IGBC, GRIHA and Eco Housing. Newer ratings are making their way in the country with a great promise. Pune city is exposed to all the four prominent rating systems of the country. Due to the incentives promised in the city for predominant ratings, the city experiences a large green building registered footprint in the country with LEED, IGBC, Eco Housing and GRIHA.

Green rating frameworks have a predefined set of criteria that plan towards direct material condition viewpoint with focuses against every one of them (IGBC, GRIHA). Few focuses are ordered thinking about the essential maintainability standards while others are deliberate according to the decision of the venture (IGBC, GRIHA). Structures are required to satisfy the characterized criteria and accomplish a specific number of focuses to be confirmed. Notwithstanding these rating frameworks, there are neighbourhood byelaws and national codes that are appropriate to the activities. Barely any codes end up being a rule while few are ordered. Energy Consumption Building Code [ECBC] has an immediate ramifications with quantifiable vitality investment funds. With every one of these rules there is National Building Code [NBC] which give directions on the vitality utilization of structures. Structures or undertakings need to conform to the rules set up by ECBC and NBC according to their pertinence (IGBC, GRIHA, Eco housing).

#### **A) Green Rating for Integrated Habitat Assessment [GRIHA]**

Green Rating for Integrated Habitat Assessment [GRIHA] is commonly made by TERI and the Ministry of Renewable Energy, Government of India. It is a green structure plan examination framework where structures are evaluated in a three-level technique. The

strategy starts with the online settlement of records as demonstrated by the proposed criteria looked for after by on region visit and assessment of the structure by a social affair of masters and experts from GRIHA Secretariat. GRIHA rating framework incorporates 34 criteria masterminded in four undeniable locales as looks for after: Site choice and site coordinating, Conservation and competent usage of points of interest, Building undertaking and support, and innovation.

### **B) LEED – USGBC**

The Leadership in Energy and Environmental Design [LEED] rating structure made for verify Green Buildings. LEED is made by the US Green Building Council [USGBC], the affiliation propelling practicality through Green Buildings. LEED is a structure for looking over structure finishing against set criteria and standard motivations behind references. The threshold for the LEED Green building rating system were made in year 2001 and are correct now available for new & existing advancements.

LEED rating framework are classified structures in six unique areas. Site determination & site arranging, water efficiency energy efficiency, materials and Innovations.

### **C) Indian Green Building Council [IGBC]**

IGBC has built up the accompanying sustainable structure rating frameworks for various sorts of structure in line and congruity with US Green Building Council. Till date following Green Building rating frameworks are accessible under IGBC –

- IGBC Green Homes
- IGBC Green SEZ
- LEED India for core and casing
- LEED India for new structure
- IGBC Sustainable factory building
- IGBC Sustainable townships

IGBC rating framework arranged structures in six distinct segments. Site choice and site arranging, water efficiency energy efficiency, materials, IEQ and innovations.

### **D) Eco Housing Certification Program**

The main ever one of a kind activity taken up together by maintainable development in the urban over occupied spreads of the state is Eco Housing Certification Program. Eco Housing is the act of expanding the effectiveness with which structures and their destinations use and

gather vitality, water, materials and decrease building impacts on human wellbeing and plan, feasible development rehearses, brought down utilization of regular assets, activity, upkeep, and evacuation the total structure life cycle.

## 1.7 Airport Detail

### 1.7.1 Shimla Airport, Jubbarhatti Shimla

Shimla\_Airport is located at Jubbarhatti, 22 km from the city of Shimla, the capital of Himachal Pradesh. Located in a mountainous area, this small domestic airport was constructed by cutting the crest of a small hill to build the runway. It is one of the three ‘table-top’ airports in the country, with the runway being surrounded by deep gorges. It is owned and administered by the Airports Authority of India.

Shimla Airport is situated at a height of 2196 meters above sea-level, on a mountain-top near the Jubbarhatti village. It has an asphalt runway that is 1230 meters long and an apron that can park two small aircrafts simultaneously. There is one small terminal that can accommodate around 50 passengers for arriving flights and 40 for departing flights. Domestic flights to New Delhi are operated by Air India and Air Alliance.



**Fig.1.1** Shimla Airport



**Fig.1.2** Terminal Building Of Shimla Airport

## **CHAPTER 2**

### **LITERATURE REVIEW**

#### **2.1 General**

In this study the green technologies of construction has to be taken in various aspects. The examination have been made dependent on various materials used in green building and to execute what sort parameters are available to use ordinary resources on the regular calendar to confine the use of imitation sources to help the systems benefits. Building influences condition, economy, and social enhancement. Building operational stage and its life cycle is an essential factor in which it is accountable for the reduction in essentialness, water and material resources. The objective of this work is to develop an important enunciation by pushing toward the Green airport advancement all through the world to save the usage of imperativeness, water and wastage of material with the help of using regular resources in Green Airport.

#### **2.2 Literature Survey**

**Ferrulli (2016) [1]** demonstrates the capacity to convey further air terminal development and improvement into foundation configuration incorporated with the urban arranging will along these lines be a noteworthy supportability challenge for what's to come. A key and incorporated way to deal with characterize the air terminal framework configuration following the particular supportability prerequisites is required. The point of the paper is to represent the consequences of a doctoral research concentrated on the advancement of a system for the maintainability execution based assessment of air terminal venture structure and mechanical procedures to upgrade the ecological limit of the framework amid its life cycle. The Green Airport Design Evaluation (GrADE) technique and its particular instruments will contribute in accomplishing the objective of reasonable improvement of airplane terminal foundation giving a methodological structure to quantify and screen natural execution and making new open doors for the flight administrative associations and air terminal proprietors to characterize plan of action and systems to upgrade feasible air terminal framework structure inside the local transport arrange.

**Kaszewskil and Sheate (2004) [2]** gives the study to demonstrate the possibility of three scenarios cheering more sustainable airport development, focus on airport terminal building design and surface access transport.

(i) A 'business as usual' (BAU) plan for an aviation surface access transport and terminal building design.

(ii) A sustainable transport plan

(iii) A sustainable architecture plan

**Carlini (2013) [3]** gives the Environmental Protection Agency (EPA) portrays maintainability as being founded on a straightforward standard. Everything that we have requirement for our survival and success depends, either specifically on our common habitat (EPA, 2012). Maintainability enables people and nature to exist together in profitable concordance, protecting the social, monetary and different prerequisites of present and who and what is to come (EPA, 2012). The U.S. Green Building Council (USGBC) built up the Leadership in Energy and Environmental Design (LEED) which gives building proprietors and activities a succinct structure for recognizing and actualizing commonsense and quantifiable green building plan, development, tasks and support arrangements(USGBC, 2009). LEED is globally perceived by designers and developers for its green building confirmation framework that utilizes procedures to enhance execution in the regions that are most critical including: vitality reserve funds, water effectiveness, Carbon Dioxide outflows decrease, enhanced indoor ecological quality, and stewardship of assets and affectability to their effects (USGBC, 2009). LEED is a willful accreditation program that advances an entire building way to deal with manageability by execution in regions, for example water effectiveness, feasible building locales, lessening vitality utilized by structures, recyclable materials and assets utilized, lastly the nature of the earth inside (USGBC, 2009). LEED gives guidelines to diminish carbon impression, increment vitality reserve funds, empowers development, and advances corporate obligation.

**Sukumaran and Sudhakar (2017) [4]** has given the commitment of aviation industry towards green house gas emission is getting consideration everywhere throughout the world. The photovoltaic energy is used for removing the CO<sub>2</sub> footprint from the aviation industry. The CO<sub>2</sub> impression of airplane terminal can be decreased by substituting the regular wellspring of vitality with sun oriented PV based power age. The necessary incredible and free space

territories around runways can be used for utility scale sun oriented PV control plants. The present research plans has to be investigate the working execution of 12 Mega Watt sun based controlled airplane terminal charged by Cochin International Airport Limited, India dependent on 1<sup>st</sup> year running information. The execution of the plant is additionally mimicked utilizing most prominent PV recreation virtual products e solar plant and Solar grid by accurately giving the plant determination. The normal execution proportion of the plant is 86.55% and relating limit use factor is 20.11% with conclusive yield of 1984. The execution parameters acquired through the product was observed to be in close match with the deliberate qualities. The monetary and ecological examinations of the sun powered fueled Cochi airport terminals affirms adequacy in lessening the CO<sub>2</sub> impression, prompting for all intents and purposes zero discharge, spotless and green supportable air terminal.

**K. Green (2007) [5]** demonstrate the article tests whether the activity at a metropolitan domain's plane terminal predicts masses and work advancement. In backslide conditions clearing up business and masses improvement, the article uses distinctive extents of air terminal activity, including boardings, beginnings, focus status and cargo volume. Since air terminals may be a component of, and furthermore an explanation behind, advancement, the article instruments for air terminals by using land and slacked factors. It finds that, under a combination of conclusions, voyager activity is a pivotal marker of advancement; cargo activity isn't.

**Thakkar et al. (2016) [6]** gives the steady augmentation of air development volume and the headway for generous wide body flying machine, runway required visit support & rebuilding practices with the ultimate objective to give satisfactory structure limit and appealing surface characteristics. Starting late, LCA has to be commonly used for evaluate the environmental impacts of pavements occurred on various stages. The main objective of LCA ponders contrast in a large range, for instance, progression for black-top improvement & upkeep.

**Peeters et al. (2006) [7]** has given a broad assortment of circulations has exhibited that the movement business territory is dynamically environmentally unsustainable. This is for the most part caused by the responsibility of flight to an extensive and creating proportion of Greenhouse Gas (GHG) surges by the movement business. In the light of this, we present an outline of progressions in the air transportation part and inspect current options for advancement towards supportability in three areas: development, lifestyle, and approach. In



view of continuing mechanical advancement, flight will be more eco-accommodating later on. Regardless, possible results are compelled and will doubtlessly not change the course of growing as a rule releases of the movement business air transport. Flight has a central occupation in achieving common viability in the movement business. All around, barometrical centralizations of carbon dioxide (CO<sub>2</sub>) should be kept underneath 450 ppm.

**Agarwal (2009) [8]** gives the study about air transportation and its impacts on condition sought after by subjects overseeing commotion and transmissions balance by mechanical courses of action including new flying machine and engine designs developments, elective forces, and materials and moreover examination of aircraft exercises collaborations including Air-Traffic Management, Air-to-Air refuelling, close formation flying and uniquely crafted passages to restrict oil devour. The ground system for conservative flying, including the possibility of 'Pragmatic Green Airport Design' is also anchored.

**Barros and Dieke (2008) [9]** gives the opinion and construing in two stage, semi-parametric models of profitable profitability. It is used to check the capability determinants of Italian plane terminals. In the important arrange, the air terminals' relative specific capability is assessed with data envelopment examination (DEA) to develop the air terminals that perform by and large successfully. These plane terminals could fill in as mates to help upgrade execution of the scarcest beneficial air terminals. In this study the use of data envelopment examination (DEA) as an instrument for assessing the effectiveness driver of Italian plane terminals. DEA perceives the capable units, intended to reduce wastage in air terminal affiliations. In this paper, the specific capability of an agent trial of Italian plane terminals from (2001-2003) has been poor down with a simultaneous two-mastermind strategy: in the fundamental stage a data envelopment examination (DEA) is used to assess the compelling scores that rank the air terminals according to their viability.

**Yadav et al. (2018) [10]** demonstrates an examination have been made dependent on various materials used in green building and to execute what sort parameters are available to use ordinary resources on the regular calendar to confine the use of counterfeit sources to help the systems benefits. Building bigly influences condition, economy, and social enhancement. Building operational stage and its life cycle is an essential factor in which it is accountable for the reduction in essentialness, water and material resources. The objective of this work is to develop an important enunciation by pushing toward the Green Building

advancement all through the world to save the usage of imperativeness, water and wastage of material with the help of using regular resources in Green Building.

This paper speak to the need of viable condition and diverse measures being completed at ISRO, As points of interest achieved progressively additional sun arranged power plant, floating daylight based sheets, saddling wind imperativeness, biogas plant are proposed to be executed. The general cost of green advancement is examined, and the discussion completes up with some cost-save subsidizes bearing. Understanding the condition, the need of the day is to get sensible green building setup approach, which is the Ultimate response for diminish the imperativeness demand of the building.

**Freestone (2009) [11]** states that air terminals are never again puts where planes basically take off and arrive anyway have formed into critical business endeavors with spatial impacts and utilitarian repercussions that expand significant into metropolitan zones. They are basic focus focuses in the overall space of streams. Plane terminal drove urban enhancement, not with standing its work and pay delivering capacities and potential outcomes, goes with costs and perils: money related, common, and social. A huge gathering of masterminding issues are raised. This paper offers a brief and fundamental layout of these issues from a broad masterminding perspective. It doesn't attempt an expansive audit of the airplane terminal condition interface or offer bare essential procedure overviews of specific wards. Or then again perhaps, the strategy taken is an endless brief one that fundamentally shows a trade between a bullish virtuoso improvement perspective clear in flight industry and government circles versus a more essential perspective tending to standard thinking that evidently grasps unlimited advancement potential. The paper has three guideline parts: a short review of the wonder and drivers of plane terminal focused urbanism, a pre'cis of air terminal organizing designs and the aerropolis thought, and an idea of money related and regular air terminal progression thinks about with a view to searching for rapprochement concerning sensible enhancement. The paper draws from a more broad examination investigating the urban course of action impacts and repercussions of the 'plane terminal city's in Australia and generally.

**Ishutkina and Hansman (2008) [12]** This paper uses both worldwide and country level examination to portray the association between air transportation and budgetary activity. In particular, we delineate how fiscal, infrastructural, institutional and geographic factors

impact the mapping of cargo and explorer streams to the engaged surges of work, learning, theory, settlements, the movement business and items. We in like manner perceive the activity of government and exogenous drivers in this relationship. The goal of this paper is to recognize and portray the parts and the critical components affecting this association. In particular, we depict the organization's activity in influencing diverse monetary and air transportation factors and the consequent air transportation influence. We use add up to generally speaking data and a couple of logical examinations to layout the irregularity in the association between air transportation and financial development around the world. There are two vital sorts of studies surveying the impact of air transportation. To begin with, are analyzes evaluating the prompt, roundabout and impelled business impact of air transportation which ignore the engaging effects. Organize impact is work in the air transportation business, variant impact is the work in the endeavors down the flying store arrange, and actuated influence is the business supported by the spending of those explicitly and roundaboutly used in the flight business. These examinations are usually enhanced the circumstance the made economies since they use data genuine commonplace data yield matrices which are rarely available for the making countries. Second, are thinks about which try to survey the engaging, or synergist, impact of air transportation. The examinations evaluating the engaging influence conventionally measure the impact of changes in air transportation use on the movement business, trade, neighborhood theory and productivity improvement.

**Abraham et al. (2017) [13]** delineate the need of supportable condition and different measures being executed at ISRO, As advantages accomplished progressively extra sunlight based power plant, drifting sun based boards, bridling wind vitality, biogas plant are proposed to be actualized. Green structures, however require an underlying capital, helps in diminishing the ecological effect and contributes in vitality preservation by establishment of inhabitation sensors, VRV, IAQ, utilization of low-producing materials and so on., Water protection activities gives an elective wellspring of water supply under the basic circumstance of short supply from water supply board and drained yield of the drag wells. All these economical measures are basically introduced and viably utilized, which brings out numerous substantial and impalpable advantages to the association and encompassing condition.

**Sundaram and Babu (2015) [14]** gives the principle target of this paper is to introduce the approved yearly execution investigation with the checked outcomes from a 5MWp matrix associated photovoltaic plant. The execution of current framework is contrasted and other network associated frameworks introduced in various parts of India. An examination is additionally made between the execution lists of sun based photovoltaic framework arranged at different areas from the writing's distributed. Moreover the impact of info factors over the yield of the framework is underscored by relapse coefficients got through relapse examination. Inside and out examination managing vitality and exergy of the framework are likewise included to fortify the investigation.

**Wybo (2013) [15]** gives the advancement of vast scale Photovoltaic vitality generation frameworks is one of the promising answers for supplant fuel based and atomic based power plants contrasted with most wellsprings of power, photovoltaic boards deliver few CO<sub>2</sub> in activity (in spite of the fact that their assembling, transport, establishment, cleaning and decommissioning/reusing makes CO<sub>2</sub> outflows), they require little support, most recent 20 years or increasingly and can be reused. One of the key inquiries brought up in growing expansive scale PV frameworks is to discover suitable areas :level, anchored against vandalism and criminals and close to existing electrical cables. Airplane terminals regions fit great those requirements so an expanding number of air terminal specialists is introducing or wanting to introduce extensive surfaces of PV boards delivering 20MW or more. In this paper, we address the wellbeing concerns identified with the usage of substantial scale PV frameworks in air terminal areas. We recognize various types of hazardous circumstances in which PV boards are inferred and we break down their causes and potential outcomes, alongside proposition for hazard decrease.

**Khosla and Singh (2014) [17]** discovering cost-ideal arrangements towards about zero-energy structures as per European vitality execution of structures mandate (EPBD-recast 2010) is a testing assignment. It requires investigating an immense number of conceivable mixes of vitality sparing measures (ESMs) and vitality supply frameworks including sustainable power sources (RESs), under a near structure procedure. The current investigation presents productive, straightforward, and efficient recreation based improvement strategy for such investigations. The technique is connected to discover the cost-ideal and zero energy structure execution levels for an examination instance of a solitary

family house in Finland. Diverse alternatives of building-envelope parameters, warm recuperation units, and warming/cooling frameworks and in addition different sizes of warm and photovoltaic heavenly bodies are investigated as plan choices by means of three-organize improvement. The ideal usage of ESMs and RES depends essentially on the introduced warming/cooling framework and the heightening rate of the vitality cost.

**Goyal et al. (2013) [18]** gives the look at their execution and multifaceted nature through recreations; the control calculations direct the indoor atmosphere of business structures. The objective of these control calculations is to utilize inhabitation data to diminish vitality use over traditional control calculations while keeping up warm solace and indoor air quality. Three tale control calculations are proposed, one that utilizes input from inhabitation and temperature sensors, while the other two process ideal control activities dependent on expectations of a dynamic model to diminish vitality utilize. In this paper, we look at how much vitality can be spared by control calculations that utilization data of inhabitation and framework elements, and how the reserve funds rely upon the loyalty of the data. With more data (forecast versus estimation), we might have the capacity to spare more, however the control calculation may turn out to be more perplexing. Our attention is on control calculations that can be utilized in VAV boxes of individual zones in existing (and new) advertisement structures; the controller needs to choose the stream rate and temperature of the air provided to the zone. In this paper we analyze the execution of a traditional controller that does not have inhabitation estimations or expectations to that of three proposed controllers that utilization fluctuating level of inhabitation data and are of differing level of computational multifaceted nature.

**Guan et al. (2010) [19]** demonstrates that 20%– 30% of building vitality utilization can be spared through advanced task and the executives without changing the building structure and the equipment setup of the vitality supply framework. In this manner, there is an immense potential for building vitality investment funds through productive activity. Smaller scale network innovation gives a chance and an alluring framework for enhancing the effectiveness of vitality utilization in structures. In this paper, the planning issue of building vitality supplies is considered with the down to earth foundation of a low vitality building. The target work is to limit the general expense of power and flammable gas for a building task over a period skyline while fulfilling the vitality balance and confounded working limitations of

individual vitality supply hardware and gadgets. The vulnerabilities are caught and their effect is broke down by the situation tree strategy. The testing results demonstrate that huge vitality cost investment funds can be accomplished through incorporated planning and control of different building vitality supply sources. It is imperative to completely use sun powered vitality and upgrade the task of electrical stockpiling. It is additionally demonstrated that pre-cooling is a straightforward method to accomplish vitality funds.

**Zeng et al. (2011) [20]** gives the weaknesses or impediments of the customary way to deal with creating vitality productive structures are that they can not decide. The perfect thermo physical properties of building envelope material, where "perfect" implies that such material can utilize surrounding air temperature variety as well as sunlight based radiation proficiently to keep the indoor air temperature in the warm solace extend with no extra space warming or cooling. The

best regular ventilation procedure. The negligible extra vitality utilization for space warming in winter or cooling in summer. To beat these issues, some new ideas for creating vitality effective structures are advanced in this paper.

**Azizi et al. (2012) [21]** gives the developing worry in Malaysia over the need to lessen vitality utilization; be that as it may, locally important arranging and the executives devices, i.e., vitality the board structures for green structures, are in their earliest stages. A sum of 10 vitality administration systems for business places of business were recognized in the Malaysian Green Building Index (GBI) with six estimations considered as pertinent to the arranging stage and four considered important amid the operational assessing and checking stage. In contrast with vitality the executives procedures in the worldwide writing, the GBI device demonstrates opportunity to get better to accomplish ideal vitality proficiency execution. In view of the universal writing, further improvement is acquainted with the present vitality the board methodologies. A sum of nine extra vitality the executives procedures were recognized to build up a progressively far reaching vitality the executives system. These methodologies were tried utilizing three contextual analyses, i.e., affirmed green structure, noncertified green structure, and regular structure, to look at the degree to which offices the executives has actualized these measures. Discoveries from these contextual analyses demonstrate that vitality lists alone are deficient to decide vitality productivity and that the proposed vitality the board system can help administrators to

improve vitality proficiency execution. This paper additionally provides details regarding green advancements that did not work appropriately amid the operational stage. It was additionally discovered that measures to draw in inhabitants in vitality preservation objectives were not successful. Future research is important to explore the tenants' conduct and view of vitality proficiency to give a progressively viable vitality the board system.

**Chiang et al. (2014) [22]** states the need to keep up a regularly expanding structure stock particularly in created economies is developing. This investigation gives a computational structure to locate the ideal answer for maintainable structure upkeep. The strategy is made out of two noteworthy advances. In the first place, the creators assess the life-cycle carbon outflow, cost, and work prerequisites of an undertaking, which encapsulate significant ecological, monetary, and social parts of maintainable structure support. Second, the creators build up a streamlining model to distinguish the ideal arrangement of materials that would limit three maintainability destinations including carbon emanation, cost, and work sending in their individual turns each one in turn. By testing the model with seven situations for a situation examine, the creators show how this run of the mill case undertaking could essentially improve its maintainability destinations from ecological, financial, and social viewpoints. This advancement technique is conventional. It tends to be promptly connected to other new and non private tasks of fluctuating scales and in conditions with an alternate arrangement of choice criteria. At last, approach recommendations are proposed to advance practical structure upkeep in Hong Kong.

**Kim et al. (2014) [23]** shows through cost similar examination for the effect of the new Green Building Code on private venture advancement from task the board points of view. As the interest for new private lodging is step by step expanding from the long subsidence, private undertaking the board is imperative for task proprietors settling on choices concerning the venture of new green structure highlights, for example, vitality effective machines, hardware, and lighting. The investigation results demonstrate that the consolidation of such green frameworks causes the development expenses to increment by 10.77% more than the conventional structure, though the measure of working days just increments by two days. The discoveries can be utilized as a guide for undertaking proprietors to settle on choices concerning their money related beginning ventures while profiting by vitality cost funds over the existence cycle of the structure.

**Vyas et al. (2019) [24]** states the greenness of a structure is estimated through green structure appraisal apparatuses. These devices have restrictions since they can't be connected to all areas. The point of this examination was to build up a sustainable structure appraisal device that can rate the sustainability of new structures in India. For this, an investigation was directed by receiving 9 green structure segments with 34 credits pertinent to the estimation of sustainability. For assessing the green building index (GBI), a three-level various levelled structure was developed for which the GBI is at Level 1, and the 9 segments and 34 qualities are at Levels 2 and 3, separately. In this investigation, a coordinated methodology comprising of an explanatory Analytical Hierarchy Process (AHP) and fluffy integrals was utilized. The 42 reactions got from sustainable structure specialists were utilized to discover the loads of the parts utilizing the AHP. The overall significance of various qualities was registered utilizing fluffy measures and fluffy integrals. At long last, the Weighted Sum Method (WSM) was utilized to get the general GBI. The after effects of the proposed methodology are contrasted and Indian contextual investigations. The investigation of this research can be useful to sustainable structure organizers, creators & designers.

**Ghosh and Roy (2009) [25]** tells about over the ongoing decades, plant support procedures have developed from a remedial to a preventive methodology. Additionally, deterministic models have been progressively supplanted by those dependent on dependability and hazard, which are probabilistic. Ways to deal with acquiring the ideal upkeep interim have commonly included minimization of the complete related expense. The present work exhibits an improved strategy including the amplification of unwavering quality based benefit-to-cost ratio (BCR), i.e., the proportion of potential financial advantage that can gather from an advanced preventive maintenance (PM) timetable to the expenses brought about in executing such a calendar. It is demonstrated that the procedure can be utilized to upgrade the PM plan for procedure units whose unwavering quality capacity is either exponential or pursues a Weibull distribution. An affectability examination has additionally been performed to show the impact of different model parameters on the advantage to-cost proportion. The proposed methodology establishes an improvement over the cost minimization system revealed in contemporary writing, and can even be stretched out to plant shutdown arranging.

**Kevern (2010) [26]** talks about a structure for consolidating reasonable plan/thinking as another structural building course and encounters from the pilot advertising. Significant



regions are illustrated to help all designers in understanding maintainability in setting with customary building standards. Green-building rating frameworks were utilized to present the ideas of supportability in structures and foundation, featured by introductions from green-building experts. By giving a superior comprehension of manageability through training, structural architects can give proactive answers for a developing worldwide framework.

**Xia et al. (2013) [27]** states that the green structure pattern has expanded quickly worldwide in ongoing decades as a methods for tending to developing worries over environmental change and an earth wide temp. increase and to trim down the effect of the structure business on the earth. A critical commitment in Australia has been the utilization of a progression of rating instruments by the Green Building Council of Australia (GBCA) for the accreditation of different kinds of structures. This paper surveys the utilization of the Green Star framework in Australian structure development and researches the potential difficulties engaged with getting such accreditation for Australian structures, by basically breaking down a database of the most as of late guaranteed GBCA ventures. The outcomes demonstrate that administration related credits and development related credits are the least demanding and most troublesome, separately, to acquire. Moreover, 6 Star green structures accomplish fundamentally higher focuses than do other guaranteed structures in the vitality classification. Interestingly, 4 Star green structures accomplish a greater number of focuses in the material classification than complete 5 and 6 Star structures. The investigation offers a valuable reference for both property engineers and venture groups that can enable them to acquire a superior comprehension of the rating plan and subsequently help in the compelling readiness of confirmation documentation.

**Robichaud and Anantatmula (2010) [28]** tells about ecologically manageable structure development is encountered huge development in the middle of the previous 10 years. The open is winding up progressively documentarians and writers feature the fabricated condition's effect on ozone depleting substance emanations and general asset utilization. Different variables include high energy price, expanded expenses of structural materials, and administrative motivations, are additionally pushing the green structure market to develop and grow. The goal of this paper is to propose explicit alterations to ordinary structure practices to upgrade the conveyance of cost-effective green structure ventures. This paper introduces a diagram of research identified with the expenses and patterns of green structure

and uses these examination discoveries to make suggestions for greening venture the executives rehearses for the development business. Our examination results demonstrate that greening venture the executives practices can increase the value of an economical development venture while conveying it inside worthy cost imperatives. A definite examination utilizing grid present explicit changes in accordance with conventional task the executives rehearses, with a reason that a green undertaking improves its odds for monetary achievement if a cross-discipline group is included at the most punctual stages and all through the venture.

**Khoshbakht et al. (2017) [29]** states about there is an incredible variety in the money saving advantages because of the contrasting approaches utilized in the estimation. This investigation goes for exhibiting a writing audit of money saving advantage forecast techniques joined with a SWOT examination, especially underscoring information accumulation and explanatory methodology. Discoveries demonstrate that the techniques utilized in green structure money saving advantage studies can be gathered into various classifications as far as information accumulation and systematic methodology. Every technique has its points of interest and drawbacks with different capacities. This writing survey uncovered that a great part of the ebb and flow money saving advantage explore needs legitimacy and unwavering quality, and has diverse degrees of inclination.

**Tam et al. (2017) [30]** Green buildings are picking up fame in Australia with the uses of Green Star rating plan. Be that as it may, the credit for utilizing timber materials in the rating plan, while timber being a fundamentally utilized material in the quickly developing private development industry, does not sufficiently control architects and manufacturers on the choice of the best timber types for private applications from the existence cycle point of view. This examination exhibits the investigation on the existence cycle cost of timber materials in their different applications for private structures in Australia and in this manner gives direction on the best way to best meet the prerequisite set out in the timber credit in the Green Start rating plan. Organized meetings were utilized to gather the information on the expense of timber materials in their lifetime from developers, tradesmen and other private development experts. Three arrangements of cost data were gotten under every application, for the individual timber species against three conditions (low, medium and outrageous climate) with reference to private structures. In view of life cycle cost investigation results,

the most appropriate timbers for various applications are prescribed.

**Bartlett and Howard (2000) [31]** This paper looks to challenge the conventional manner by which we evaluate the estimation of green structures as far as their ecological invitingness, vitality proficiency and entire life cost. In the UK, amount surveyors (or cost advisors) have a discernment that more vitality proficient and ecologically agreeable structures cost somewhere in the range of 5% and 15% more to work from the beginning. This normal supposition that isn't sponsored up by ongoing exploration and ought to be addressed. Development experts should be educated regarding the entire life cost and ecological effect of structures so they can urge key partners to settle on progressively practical decisions. These developing issues together with down to earth devices are considered with contextual investigations from late activities.

**Castleton et al. (2010) [32]** This paper audits the present writing and features the circumstances in which the best structure vitality reserve funds can be made. More seasoned structures with poor existing protection are esteemed to profit most from a green rooftop as current structure guidelines require such large amounts of protection that green rooftops are seen to scarcely influence yearly structure vitality utilization. As over portion of the current UK building stock was worked before any rooftop protection was required, it is more established structures that will profit most from green rooftops. The case for retrofitting existing structures is in this manner audited and it is found there is solid potential for green rooftop retrofit in the UK.

**Liu et al. (2014) [33]** In order to start financial assessment of sustainable structures and encourage their advancement, this article directs the price advantage assessment of energy efficiency technology application (EETA) on green structures in China. In order to the economic evaluation theory of construction project, the creators initially sets up the hypothetical structure arrangement of cost– advantage assessment of the EETA on economical structures and afterward builds up the investigation strategies for gradual expenses and quantitative figuring recipe of steady advantages of the EETA on green structures. Utilizing these speculations and strategies, this article takes the Wanke City venture in China as an investigation case, leads the cost– advantage experimental examination of the EETA on green structures, and makes the accompanying significant inferences: (1) the gradual expenses of the EETA represent a huge extent of all out steady

expenses of green structures, which are over half for this situation; (2) the EETA on green structures can bring gradual monetary advantages, just as ecological advantages; (3) if just think about the gradual financial advantages of the EETA on green structures, the money related assessment records show green structures don't have advertise venture potential; (4) among every one of the elements impacting the budgetary assessment consequences of the EETA on green structures, influence cost is the most delicate factor, trailed by the unit gradual expenses, and the lifetime has the littlest impact.

**Zuo and Zhao (2014) [34]** Green structure is one of the advanced to improve critical effects of the structures to on the earth, society and economy. Be that as it may, there is absence of a framework aticre perspective on this expansive number of concentrates that is basic for the future undertaking. The most recent decades have observer hung developing number of concentrates on green structure. This paper reports a basic audit of the current assemblage of information of explores identified with green structure. The basic research them esand approach were recognized. These basic sustainable structure evaluation of advantages of green structures contrasted with ordinary structures and it deals with different ways with accomplish sustainable structures. It is discovered that the current investigations played predominately centre around the natural part of sustainable structure. Different elements of supportability of green structure, particularly the social maintainability is generally over looked. Future research openings were distinguished, for example, impacts of climatic conditions on the viability of green structure evaluation devices, one of a kind requests of explicit populace, and future sealing.

### **2.3 Research Objectives:**

- Comparing various components of conventional airport and green airport.
- Cost efficiency of Shimla Airport using green technology with the help of REVIT Software.

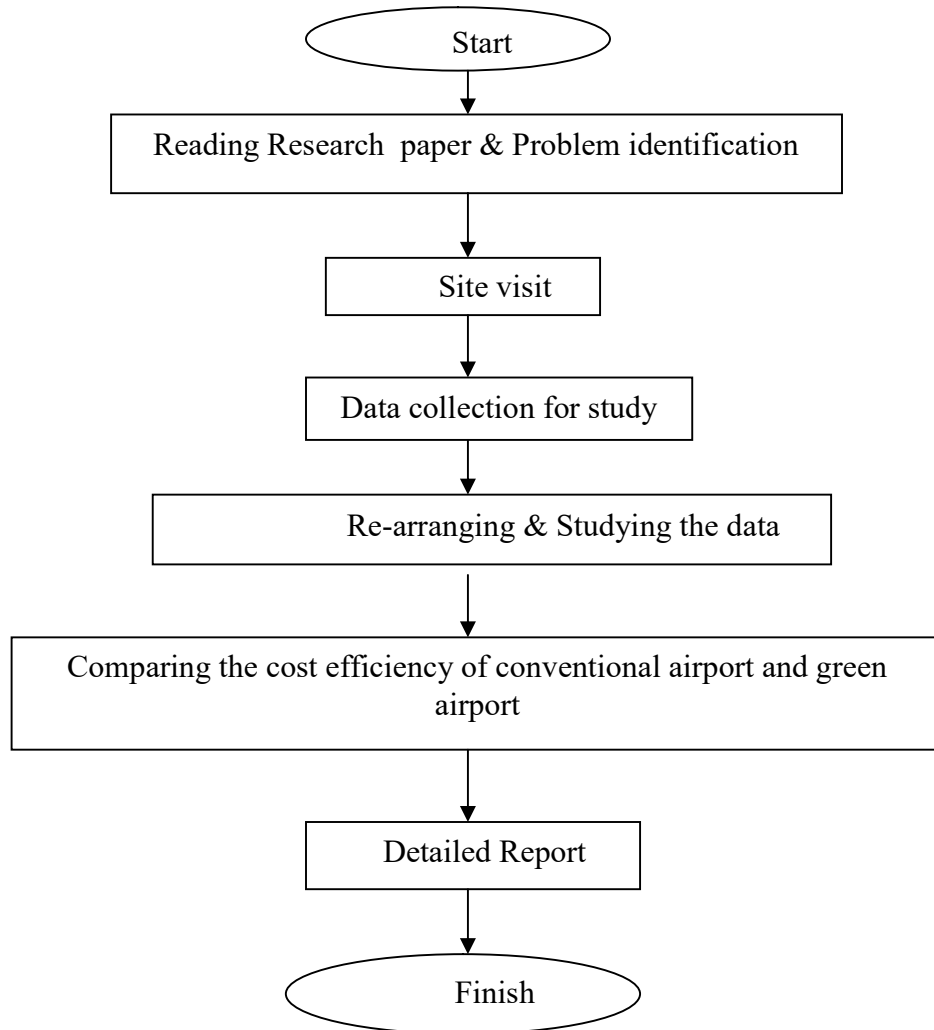
# CHAPTER-3

## METHODOLOGY

### 3.1 General

In order to achieve the projected objectives an underlying period of examination and study has been completed concerning the airplane terminal undertaking configuration process and the cutting edge of guidelines. The analysis has been carried by taking different-2 technique for constructing green airport terminal and provide less energy efficient power saver equipment for showing the long haul advantage of green airport terminal.

### 3.2 Methodology Flow Chart



In this report I consider two airport by assuming it one conventional airport and other one is green airport. Conventional airport which is Shimla Airport and taking the total cost of construction by providing conventional techniques and green construction technique.

### **3.3 Methods to be applied in Shimla Airport**

#### 3.3.1 Solar Panels

#### 3.3.2 Night Glow Airstrip Runway (use of Photo-luminishing powder in Marking)

#### 3.3.3 Material replaced in Terminal Building

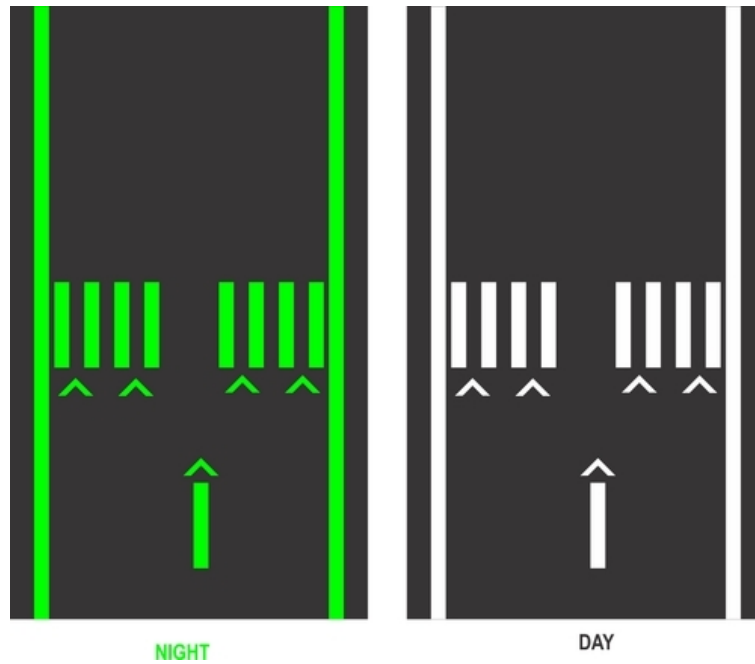
##### **3.3.1 Solar Panels**

Solar panels absorb sunlight heat as source of energy to make electricity for energy saving purpose. These panels modules store the photons (light energy) direct from the sun for generation of electricity through the photo-voltaic effect.

In Shimla Airport total consumption of energy is up to 270000 kW per year. We can reduce this bill amount if we set up 200 kW solar power plant for this airport. This solar power plant generally produces up to 300000 kW units per year and maximum demand of this airport is 270000 kW energy.

##### **3.3.2 Night Glow Airstrip Runway**

The night glow paint can be effectively used for marking air strip. The conventional method for marking air strips to use white paint. However they are useful for parking the helicopter in daylight. In the dark this conventional paint becomes invisible. Further it is many times not possible to illuminate the air strip by external source of light. Air strip marked with night glow paint can offer a very good safety measure. It gets charged by the sunlight & glow in the dark. The application method of using Night glow paint is as simple as any conventional paint. Apply a base coat of white color. As per the surface the base coat can be enamel paint, oil paint, epoxy, distemper or polyurethane. Apply night glow paint as second coat. One kg of night glow paint covers 50 sq. ft. area. Night glow paint can be applied by brush method depending upon formulation. However spray painting method gives uniform surface. For good results two coats are advisable. The paint is air dried. The drying period varies upon the type formulation. The night glow paint is available in various types distemper, enamel, acrylic base, plastic base, alkyd base, epoxy base, etc. It should be noted that for Airstrips water based non glossy formulation is useful.



**Figure: 3.1** Marking lines of Runway

### 3.3.3 Material replaced in Green Airport

According to our study we are comparing the materials of conventional and green airport. The cost of the material is different with each other. In addition this analysis involves this data to ensure feasible output. In this we can replace various items of conventional airport into green airport techniques. These items are converted conventional to green for increase the sustainability of the airport. Various items are converted like windows and opening, lighting fixture, plumbing fixture, paints, rain water harvesting, solar panels etc.

## CHAPTER-4

### DATA COLLECTION & DISCUSSION

#### 4.1 Electricity bill and electricity consumption of Shimla Airport

**Table 4.1.1:** Consumption Unit & Bill Amount Details 2016-17

<b>Months</b>	<b>KVAH</b>	<b>kWh</b>	<b>Maximum Demand KVA</b>	<b>Bill Amount (Rs.)</b>
April 16	13725.00	13451.00	54	82424.00
May 16	14062.00	13801.00	54	84037.00
June 16	14048.00	13688.00	54.73	173203.00
July 16	13807.00	13603.00	35.12	62444.00
Aug 16	14126.00	13997.00	44	94183.00
Sep 16	14258.00	14148.00	36	90027.00
Oct 16	16320.00	15997.00	23.81	100234.00
Nov 16	13706.00	13297.00	45.63	87295.00
Dec 16	15180.00	14739.00	42	94591.00
Jan 17	16759.00	16515.00	49.64	102408.00
Feb 17	14954.00	14764.00	49.13	93472.00
Mar 17	18548.00	18456.00	42.57	111263.00
<b>Total</b>	<b>179493.00</b>			<b>Rs. 1175581.00</b>
<b>Avg. Total</b>	<b>14957.00</b>			<b>Rs. 97965.08</b>



**Table 4.1.2: Consumption Unit & Bill Amount Details 2017-18**

<b>Months</b>	<b>KVAH</b>	<b>kWh</b>	<b>Maximum Demand KVA</b>	<b>Bill Amount (Rs.)</b>
April 17	19167.00	19046.00	54	114327.00
May 17	18093.00	17983.00	54	109011.00
June 17	26094.00	25494.00	51.98	148615.00
July 17	17416.00	17046.00	58.45	107217.00
Aug 17	20172.00	19706.00	54	113996.00
Sep 17	21615.00	21064.00	54.07	126470.00
Oct 17	21696.00	20934.00	37.82	126845.00
Nov 17	22214.00	21714.00	66.32	138145.00
Dec 17	22804.00	22152.00	55.55	132871.00
Jan 18	25987.00	25360.00	61.62	151887.00
Feb 18	29124.00	28648.00	65.38	171363.00
Mar 18	24913.00	24372.00	52.25	142769.00
<b>Total</b>	<b>269295.00</b>			<b>Rs. 1583516.00</b>
<b>Avg. Total</b>	<b>22441.25</b>			<b>Rs. 131959.67</b>

**Table 4.1.3: Consumption Unit & Bill Amount Details 2018**

<b>Months</b>	<b>KVAH</b>	<b>kWh</b>	<b>Maximum Demand KVA</b>	<b>Bill Amount (Rs.)</b>
April 18	26208.00	25560.00	52.95	149180.00
May 18	25598.00	24616.00	58.86	147860.00
June 18	24516.00	23856.00	58.26	142295.00
July 18	21671.00	21081.00	53.86	121839.00
Aug 18	21531.00	21151.00	55.23	126460.00

Sep 18	24854.00	24330.00	41.58	142477.00
Oct 18	18809.00	18552.00	37.75	112554.00
<b>Total</b>	<b>188041.00</b>			<b>Rs. 1085142.00</b>
<b>Avg. Total</b>	<b>15670.08</b>			<b>Rs. 90428.50</b>

## 4.2 Calculation of Charges to be paid

**Table 4.2.1:** Calculation of energy/cost in October 2018

1	Energy Charges (on consumption unit slab calculation)	
(i)	Consumption in Night Hours (in kw)	4679
(ii)	Consumption in Peak Hours (in kw)	2226
(iii)	Consumption in Normal Hours (in kw)	11904
(iv)	Energy Charges= Rs. 4.5 x Night Hours	21055.50
(v)	Energy Charges= Rs. 4.5 x Peak Hours	10017.00
(vi)	Energy Charges= Rs. 4.5 x Normal Hours	53568.00
	Total (iv to v)	84640.50
2	Demand Charge [If demand is $\leq 54$ then charge (54 x 350), if demand between 55 and 60 then (actual demand x 350), if demand is $>60$ then demand charge= (60 x 350 + excess x 350 x 3)]	18900.00
3	Meter Charges (Rs.)	550.00
4	Other Charges	0.00
5	Electricity Duty @10% of Energy Charge (Rs.)	8464.00
6	Total (1+2+3+4+5) (Rs.)	112554.50
	Gross Total (Rs.)	112555.00

In the Shimla Airport the contract demand of electricity is 60 KVA per month. If the electricity consumption is less than and more than the contract demand then the electricity rate is different. If demand is  $\leq 54$  then charge (54 x 350), if demand between 55 and 60 then (actual demand x 350), if demand is  $>60$  then demand charge= (60 x 350 + excess x 350 x 3). In many months the maximum demand of electricity is less than 54 and we have to

pay the extra charges as per rule of 90% of contract demand payed.

In this data we have total bill amount and total energy consumption of Shimla Airport for last three years. Energy consumption and bill amount may increase time to time. In order to achieve the proposed destinations, an underlying period of investigation and study has been completed concerning the airplane terminal venture configuration process and the cutting edge of directions, benchmarks and operational and venture procedures identified with the green building plan and the flight business. The examination has been carried on through the logical writing survey and the investigation of global research results worried specifically the advancement of manageability rating frameworks. Further solar panel installation has been carried out and the data for the panel installation will also be studied.

We can reduce these bill amount if we set up 200 kW solar power plant for this airport. This solar power plant generally produce up to 300000 kW units per year and maximum demand of this airport is 270000 kW energy. Total cost of 200 kW solar power plant is up-to 8-9 million and the installation amount is recovered within 5-6 years because the average bill amount is 1.2-1.6 million.

#### 4.2.1 Comparison between Conventional and Green Airport Energy

**Table 4.2.2:** Shimla Airport Energy Consumption:

Year	Contract Demand (per month)KVA	Bill Amount (per annum)Rs.	Energy consumed (per annum)KVAH
2016-17	60	1175581.00	179493
2017-18	60	1583516.00	269295
2018	60	1085142.00	188041

**Table 4.2.3 : PV Plant Energy Generation in Green Airport Energy consumption**

Energy Source	Energy Generation (kWh)	Max. Energy req. as per past bills(per annum) (kWh)	Installation Amount (Rs.)	Avg. Bill amount of conventional airport(per annum)
200kW PV Plant	300000kWh	270000kWh	9 million	1.5 million

### 4.3 Material Replaced in Terminal Building of Shimla Airport:-

**Table 4.3.1:** Detail of Materials to be used

Item	Conventional Airport (C.A)	Green Airport (G.A)
Windows and Openings	Aluminium Panelled Glass	Heat-Insulated Glass
Plumbing Fixture	Conventional fixture	Special green fixture
Flooring	Vitrified & Glazed tiles and China mosaic	PVC flooring , Glazed tiles and China mosaic
Paints	Plastic-VOC	Plastic Non-VOC
Bricks	Clay Bricks	Fly ash Bricks
Rain Water Harvesting	Not Provided	Provided
Solar Panels	Not Provided	Provided

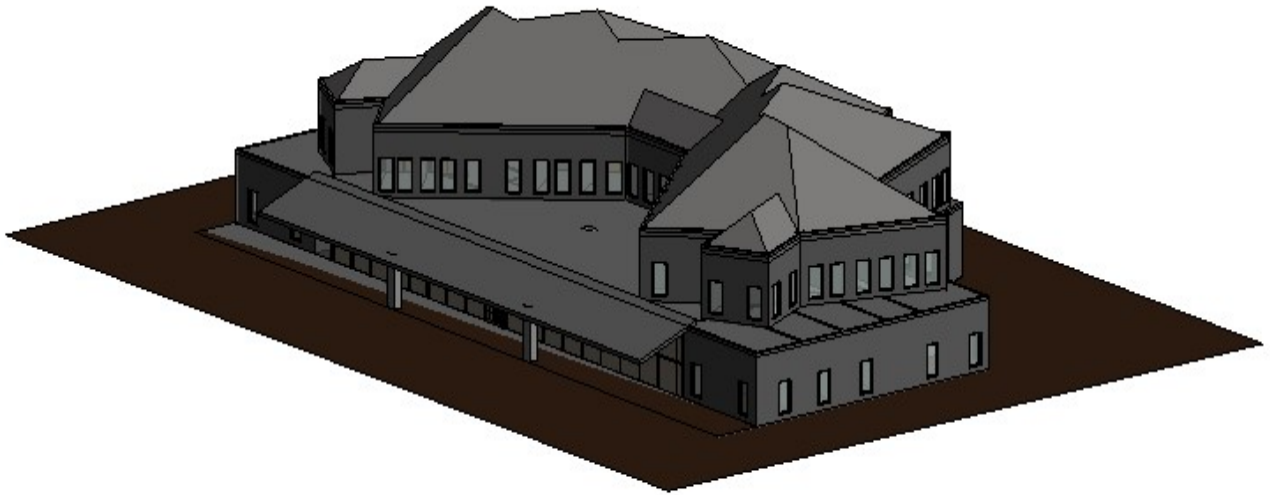
## 4.4 Terminal Building Detail:

### 4.4.1: Detail of Terminal Building

Airport Location	Jubbarhatti Shimla
Land Acquired	1500 square meter
Airport type	Domestic Airport
Material type	Conventional type

Total built up area = 20282 Sq. ft.

By using RIVET software the frame structure and the estimation of terminal building has to be taken



**Figure 4.1:** Terminal Building of airport shows in REVIT software

**Table 4.4.2:** Estimation of 1<sup>st</sup> floor by using REVIT software

<b>Type of Work</b>	<b>Name of material</b>	<b>Area of material (Sq. ft.)</b>	<b>Cost of material (Rs.)</b>	<b>Total Cost of work (Rs)</b>
Column 24"x24":120	Default Wall	13200	110	1452000
Basic Wall	Concrete Masonry	2756	110	427180
Roof	Default Room	12256	300	3676800
Floor	Generic	11233	250	2808250
Glass	Glass	872	85	74120
Single Flush	Door Panel	474	250	118500
Single Flush	Door Frame	237	250	59250
System Panel Glazing	Glass	5325	500	2662500
Sash	Sash	1163	450	523350
Trim	Trim	1163	210	244230
<b>Total</b>				<b>Rs. 12046180</b>

**Table 4.4.3:** Estimation of 2<sup>nd</sup> floor by using REVIT software

<b>Type of Work</b>	<b>Name of material</b>	<b>Area of material (Sq. ft.)</b>	<b>Cost of material (Rs.)</b>	<b>Total Cost of work (Rs)</b>
Column 24"x24" :64	Default Wall	7040	110	774400
Basic Wall	Concrete Masonry	2446	110	269060
Roof	Default Room	9038	300	2711400
Floor	Generic	7242	250	1810370
Glass	Glass	2840	85	241400
Single Flush	Door Panel	860	250	215000
Single Flush	Door Frame	430	250	107500
Sash	Sash	2840	450	1278000
Trim	Trim	2840	210	596400
<b>Total</b>				<b>Rs. 8003530</b>

Total construction cost of 1st floor and 2nd floor terminal building = ₹12046180+₹8003530  
 = ₹20049710

**Table 4.4.4:** Construction Cost of terminal building

Construction cost	₹20049710
Cost of painting per Sq. ft.	₹27
Total painting cost	₹547614
Total construction cost	₹20597324
Tools & Tackles @ 1% of total cost	₹205973
Water charge @ 2% of total cost	₹411946
Sanitary fitting @ 5% of total cost	₹1029865
Contractors profit @ 10% of total cost	₹2059730
Total construction cost of terminal building	₹24304838

#### 4.5 Terminal Building:

**Table 4.5.1:** Detail of Terminal Building

Airport Location	Jubbarhatti Shimla
Land Acquired	1500 square meter
Airport type	Domestic Airport
Material type	Sustainable Material

By using green fixtures in terminal building the building the building may acquire more economical and has more energy efficiency. With the help of RIVET software the terminal building has to be designed with the specific area of terminal building design and calculate the total cost estimate of terminal building.



**Table 4.5.2:** Estimation of 1<sup>st</sup> floor by using REVIT software

<b>Type of Work</b>	<b>Name of material</b>	<b>Area of material (Sq. ft.)</b>	<b>Cost of material (Rs.)</b>	<b>Total Cost of work (Rs)</b>
Column 24"x24" :120	Default Wall	13200	110	1452000
Basic Wall	Fly ash bricks	2756	160	440960
Roof	Default Room	12256	300	3676800
Floor	Tiles	11233	390	4380870
Glass	Insulated	872	220	191840
Single Flush	Door Panel	474	250	118500
Single Flush	Door Frame	237	250	59250
System Panel Glazing	Glazing Glass	5325	800	4260000
Sash	Sash	1163	450	523350
Trim	Trim	1163	210	244230
<b>Total</b>				<b>Rs. 15347800</b>

**Table 4.5.3** Estimation of 2<sup>nd</sup> floor by using REVIT software

<b>Type of Work</b>	<b>Name of material</b>	<b>Area of material (Sq. ft.)</b>	<b>Cost of material (Rs.)</b>	<b>Total Cost of work (Rs)</b>
Column 24"x24" :64	Default Wall	7040	110	774400
Basic Wall	Fly ash bricks	2446	160	391360
Roof	Default Room	9038	300	2711400
Floor	Tile	7242	390	2824380
Glass	Insulated glass	2840	220	624800
Single Flush	Door Panel	860	250	215000
Single Flush	Door Frame	430	250	107500
Sash	Sash	2840	450	1278000
Trim	Trim	2840	210	596400
<b>Total</b>				<b>Rs. 9523240</b>

Total construction cost of terminal building by using green technology = ₹15347800+₹9523240 = ₹24871040

**Table 4.5.4:** Construction Cost of terminal building

Construction Cost	₹24871040
Cost of painting per Sq. ft.	₹52
Total painting cost	₹1054664
Total construction cost	₹25925704
Tools & Tackles @ 1% of total cost	₹259257.04
Water charge @ 2% of total cost	₹518514.08
Sanitary fitting @ 5% of total cost	₹1296285.2
Contractors profit @ 10% of total cost	₹2592570.4
Total construction cost of terminal building	₹30592330.72

## 4.6 Comparison of Costs

**Table 4.6.1:** Comparison of costs between conventional airport and green airport

Conventional Airport Terminal Building	Green Airport Terminal Building
₹24304838	₹30592330.72



**Figure 4.2:** Cost comparison of conventional airport and green airport

This graph shows the conventional cost of airport terminal and the green cost of airport terminal . The conventional airport cost is Rs 24304838 and the green airport cost is Rs 30592330.72. Cost of green airport is more because the green techniques are used in the green airport. The cost is more but it is more economical and more energy saving.

#### 4.7 Night Glow Airstrip Runway

Runway Length = 4035 ft

Marking Width = 1.6 ft/ 1 ft

Total Marking Area = 16947 sq ft

Material = Night Glow Paint (Photo-luminishing powder)

Total Paint Used = 243 litres

One litre paint covers 70 sq ft area

Cost of paint = Rs 4000 /lt

**Table 4.7.1:** Details of Runway Marking

<b>Material</b>	<b>Marking Location</b>	<b>Runway Length(ft)</b>	<b>Marking Width (ft.)</b>	<b>Area (Sq. ft)</b>	<b>Cost of Paint (Rs.)</b>
Paint	Edge	4035	1.6	6456	368914
	Edge	4035	1.6	6456	368914
	Centre	4035	1	4035	230571
<b>Total</b>				<b>16947</b>	<b>968399</b>

#### Energy Charges at Runway

Consumption of energy in night hours/ month = Rs 21000.00

Per Annum = Rs. 252000.00

Total saving of bill amount per annum is up to Rs. 250000.00

With this total cost of material which is used for marking in runway is recovered within 4 years

# CHAPTER - 5

## CONCLUSION

### 5.1 CONCLUSION

The main principle of representing this study is to culminate the long haul advantages of green-airplane terminals. The followed research is uniform for who is related with type of work. As per the work that has been done in this study concludes that, although the construction cost of green airport is somewhat more than that of conventional airport but the green airport provides better future scope as per the maintenance and environmental issues. The construction cost of conventional terminal building is ₹24304838 and the construction cost of green airport terminal building is ₹30592330.72. The cost between both the construction is not as more as in which we drop a plan of constructing a green airport terminal because the long haul advantages are more in the green airport terminal. If the green construction is used than the long term benefits are increased and provides a economical environment.

### 5.2 Future Scope:

**Economical:** In this method the costs of airport has to be taken. The initial cost of green construction is higher than the conventional construction but the long haul advantages are more by constructing green construction.

**Technical:** For making building more economical there are different-2 techniques for making airport sustainable. Use of solar panels, green construction material, water harvesting are the main techniques for making building more sustainable.

**Institutional:** The basic knowledge about green building and their future benefits has to be discussed in whole the educational institutions for awareness among sustainability.

**Organization:** For developing awareness among the people about green building and less use of resources. A specific organization has to be assign for making awareness in between the peoples. But airport is that medium in which we can demonstrate whole the benefits and long haul advantage of green building.

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