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A STUDY OF PASSIVE SOLAR ENERGY SYSTEM IN BUILDING CONSTRUCTION

Submitted by

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ABSTRACT

The rate of expanding population development with expanding advancements in the field of businesses and innovations have all together brought about the expanding energy consumption enormously. This high utilization is a worry for supportability. This negatively affects the earth and energy conservation. Along these lines, a development in the building construction, that would perform with the existing energy, without abusing any extra mechanical or electrical sources is called as passive solar based building plan idea. These structures take the benefit of the atmosphere, where it must be built. An appropriate site examination would judge the execution of the building.

The idea of passive solar based building structures is embraced in new structures. Be that as it may, officially existing structures can be retrofitted to carry on inactively. The building is named latent sunlight-based structures since we do not make utilization of any mechanical or electrical gadgets inside the working to bring the idea.

The principle idea of latent sun powered structures is that its building components i.e. the windows, dividers and the floors are made ready to gather sun based vitality and store them. This vitality is then utilized as a part of the winter for warmth and used to dismiss the warmth amid the late spring seasons. The structures change over the sun-oriented vitality into valuable vitality without the assistance of some other mechanical framework.

CHAPTER 1

INTRODUCTION

1.1 GENERAL

The present society utilizes the electrical energy for their comfort. This electrical energy is majorly obtained by burning the fossil fuels. These fuels are decreasing in a dramatic rate and it is also contributes to the pollution. Passive solar design for home helps to reduce the consumption of electrical energy by utilizing the solar energy. Passive solar design is a green concept which is aimed to utilize the maximum solar energy in the form of heat to maintain interior thermal comfort. Throughout the sun's daily and annual cycles, thereby the reducing the dependence of energy consuming mechanical and electrical systems of heating and cooling. The windows, walls and floors of the homes are designed to collect the solar heat from the sun in winter and reject it in the summer. In Industrial and technological innovations, population growth and rapid urbanization lead to an increase in energy consumption.

Negative effect of energy on environment impact has made this as critical issue. We need to make a quick switch about the use of energy in building and by this I indicate to my topic Passive Solar Building. In passive solar building design, windows, walls, and floors are made to collect, store, and distribute solar energy in the form of heat in the winter and reject solar heat in the summer. This is called passive solar design because, unlike active solar heating systems, it does not involve the use of mechanical and electrical devices. The key to design a passive solar building is to best take advantage of the local climate performing an accurate site analysis. Elements to be considered include window placement and size, and glazing type, thermal insulation, thermal mass, and shading. Passive solar design techniques can be applied most easily to new buildings, but existing buildings can be adapted or "retrofitted". The scientific basis for passive solar building design has been developed from a combination of climatology, thermodynamics (particularly heat transfer: conduction (heat), convection, and electromagnetic radiation, fluid mechanics/natural convection (passive movement of air and water without the use of electricity, fans or pumps), and human thermal comfort based on heat index, psychometrics and enthalpy control for buildings to be inhabited by humans or animals, sunrooms, solariums, and greenhouses for raising plants. Specific attention is divided into the site, location and solar orientation of the building, local sun path, the prevailing level of insulation (latitude/sunshine/clouds/precipitation), design and construction quality/materials, placement/size/type of windows and walls, and incorporation of solar-energy-storing thermal mass with heat capacity. While these considerations may be directed toward any building, achieving an ideal optimized cost/performance solution requires careful, holistic, system integration engineering of these scientific principles. Modern refinements through computer modeling (such as the comprehensive U.S. Department of Energy "Energy Plus" building energy simulation software), and application of decades of lessons learned (since the 1970s energy crisis) can achieve significant energy savings and reduction of environmental damage, without sacrificing functionality or aesthetics. In fact, passive-solar design features such as a greenhouse/sunroom/solarium can greatly enhance the livability, daylight, views, and value of a home, at a low cost per unit of space. Passive solar building construction may not be difficult or expensive (using off-the-shelf existing materials and technology), but the scientific passive solar building design is a non-trivial engineering effort that requires significant study of previous counter-intuitive lessons learned, and time to enter, evaluate, and iteratively refine the simulation input and output.

1.2 LIFE CYCLE ASSESSMENT

Scientific passive solar building design with quantitative cost benefit product optimization is not easy for a novice. The level of complexity has resulted in ongoing badarchitecture, and many intuition-based, unscientific construction experiments that disappoint their designers and waste a significant portion of their construction budget on inappropriate ideas. The economic motivation for scientific design and engineering is significant. If it had been applied comprehensively to new building construction beginning in 1980 (based on 1970s lessons learned), America could be saving over 250,000,000 per year on expensive energy and related pollution today. Since 1979, Passive Solar Building Design has been a critical element of achieving zero energy by educational institution experiments, and governments around the world, including the U.S. Department of Energy, and the energy research scientists that they have supported for decades. The cost-effective proof of concept was established decades ago, but cultural assimilation into architecture, construction trades, and building-owner decision making has been very slow and difficult to change.

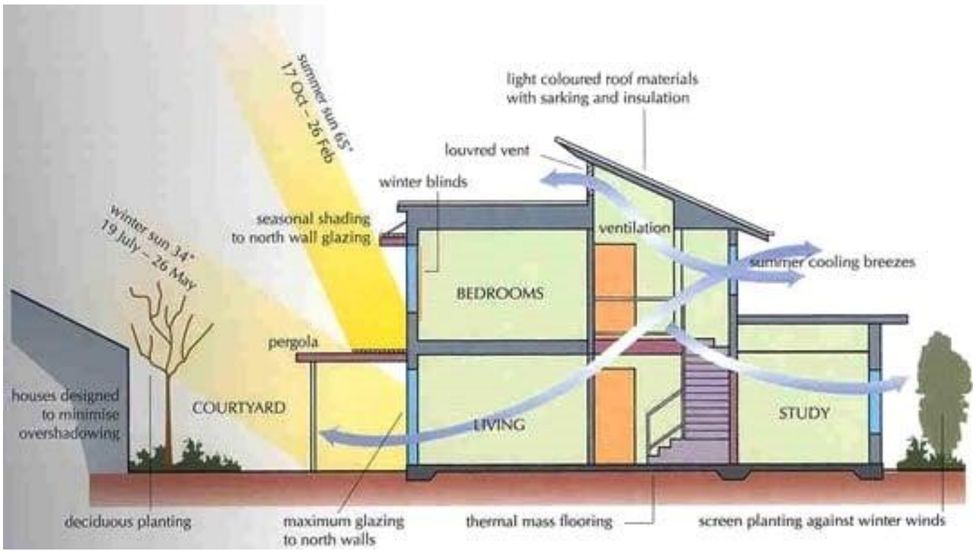


Figure1.1 concept of Passive Solar building

For a building to be considered, it must reduce its energy consumption and generate energy from renewable sources, which can compensate for the majority of the building's consumption assuring at the same time thermal comfort. Taking into account the specific requirements and specifications for performance, a special attention has been paid to the integration of renewable systems in the buildings footprint or nearby. At building level these renewable technologies are mostly integrated in the building envelope (walls and roofs).

Usually, the building façade has a crucial role in performing as the interface between the environment and the indoor ambient. With the integration of renewable energy (especially solar), the building's facade has a significant impact on the occupant's comfort, building energy demands, and the aesthetics of the building. Commonly, designing a building façade takes into consideration several factors, as the climatic conditions and surrounding structures, indoor and spatial characteristics, needs of the building occupants regarding comfort and costs, among others. From an engineering and architecture perspective, in the last years, there has been a growing focus on the strategic development of building façades, it is, to contribute to meet the requirements of the high-performance regulations while being sustainable and aesthetically pleasant. This strategic development brings new experiments, innovative systems, and technology to be integrated into the formal functions of the envelope.

It is estimated that the residential and service sector, most of which are buildings contribute to more than 40% of energy consumption. Part of the major energy consumption in buildings is the heating, ventilating, and air-conditioning (HVAC) system. In order to lessen the burden on the active systems transforming renewable energy into the thermal or electrical energy, a necessary first step is to apply the optimal combination of passive design strategies, foremost among them passive solar design strategies

1.2.1 Energy 47efficiency

Another strategy, passive solar building design, is often implemented in low- energy homes. Power generation is generally the most expensive feature to add to a building. The salient features which improve energy efficiency are

- Passive Cooling System
- Passive ventilation System
- Advanced Windows& Energy Savings
- Minimum Energy Performance

1.3 Passive Solar Design

Passive solar design (Figure1.1) uses sunshine to heat, cool and light homes and other buildings without mechanical or electrical devices. It is usually part of the design of the building itself, using certain materials and placement of windows or skylights.

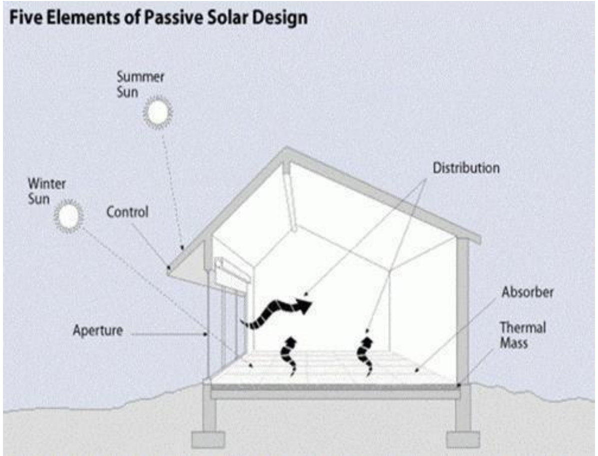


Figure1.2 Passive Solar Design

a) Rules Of Passive Solar Systems

• The building should be elongated on an east-west axis.

• The building south face should receive sunlight between the hours of 9:00A.M.and3:00P.M. (sun time) during the heating season.

• Interior spaces requiring the most light and heating and cooling should be along the south face of the building.

• Less used spaces should be located on the north.

b) The Advantages of Passive Solar Design

• High energy performance: lower energy bills all year round.

• Investment: independent from future rises in fuel costs, continues to save money long after initial cost recovery.

• Value: high owner satisfaction, high resale value.

• Attractive living environment: large windows and views, sunny interiors, open floor plans.

• Low Maintenance: durable, reduced operation and repair.

• Unwavering comfort: quiet (no operating noise), warmer in winter, cooler in summer (even during a power failure).

1.3.1 Passive Solar Heating

The goal of all passive solar heating systems is to capture the sun's heat within the buildings elements and release that heat during periods when the sun is not shining. At the same time that the building elements (or materials) is absorb in heat for later use, solar heat is available for keeping the space comfortable(not over heated).

Two primary elements of passive solar heating are required:

South facing glass Thermal mass to absorb, store, and distribute heat.

There are three approaches to passive systems

Direct Gain: Sun light shines into and warms the living space.

Indirect Gain: Sunlight warms thermal storage, which then warms the living space.

Advantages of Solar Energy in Building Design

Solar energy can substantially enhance building design. It offers several advantages compared to conventional energy:

Free after recovering upfront capital costs; payback time can be relatively short; available everywhere and inexhaustible; clean, reducing demand for fossil fuels and hydroelectricity, and their environmental drawbacks; can be building-integrated, which can reduce energy distribution needs.

Characteristics of Building Design Issues

• Maximize possible solar transmission and absorption in winter to
minimize or reduce to zero the heating energy consumption, while preventing overheating.

• Use received solar gains for instantaneous heating load and stores
the remainder in embodied thermal mass or specially built storage devices.

• Reduce heat losses using insulation and windows with high solar heat gain factors.

• Employ shading control devices or strategically planted deciduous trees to exclude summer solar gains that create additional cooling load.

• Employ natural ventilation to transfer heat from hot zones to cool zones in winter and for natural cooling in the summer; use ground-source cooling and heating to transfer heat to and from the utilize evaporative cooling.

• Integrate building envelope devices such as windows which include Photovoltaic panels as shading devices or roofs with photovoltaic shingles; their dual role in producing electricity and excluding thermal gain increase their cost-effectiveness.

• Use solar radiation for day-lighting, which requires effective distribution into rooms or onto work planes, while avoiding glare.

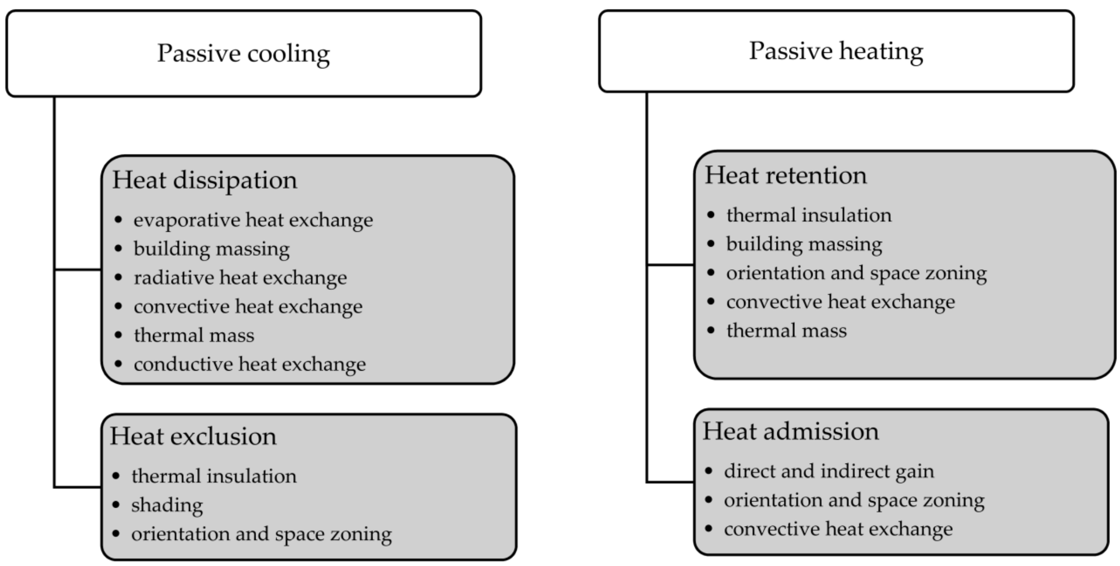


Figure1.3 Passive Cooling & passive heating

1.4 Passive Solar Systems

Passive solar refers to systems that absorb, store and distribute the sun's energy without relying on mechanical devices like pumps and fans, which require additional energy. In other terms, passive solar involves no panels, no batteries, and nothing is fed into the general power grid. Passive systems could be used either for heating or cooling purposes.

A passive solar building makes the greatest use possible of solar gains to reduce energy use for heating and, possibly, cooling by using natural energy flows through air and materials-radiation, conduction, absorption and natural convection (Robertson and Atheneites, 2010). It can optimize solar heat gain in direct heat gain systems, in which windows are the collectors and interior materials are the heat storage media. The principle can also be applied to water or air solar heaters that use natural convection to thermosiphon for heat storage without pumps or fans. According to Hibshman (1983), a good passive solar design should be as presented

- The three most common solar passive systems are Hibshman (1983): direct gain system, which allows sunlight to windows into an occupied space where it is absorbed by the floor and walls.
- Indirect gain system, where a medium of heat storage such as wall, in one part of the building absorbs and stores heat, which is then transferred to the rest of the building by conduction, convection or radiation.
- Isolated gain system, where solar energy is absorbed in a separate area such as greenhouse or solarium and distributed to the living space by ducts.

1.5 Heating and cooling

A Roof-top shallow solar pond: It acts like a panel radiant heater/cooler and is primarily meant only for one-storey buildings with thin horizontal roofs. It is also ineffective during monsoons and roofs need special care with regard to weather proofing. Building form - Since the roof itself is a collector, this system is most suitable for heating or cooling one-storey buildings, or the top floor of a multi-storeyed structure.

Glazing - For summer cooling, the pond must be exposed to as much of the night sky as possible.

Materials - Roof ponds are generally 10-20 cm in depth. A structural RCC grid system or metal deck, which also acts as a finished ceiling and radiating surface, is the most commonly used support for the pond itself.

Thermal control-Roof-pond heating and cooling is characterized by stable indoor temperatures and high levels of comfort due to ‘the large area of radiative surface.

System efficiency- Roof ponds, which are lined with plastic and have movable insulation, range in efficiency from 30 to 45~. It should be noted that the effectiveness of the seal made by the movable insulation will have an impact on the efficiency of the system. Retrofitting - The requirements of a large area of radiating surface plus structural and modular considerations make it difficult to apply to existing structures.

Solar roof ponds are an inexpensive and effective method of providing both heating and cooling in dry climates with clear night skies.

1.6 Passive Solar Building Configurations

The aim of a passive solar building is to absorb (in winter) the maximum amount of radiation from the sun during the day, and to utilize this heat to warm the interior. The sides of the buildings exposed to the sun gain heat during the day, while the other sides, in the shade, lose heat. This helps to avoid overheating during the summer. To maximize the amount of radiation received, passive solar buildings are designed along an east-west axis, and the south facing walls are increased to present the largest possible surface area to the sun.

The east and west-facing walls, which are less exposed to sun, are reduced as much as possible to minimize heat-loss. Buildings should be aligned along an East-West axis, to maximize the surface area facing south. As the overall shape of the building determines the heat exchange with the exterior, it is also important to minimize the area / volume ratio so as to limit the heat loss: compact buildings with several storey’s are more efficient. The area to volume ratio should be minimized as much as possible: compact buildings with a large surface area are more efficient. The rooms to be heated are positioned on the side of the building, which is the most exposed to the sun: the south face.

The rooms which are used the least (such as storage rooms, toilets etc) are placed on the north face, in the shade. The surfaces in the shade, such as the north wall, or those exposed to severe conditions must be kept to a minimum. They can be underground or adjacent to an earth bank. Heat loss from north-facing walls can be minimized by embedding the building in an earth bank or burying the north wall into the hillside.

1. Collection and absorption of the maximum amount of solar radiation during the day
2. Storage of the heat collected from the sun’s radiation during the day
3. Release of this heat into the interior of the building during the night

4. Insulation of the whole building to retain as much of the heat as possible inside the building

1.7 Bio climatic Design

The passive solar concepts described above all work in conjunction and are themselves influenced by a wide variety of external factors. The term bioclimatic design refers to the interrelationship between the four concepts above, and the rest of the environment. Bioclimatic influences are complex, and are summarized below:

1.7.1 Specification and usage of Building

The first stage of the design process of a passive solar building is determining the specification and the schedule. Specifications The specifications of the building are defined by the proposed use of the building The specifications are the physical parameters that influence the design of any building, not just passive solar ones. They include: - Proposed number of rooms - Proposed number of storey's - Desired area of each room - Number of doors Schedule The schedule of the building is also defined by the proposed use of the building, but the term refers specifically to the proposed usage of the building. These include: -The purpose of the building (domestic house, office, store room etc) - Whether the building will be for winter or summer use, or all year round - Whether the building will be used during the day, the night, or all day - The number of persons who will be using the building The schedule helps designers to plan the position of each room in the building to maximize the benefit of the passive solar heating system to the occupants. The schedule also defines the type of passive solar technology that is used. Š

1.7.2 General Rules of passive solar energy building

It is possible to formulate a number of general rules for the design of passive solar buildings, according to three common building configurations: In multi-storey buildings, the following design guidelines should befollowed:

1. The ground floor should be used for cattle and livestock
2. The first floor should be used for rooms that are used mainly during the winter
3. The second floor should be used for rooms that are used mainly during the summer an example of a building that uses a stable on the ground floor to provide additional heating.
4. The north-facing side should be used for storerooms and other little used areas, to create a buffer zone.
5. The south-facing side should contain the most commonly used rooms, including the living room, the kitchen, and the bedrooms.

6. The east-facing side of the building should contain rooms that are used mainly in the morning.
7. The west-facing side should contain rooms that are used mainly in the evening.

Proportionately, a horizontal window (a skylight) will collect three times as much sunlight as a vertical window. It also distributes light into the inside of the building more evenly than a vertical window. However, because the sun is higher in the sky during the summer months, a horizontal window collects too much heat and light during the summer, which can make the building too hot. By making sure windows are completely vertical, the maximal amount of sunlight can still be collected during the winter,

when the sun is lower in the sky. To ensure the window area is as vertical as possible, buildings constructed on a slope should be built in the following ways:

• If the upward slope is north facing: Dig the building into the northern part of the earth, so that a part of the north wall is underground.

• If the upward slope is south facing: Dig the building into the southern part of the earth, and elevate the northern side.

Application of passive solar building

- day use
- evening use Positive aspects
- cheap
- easy to construct

Negative aspects

- cold during the night
- cold during cloudy days

1.8 Thermal mass

A passive solar heated building admits the solar radiation through the glass and stores it in a dense material, the thermal mass, which will release it later: this reduces the temperature fluctuations of the building: the building will be less hot at midday, and more comfortable after sunset. Thermal mass is dense material such as mud, earth and stone: it is the load bearing wall,partition and floor. The thermal mass should be well distributed throughout the building. Keep the walls clear of posters and pictures. For each m² of south facing glass, install at least 6 m² of thermal mass. Thermal mass, coupled with insulation, is a much more efficient way of heating a building than the simple direct gain designs.

1.9 Window insulation

Glazing is the greatest source of heat loss in a passive solar building. The effectiveness is doubled if: - the glazing is double or an extra polyethylene membrane covers the single glazing, - a curtain or blanket is added during the night.

1.10 Cooling

Extremely valuable in the winter, south-facing windows can overheat the building in summertime. This can be avoided if: - a generous eave provides shading by blocking high summer sun but still admits low winter sun for heating, - plan enough operable windows or vents to allow cross ventilation, - trees shade windows with their leaves in the summer and let the sun through the branches in the winter.

1.11 Construction Wooden frame

Select wood of good quality: Karu - The section is 4 inches x 3 inches. If less, the structure may bend. - Cut a 1 inch deep and ½ inch thick band in the inner periphery of the outer side. The glazing is pinned to the back. If double-glazing is fitted, the size of the band is 1 ½ inch deep and ½ inch thick.

1.12 Glazing

Take accurate measurements and, because the glazing will expand with the heat, reduce the length and width by 4 mm. - Fix the glazing on the wood frame with wooden battens. - Fill all the air gaps between the glazing and the battens, the battens and the wood frame with wood. The infiltration will be limited.

CHAPTER 2

LITERATURE REVIEW

2.1 GENERAL

This chapter confers the review of literature regarding the concepts and awareness of passive solar building in the past research and studies. The most noteworthy of them which are related to the current study are being reviewed.

2.2 LITERATUREREVIEW

Serkanet.al (2003) concluded that the energy-efficiency design strategies by passive solar components having the additional cost of about 9% of the total building cost, it is possible to save the total annual energy used in this specific residential building by 18%. It will save three types of energy need for the space conditioning and visual comfort (i. e., heating, cooling and lighting), 61% energy use reduction in heating is the maximum energy saving, lighting energy use is also decreased by 40%. However, in cooling energy need, there is an increase of 34%.

Andreas Athienitiset. al (2008) stated that Based on the design of the houses, it is expected that homes with low and near net-zero energy use can be designed in a cost-effective manner within a period of about 5 years, provided a heat pump-based system is used for heating and heat is recovered from the PV system and efficiently utilized in the house.

Tanbiruj et.al (2010) finalized that the solar energy that receive naturally by a building can be used to heat the building without special devices to capture or collect sunlight in direct gain passive solar system. Passive solar heating can be applied by using of large sun-facing windows (south-facing in the Northern Hemisphere) and building materials. A well-insulated building with such construction element can absorb the sun's energy and reduce heating bills around 50 percent. According to U.S Department of energy a special builder-friendly computer program called BuUderGWd.e has been developed to automate the calculations involved in telling out the four worksheets. The program operates like a spreadsheet: the user fills in values for the building and the computer completes the calculations. Including all table lookups and prints out the answers. The results are the same as if you completed the worksheets manually, but it is much faster more convenient and less prone to arithmetic error. Many design variations can be evaluated very quickly.

JavadSadeghsaberi et.al (2013) observed the different methods which use in passive solar energy building like direct gain, indirect gain, isolated gain etc.

NajmehNajafiet.al (2013) studied the experience in conventional architecture of Shiraz, it is possible to create an environmental and sustainable architecture.

Anil kumar (2013) concluded that concept of appliance of solar energy distribution through the use of a sun path diagram and the multiple ways in which this can be used for energy efficient buildings and also for evolving passive solutions possible in buildings and also provides an overview of the sun based passive solutions and design approaches possible in the case of buildings especially with reference to tropical countries.

AbdolvahidKahoorzadeh et.al (2014) shows passive solar elements like shading devices. Additional elements would keep the interior space at a more comfortable and stable temperature. Similarly, the indoor humidity can be controlled. Open the building up at night to ventilate and cool interior thermal mass. Close the buildings up during the daytime to keep the heat out. Therefore, with a standard passive solar system, dwellers feel more comfortable in terms of any conditions either cold weather or hot weather. It also has financial benefits. In fact, buildings require relatively small cooling or heating systems.

Singh et.al (2016) research that the height to width ratio of the built mass with each other and other physical features like trees, streets etc. can help not only in desirable thermal indoor conditions but, can also reduce the use of valuable land for other purposes.

According to design of P J Trade Centre (2016) observed that the shading device, orientation, vegetation, natural ventilation, concrete vent blocks and material act as effective passive design that plays an important role in achieving thermal comfort. The garden plaza and trees planted around the building acts as filtration to cool the heated air. The uses of concrete vent blocks on parts of the building improve the space quality and enhance the ventilation for user's comfort. The concrete vent block also act as shading device that allows air to flow in thus making the building naturally ventilated. The natural ventilation and stack effect system used in PJ Trade Centre also help to enhance the ventilation system and fasten the time for the air to ventilate through the building. The orientation of the building helps support the design of the concrete vent block as natural cooling strategy. The brick material on the building also helps to absorb heat to achieve an average temperate of the surrounding for thermal comfort.

2.3 SUMMARY OF LITERATURE

There search articles published by various authors were reviewed and noticed that there are numerous green building elements which are in cured inconstruction actties. It is also noticed that the green buildings significant development in several countries and also the concepts involved in them. It is found that the green building technology is emerging trend which improves the environmental aspects.

CHAPTER-3

METHODOLOGY

3.1 RESEARCH SAMPLE & DATA COLLECTION

Although green building is not a new term or new concept to the general public, it is not so easy for people to realize the performance and understand the actual benefit if they has no experience of living in passive solar buildings. Even for people who have experience of living in passive solar buildings, it is uncertain whether the passive solar energy building from the occupant's attitudes and to find out whether the occupants shave a healthy and comfortable living environment provided by green buildings.

3.2 QUESTIONNAIRE DESIGN

There are two sets of questionnaires for the occupants and other to the industry. The questionnaires are framed based on four sections. The questionnaires are with closed questions and open question written in simple English.

The four sections are:

1. Concept of passive solar building
2. Attitude towards the green features
3. Suggestions for improvement

3.3 BASIC PRINCIPLE OF DESIGNING QUESTIONS

Two types of questions, closed questions and open questions, are used in the questionnaire. In the survey, the closed questions will be used if there are time constrains and need to produce quantitative answers for statistical analysis. As a result, three out of four sections in the questionnaire are used to collect. It is convenient for respondents to choose and fill it in easily. Apart from the closed questions, the open question is also used for the questionnaire in the last section to collect any unprompted responses. It explains that open questions are used when the researcher does not want to lead the respondent in anyway. The purpose of the questions is usually to find out about respondents behaviour, to understand their attitudes.

3.4 DATA ANALYSIS TOOLS AND TECHNIQUES

The various is used for collecting the data are as follows:

Questionnaire

Questionnaires refer to form filled in by respondents alone. Questionnaires were handed to the respondents in field and ask them to fill it.

Observation

Observation is either an activity of aliving being, such as a human, consisting of Receiving knowledge of the outside world through the senses, or the recording of data using scientific instruments. The term may also refer to any data collected during this activity. An observation can also be the way you look at things or when you look at something.

Interviews

In interviews information is obtained through inquiry and recorded by enumerators. The interviewer in one-to one conversation collects detailed personal information from individuals using oral questions. In this research we have deal with approximately 28 direct interviews and 15 through online.

CHAPTER - 4

DATA ANALYSIS AND RESULTS

4.1 INTRODUCTION

Passive solar heating is one of several design approaches collectively called passive solar design. When combined properly, these strategies can contribute to the heating, cooling, and daylighting of nearly any building. The types of buildings that benefit from the application of passive solar heating range from bar racks to large maintenance facilities.

Typically, passive solar heating involves:

- The collection of solar energy through properly oriented, south-facing windows.
- The storage of this energy in "thermal mass," comprised of building materials with high heat capacity such as concrete slabs, brick walls, or tile floors.
- The natural distribution of the stored solar energy back to the living space, when required, through the mechanisms of natural convection and radiation.

- Window specifications to allow higher solar heat gain coefficient in south glazing.

4.2 Benefits of Passive Solar Buildings

The benefits of passive solar building systems are as follows:

- The building interior are bright - The interior of the building would be filled with sufficient light. This is due to the transmission of visible light frequencies. The system is designed such a way that the control of glare and over lighting is kept in mind.
- The ultraviolet energy is blocked - The direct ultra violet rays are harmful. The passive solar building system has the advantage of blocking almost 99.9% of the ultraviolet radiation energy. Preventing this would save the interior fabrics as well as decor and make them long lasting.
- Summer is Made cooler and comfortable - It keeps the interior cool during the hot season. This would obviously reduce cooling energy costs. This would give a low solar gain coefficient value (SHGC).
- Winter made warmer

The main elements considered are:

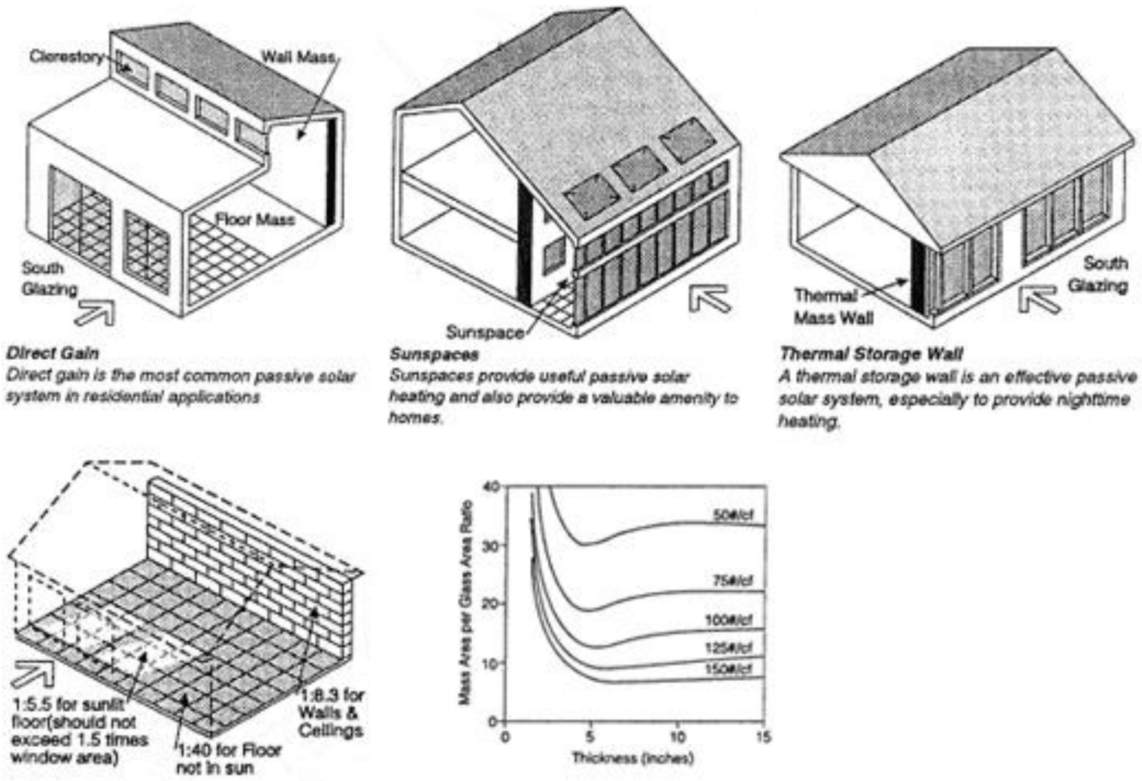
- Room types, internal doors, walls and furniture in buildings
- The Equator faced orientation for the building
- Building dimension extension in east-west direction
- Window size fixed to get adequate solar in winter and shade in summer.
- Windows in the west are avoided.
- Use of thermal mass like floors or wall

4.3 Types and Costs of Technology

There are four generic passive solar heating approaches for skin-load dominated buildings: (1) sun-tempered, (2) direct gain, (3) indirect gain, and (4) isolated gain.

1. Sun-tempering is achieved through modest increases in south-facing windows. A tract builder's house typically has about one quarter of its windows on each facade with a south glass equal to about 3% of the house's total floor area. Depending on the climate, a sun-tempered house or barracks might increase this percentage to between 5% and 7%. In this case, no ther-

mal mass needs to be added to the basic design (the "free mass" of gypsum wallboard and furnishings is sufficient to store the additional solar heat.)



The four approaches for passive solar heating in skin-load dominated buildings

2. Direct gain is the most basic form of passive solar heating. Sunlight admitted through south-facing glazing (in the Northern Hemisphere) enters the space to be heated and is stored in a thermal mass incorporated into the floor or interior walls. Depending on climate, the total direct gain glass should not exceed about 12% of the house's floor area. Beyond that, problems with glare or fading of fabrics are likely to occur, and it becomes more difficult to provide enough thermal mass for year-round comfort.

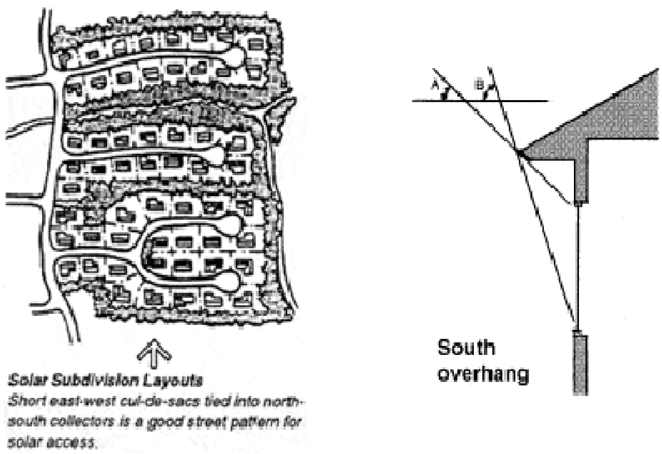
4.4 Design Considerations

The following are general recommendations that should be followed in the application of passive solar heating technology.

- Pay careful attention when constructing a durable, energy-conserving building envelope.
- Address orientation issues during site planning. To the maximum extent possible, reduce glass on the east and west sides and protect openings from prevailing winter winds.
- Establish an air-tight seal around windows, doors, and electrical outlets on exterior walls. Employ entry vestibules and keep any ductwork within the insulated envelope of the building to

ensure thermal integrity. Consider requiring blower-door tests of model homes to demonstrate airtightness and minimize duct losses.

- Specify windows and glazing that have low thermal transmittance values (U values) while admitting adequate levels of incoming solar radiation (higher solar heat gain coefficient [SHGC]). Data sources such as the National Fenestration Rating Council's Certified Products Directory should be consulted for tested performance values. The amount of glazing will depend on building type and climate.
- Ensure that the south glass in a passive solar building does not contribute to increased summer cooling. In many areas, shading in summer is just as critical as admitting solar gain in winter. From the overhang figure below, use summer (B) and winter (A) sun angles to calculate optimum overhang design.



Solar Subdivision Layouts and South Overhang Angles

- Avoid overheating. In hot climates, buildings with large glass areas can overheat. Be sure to minimize east and west-facing windows and size shading devices properly. For large buildings with high internal heat gains, passive solar heat gain is a liability, because it increases cooling costs more than the amount saved in space heating.
- Design for natural ventilation in summer with operable windows designed for cross ventilation. Ceiling fans or heat recovery ventilators offer additional air movement. In climates with large diurnal temperature swings, opening windows at night will release heat to the cool night air and closing the windows on hot days will keep the building cool naturally.

- Provide natural light to every room. Some of the most attractive passive solar heated buildings incorporate elements of both direct and indirect gain. This can provide each space with a quality of light that is suitable to its function.
- Elongate the building (if possible) along the east-west axis to maximize the south-facing elevation and the number of south-facing windows that can be incorporated.
- Plan active living or working areas on the south side of the building and less frequently used spaces, such as storage and bathrooms, on the north side. Keep south-facing windows to within 20° of either side of true south.
- Improve building performance by employing either high-performance, low-e glazing or nighttime, moveable insulation to reduce heat loss from glass at night.
- Locate obstructions, such as landscaping or fences, so that full exposure to the sun is available to south windows from 9 a.m. to 3 p.m. for maximum solar gain in winter.
- Include overhangs or other devices, such as trellises or deciduous trees, for shading in summer.
- Reduce air infiltration and provide adequate insulation levels in walls, roofs, and floors. As a starting point for determining appropriate insulation levels, check minimum levels in the Council of American Building Official's Model Energy Code.
- Select an auxiliary (HVAC) system that complements the passive solar heating effect. Resist the urge to oversize the system by applying "rules of thumb."
- Make sure there is adequate quantity of thermal mass. In passive solar heated buildings with high solar contributions, it can be difficult to provide adequate quantities of effective thermal mass.
- Design to avoid sun glare. Room and furniture layouts need to be planned to avoid glare from the sun on equipment such as computers and televisions

DESCRIPTIVE STATISTICS FOR COMPANIES

Descriptive statistics are brief descriptive coefficients that summarize a given dataset, which can be either a representation of the entire or a sample of a population. Descriptive statistics are broken down into measures of central tendency and measures of variability (spread).

- Plan active living or working areas on the south side of the building and less frequently used spaces, such as storage and bathrooms, on the north side. Keep south-facing windows to within 20° of either side of true south.

- Improve building performance by employing either high-performance, low-e glazing or nighttime, moveable insulation to reduce heat loss from glass at night.
- Locate obstructions, such as landscaping or fences, so that full exposure to the sun is available to south windows from 9 a.m. to 3 p.m. for maximum solar gain in winter.

	N	Min	Max	Mean	SD	Variance	Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error
Customers willingness to Passive solar building	25	1.0	4.0	2.2	.1929	.833	-.62	.902
Customers willingness to Passive solar building	25	1.0	4.0	2.32	.8021	.643	-.52	.902
Market requirements for Passive solar building	25	1.0	4.0	1.96	.7895	.623	-.434	.902
Sustainment of Passive solar building in market	25	1.0	4.0	2.00	.9574	.917	-.48	.902
Comparative requirement	25	1.0	3.0	2.48	.7141	.510	-.15	.902
Need for eco-friendly homes	25	1.0	3.0	1.88	.6658	.443	-.56	.902
favor of Passive solar building Index	25	1.0	3.0	1.92	.7594	.577	-1.2	.902
Significance of eco-friendly homes	25	1.0	4.0	2.12	.8813	.777	-.09	.902
Aesthetic preference of Passive solar building	25	1.0	3.0	2.08	.7024	.493	-.82	.902
Impact value of Passive solar building	25	1.0	3.0	2.04	.7895	.623	-.1.4	.902
Sensibility of eco homes	25	1.0	4.0	2.04	.9781	.957	-.78	.902
Uniqueness of buildings	25	1.0	4.0	2.40	1.00	1.00	-.92	.902
Awareness of Passive solar building	25	1.0	4.0	2.84	.9866	.973	-.62	.902
Aspects of Passive solar building	25	1.0	3.0	2.00	.7071	.500	-.85	.902
Customers perspective on Passive solar building	25	1.0	3.0	2.32	.8021	.643	-1.1	.902
Company pattern to environment	25	1.0	4.0	2.32	.9883	.977	-.71	.902
Incorporation of Passive solar building	25	1.0	3.0	2.20	.7071	.500	-.85	.902
Adoption of Passive solar building concepts	25	1.0	4.0	1.72	.8907	.793	.097	.902
Adoption of Passive solar building concepts	25	1.0	4.0	2.28	.9798	.960	-.84	.902
Adoption of Passive solar building concepts	25	1.0	4.0	2.00	.9574	.917	-.48	.902
ValidN(listwise)	25							

Table 4.2 Descriptive Statistics

4.1 FREQUENCY ANALYS IS FOR COMPANIES

Frequency analysis is a descriptive statistical method that shows the number of occurrences of each response chosen by the respondents. When using frequency analysis, SPSS Statistics can also calculate the mean, median and mode to help users analyze the results and draw conclusions.

1. Do your customers ask for passive solar features in homes

		Frequency	Percent	Valid Per-cent	Cumulative-Percent
Valid	StronglyAgree	6	24.0	24.0	24.0
	Agree	10	40.0	40.0	64.0
	Neutral	7	28.0	28.0	92.0
	Disagree	2	8.0	8.0	100.0
	Total	25	100.0	100.0	

Table 4.3 Customer's willingness to passive solar building

Interpretation: From the above table it is inferred that the respondents 24 % strongly agree, 40% are Agree, 28% are Neutral and 8% disagree with the statement.

2. Do you think customers would like to prefer passive solar homes

		Frequency	Percent	Valid Per-cent	Cumulative-Percent
Valid	StronglyAgree	4	16.0	16.0	16.0
	Agree	10	40.0	40.0	56.0
	Neutral	10	40.0	40.0	96.0
	Disagree	1	4.0	4.0	100.0
	Total	25	100.0	100.0	

Table 4.4 Customers willingness to passive solar building

Interpretation: From the above table it is inferred that the respondents 16 % strongly agree, 40% are Agree, 40% are Neutral and 4% disagree with the statement.

3. Do you think companies which can establish themselves with passive solar image will have distinctive advantage in the market place

		Frequency	Percent	Valid Per-cent	Cumula-tivePercent
Valid	StronglyAgree	7	28.0	28.0	28.0
	Agree	13	52.0	52.0	80.0
	Neutral	4	16.0	16.0	96.0
	Disagree	1	4.0	4.0	100.0
	Total	25	100.0	100.0	

Table 4.5 Market requirements for passive solar building

Interpretation: From the above table it is inferred that the respondents 28 % strongly agree, 52% are Agree, 16% are Neutral and 4% disagree with the statement.

4. Do you think companies which sell passive solar homes will be able to sustain for a longer period of time in the market in comparison to others

		Frequency	Percent	Valid Percent	Cumulative-Percent
Valid	StronglyAgree	9	36.0	36.0	36.0
	Agree	9	36.0	36.0	72.0
	Neutral	5	20.0	20.0	92.0
	Disagree	2	8.0	8.0	100.0
	Total	25	100.0	100.0	

Table 4.6 Sustainment of passive solar building in market

Interpretation: From the above table it is inferred that the respondents 36 % strongly agree, 36% are Agree, 20% are Neutral and 8% disagree with the statement.

5. How are your passive solar energy buildings priced in comparison to equivalent building in themarket

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	StronglyAgree	3	12.0	12.0	12.0
	Agree	7	28.0	28.0	40.0
	Neutral	15	60.0	60.0	100.0
	Total	25	100.0	100.0	

Table 4.7 comparative requirement

Interpretation: From the above table it is inferred that the respondents 12% strongly agree, 28% are Agree, 60% are Neutral with the statement.

6. Eco-friendly homes are valuable because these homes are developed and constructed using an environmentally friendly process

		Frequency	Percent	ValidPercent	Cumulative-Percent
Valid	StronglyAgree	7	28.0	28.0	28.0
	Agree	14	56.0	56.0	84.0
	Neutral	4	16.0	16.0	100.0
	Total	25	100.0	100.0	

Table 4.8 Need for eco-friendly homes

Interpretation: From the above table it is inferred that the respondents 28% strongly agree, 56% are Agree, 16% are Neutral with the statement.

7. Eco-friendly homes that meet passive solar energy Building Index standards are favorable.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	StronglyAgree	8	32.0	32.0	32.0
	Agree	11	44.0	44.0	76.0
	Neutral	6	24.0	24.0	100.0
	Total	25	100.0	100.0	

Table 4.9 Favor of passive solar Index

Interpretation: From the above table it is inferred that the respondents 32%

Strongly agree, 44% are Agree, 24% are Neutral with the statement.

8. Eco-friendly homes are beneficial because these homes may enhance our quality of life without sacrificing the internal comfort to the occupants

		Frequency	Percent	ValidPercent	Cumula-tivePercent
Valid	StronglyAgree	6	24.0	24.0	24.0
	Agree	12	48.0	48.0	72.0
	Neutral	5	20.0	20.0	92.0
	Disagree	2	8.0	8.0	100.0
	Total	25	100.0	100.0	

Table 4.10 Significance of eco-friendly homes

Interpretation: From the above table it is inferred that the respondents12%

Strongly agree, 28% are Agree, 60% are Neutral with the statement.

4.2 CORRELATIONS FOR COMPANY'S DATA

Correlation is a statistical technique that shows how strongly two variables are related to each other or the degree of association between the two. We can also find the correlation between these two variables and say that their weights are positively related to height. Correlation is measured by the correlation coefficient. It is very easy to calculate the correlation coefficient in SPSS. Before calculating the correlation in SPSS, we should have some basic knowledge about correlation. The correlation coefficient should always be in the range of -1 to 1.

4.2RELIABILITY ANALYSIS FOR CONSUMERS

Technically speaking Cronbach's alpha of 0.705, which is greater than 0.7 indicates that there is a high Consistency and Inter-Correlation between the dataset of 40 items. It is noted that the values above 0.7 are considered acceptable and values above 0.8 is preferable.

4.3DESCRIPTIVE STATISTICS FOR CONSUMERS

Descriptive statistics are brief descriptive coefficients that summarize a given dataset, which can be either a representation of the entire or a sample of a population. Descriptive statistics are broken down into measures of central tendency and measures of variability (spread).

4.4FREQUENCY ANALYSIS FOR CONSUMERS

Frequency analysis is a descriptive statistical method that shows the number of occurrence so fetch response chosen by the respondents. When using frequency analysis, SPSS Statistics can also calculate the mean, median and mode to help users analyze the results and draw conclusions.

	N	Min	Max	Mean	SD	Variance	Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Std.Error
Aspects of passive solar energy building	40	1.0	3.0	1.08	.3499	.122	25.614	.733
Adoption of passive solar energy building concepts	40	1.0	3.0	1.83	.9842	.969	1.933	.733
Adoption of passive solar energy building concepts	40	1.0	4.0	1.70	.9392	.882	.628	.733
Energy saving methods Issues	40	1.0	4.0	1.65	.8930	.797	.355	.733
passive solar energy building eco-friendly home	40	1.0	4.0	1.60	.9554	.913	.544	.733
Passive solar Marketing activities are good at addressing	40	1.0	4.0	1.63	.9524	.907	.638	.733
passive solar energy building s/ houses increases its resale value	40	1.0	4.0	2.17	1.035	1.071	1.643	.733
passive solar energy building practice should be encouraged by marketers	40	1.0	4.0	1.75	.9806	.962	1.223	.733
Premium prices for eco-Friendly homes	40	1.0	4.0	1.65	.9753	.951	.870	.733
passive solar energy building will strengthen company's Image	40	1.0	3.0	1.50	.8473	.718	.489	.733
Recommendation passive solar energy building to other	40	1.0	4.0	1.43	.8738	.763	1.274	.733
passive solar energy building Marketing will improve quality of Construction.	40	1.0	4.0	1.53	.9334	.871	.002	.733
Family expect town Eco friendly home	40	1.0	4.0	2.00	1.1547	1.333	1.563	.733
Implementing psive solar energy marketing state to companies	40	1.0	4.0	1.88	1.0424	1.087	1.738	.733
Support environmental Protection	40	1.0	3.0	1.75	.8987	.808	1.582	.733
Advice my friends should own Eco friendly home	40	1.0	3.0	1.63	.8969	.804	1.242	.733
Make moresocially Attractive	40	1.0	4.0	1.40	.8102	.656	2.283	.733
Invest in passive solar energy buildings	40	1.0	3.0	1.68	.9443	.892	1.535	.733
ValidN(list wise)	40							

Table4.26DescriptiveStatistics

Frequency analysis

1. Do you consider the environmental aspects of the house/ building before buying them

		Frequency	Percent	ValidPer-cent	Cumulative Percent
Valid	Yes	38	95.0	95.0	95.0
	No	1	2.5	2.5	97.5
	Sometimes	1	2.5	2.5	100.0
	Total	40	100.0	100.0	

Table 4.27 Aspects of passive solar building

Interpretation: From the above table it is inferred that the respondents 95% are said yes, 2.5% are no, 2.5% are Sometimes with the statement.

2. Have you taken any measure to reduce your water consumption at home

		Frequency	Percent	ValidPer-cent	Cumulative Percent
Valid	Yes	23	57.5	57.5	57.5
	No	1	2.5	2.5	60.0
	Sometimes	16	40.0	40.0	100.0
	Total	40	100.0	100.0	

Table 4.28 Adoption of passive solar building concepts

Interpretation: From the above table it is inferred that the respondents 57.5% are said yes, 2.5% are no, 40% are Sometimes with the statement.

3. Have you taken any steps to reduce your heating and cooling expenses in your home by insulating your home

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	22	55.0	55.0	55.0
	No	11	27.5	27.5	82.5
	Sometimes	4	10.0	10.0	92.5
	Not atall	3	7.5	7.5	100.0
	Total	40	100.0	100.0	

Table 4.29 Adoption of passive solar building concepts

Interpretation: From the above table it is inferred that the respondents 55 % are said yes, 27.5

% are no, 10% are Sometime sand 7.5% are Not at all with the statement.

4. Did you learn about Energy saving methods issues during your schooling /degree or training program

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	24	60.0	60.0	60.0
	No	7	17.5	17.5	77.5
	Sometimes	8	20.0	20.0	97.5
	Not at all	1	2.5	2.5	100.0
	Total	40	100.0	100.0	

Table 4.30 Energy saving methods issues

Interpretation: From the above table it is inferred that the respondents 60% Said Yes, 17.5% are no, 20% are Sometimes and 2.5 % not at all with the statement.Are you aware of the term passive solar building/eco-friendly home

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	28	70.0	70.0	70.0
	No	1	2.5	2.5	72.5
	Sometimes	10	25.0	25.0	97.5
	Not atall	1	2.5	2.5	100.0
	Total	40	100.0	100.0	

Table 4.31 passive solar building/eco-friendly home

Interpretation: From the above table it is inferred that the respondents 70% Said Yes, 2.5% are no, 25% are Sometimes and 2.5% not at all with the statement.

5. Do you think that passive solar Marketing activities are good at addressing environmental issues pertaining to passive solar energy building

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	27	67.5	67.5	67.5
	No	2	5.0	5.0	72.5
	Sometimes	10	25.0	25.0	97.5
	Not atall	1	2.5	2.5	100.0
	Total	40	100.0	100.0	

Table 4.32 passive solar Marketing activities are good at addressing

Interpretation: From the above table it is inferred that the respondents 67.5% said Yes, 5% are no, 25% are Sometimes and 2.5% not at all with the statement.

o you think that passive solar energy buildings/houses increases its resale value?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	16	40.0	40.0	40.0
	No	3	7.5	7.5	47.5
	Sometimes	19	47.5	47.5	95.0
	Not atall	2	5.0	5.0	100.0
	Total	40	100.0	100.0	

Table 4.33 passive solar energy buildings/houses increases its resale value

Interpretation: From the above table it is inferred that the respondents 40% Said Yes, 7.5% are no, 47.5% are Sometimes and 5% not at all with the statement.

6. Specify the importance level of the passive solar energy building practice that should be encouraged by marketers.

		Frequency	Percent	ValidPercent	CumulativePercent
Valid	Yes	24	60.0	60.0	60.0
	No	3	7.5	7.5	67.5
	Sometimes	12	30.0	30.0	97.5
	Not atall	1	2.5	2.5	100.0
	Total	40	100.0	100.0	

Table 4.34 passive solar energy building practice encouraged by marketers

Interpretation: From the above table it is inferred that the respondents 60% Said Yes, 7.5% are no, 30% are Sometimes and 2.5% not at all with the statement.

4.5 CORRELATIONS FOR CONSUMER'S DATA

Correlation is a statistical technique that shows how strongly two variables are related to each other or the degree of association between the two. We can also find the correlation between these two variables and say that their weights are positively related to height. Correlation is measured by the correlation coefficient. It is very easy to calculate the correlation coefficient in. Before calculating the correlation in SPSS, we should have some basic knowledge about correlation. The correlation coefficient should always be in the range of -1to1.

4.6 DISCUSSION

The Questionnaire aspect of the current study aimed cover the underlying feelings, experiences, likes and dislikes which 'passive solar energy' buildings hold for each individuals and the ways in which they cope with the changes that they are exposed to. Furthermore, many participants emphasized that to truly see the effects of going passive solar energy building, there needs to be a collaborative effort among all parties within the community. It was also stated that the moral reasoning behind implementing was vital. Prior research has established that 'passive solar energy' building practices are predominantly implemented to reduce negative environmental impacts and improve building.

It is emphasized that the moral reasoning should be in line with improved benefits for society, and the employees, rather than just being profit orientated. Furthermore in the analytical part the result obtained were satisfying to some extent.

Descriptive analysis:

Through this analysis pattern which has been carried out in software it was found that the results were satisfying and optimum. It is also noted that there was utmost probability of positive response from the respondents. The variance was also found to be within the acceptance range except for one or two.

Frequency range:

This was a key tool notifying the probabilities in percentage. Even through this most of the elements were found to be adequate through the responses from both company and consumers side.

Correlation:

In this the tolerance factors were obtained from the correlation values. Even this resulted in a satisfactory manner.

However, the results create a better understanding of why and how people believed in going green and also benefits existed. Whereas, other participants saw negative aspects of the green phenomenon, thus only seeing the bad within erecting 'passive solar energy' buildings.

CHAPTER V

CONCLUSION AND RECOMMENDATIONS

5.1CONCLUSION

This study investigated the adoption of passive solar energy buildings and the pros and cons involved in adoption of passive solar energy buildings in our ambiance. The main aim of this study is to know in depth the concepts and factors hindering the eco-friendly construction and also to find the possible ways to create an awareness and to notify the benefits of eco-friendly construction to the society for improvising the betterment of the environment.

This was carried out by compiling various views of individuals as a consumer or in a company regarding their impressions and requirements to passive solar energy building and here commendation sere formulated. Furthermore, a deeper analysis into this phenomenon on was investigated by means of documenting employee's opinions, experiences, Likes and dislikes associated with adoption of passive solar energy building.

This study helps in knowing the opportunities and obstacles involved in improvising the efficiency of environmentally friendly construction in our locality. The significance of this study stems from being one of the few studies to incorporate a Questionnaire aspect into the analysis of 'passive solar energy' buildings, particularly within the Indian context.This allowed for a more clear description of the results that were found by providing important information as to why the questionnaire results were surprising, as well as documenting vital information that can be used to understand the dynamics within the realm of passive solar building.

From this study it is found that there is tolerable positive prospect prevailing among the construction industry regarding the adoption of passive solar energy buildings, eventhough impressions of each individual differs prominent ways of adopting concepts would help in making up of passive solar energy buildings.

QUESTIONNAIRE

ANNEXURE I

COMPANYDETAILS

Firm/Individual Name :

Designation :

Gender : Male/Female

Location and year of incorporation :

City: State: Country:

Contact Numbers:

1)

2)

Website:

E-Mail id:

Professional affiliation:

Architect	Contractor	Residential developers	Non-Residentialdevel-opers	Engineer	Others (Speci-fy)

QUESTIONNAIRE (COMPANY)

1) Do your customers ask for Passive solar features in homes.

a. Strongly agree b. Agree c. Neutral d. Disagree

2) Do you think customers would like to prefer passive solar homes?

a. Strongly agree b. Agree c. Neutral d. Disagree

3) Do you think companies which can establish themselves with passive solar image will have distinctive advantage in the marketplace

a. Strongly agree b. Agree c. Neutral d. Disagree

4) Do you think companies which sell passive solar homes will be able to sustain for a long period of time in the market in comparison to others

a. Strongly agree b. Agree c. Neutral d. Disagree

5) How are your passive solar buildings priced in comparison to equivalent building in the market

a. Strongly agree b. Agree c. Neutral d. Disagree

6) Eco-friendly homes that meet passive solar Building Index standards are favourable

a. Strongly agree b. Agree c. Neutral d. Disagree

7) Appearance design of passive solar building with low consumption and high efficiency

a. Strongly agree b. Agree c. Neutral d. Disagree

8) Passive Solar Building Label is valuable for me because it helps me to understand the implication of passive solar building

a. Strongly agree b. Agree c. Neutral d. Disagree

ANNEXURE-II

QUESTIONAIRE (CONSUMERS)

1) Do you consider the environmental aspects of the house/ building before buying them?

a. No b. Yes c. Sometimes d. Not at All

2) Have you taken any measure to reduce your water consumption at home

a. No b. Yes c. Sometimes d. Not at All

3) Are you aware of the term passive solar building/eco-friendly home

a. No b. Yes c. Sometimes d. Not at All

4) Do you think that passive solar buildings/houses increases its resale value

a. No b. Yes c. Sometimes d. Not at All

5) Specify the importance level of the solar building practice that should be encouraged by marketers

a. No b. Yes c. Sometimes d. Not at All

6) I would recommend passive solar buildings to others

a. No b. Yes c. Sometimes d. Not at All

7) Do you think that by implementing solar marketing strategy the companies are able to gain competitive advantage over others

a. No b. Yes c. Sometimes d. Not at All

8) I will be perceived by others as "out-dated" if I do not support Environmental protection

a. No b. Yes c. Sometimes d. Not at All

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