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Green Building Standards and Hospital Design : An Evaluation of Sustainable Features

Ravina Nagrare & Dr. Sangeeta Shinde

Brihan Maharashtra College of Commerce, Pune, Maharashtra, India

ABSTRACT: The deteriorating health of our planet is an issue of international concern and has a direct impact on human health. Healthcare industry uses modern medications, equipment and sophisticated technologies for the treatment, but through resource intensive processes.Healthcare sector consumes a large number of resources, energy-intensive equipment and generates an array of wastes which has a direct impact on human health. In India, it is estimated that the commercial sector, which includes the healthcare sector, consumes 7.58 per cent of the total electricity and generates approximately 1.48 million tons of healthcare waste per year according to the Central Pollution Control Board (CPCB) of India.According to an American journal,"The health sector is one of the most trusted and respected sections of society, and it is also one of the largest employers and consumers of energy. This presents both: a duty and a window of opportunity to achieve climate-neutrality, efficiency and cost reduction all at the same time".This vision can be achieved by improving the hospital design, minimising the waste and its disposal, using natural light and ventilation as much as possible, using inverter-based air conditioners and ventilation system (HVAC).

KEYWORDS: green, buildings, design, hospitals, health, sustainable, management, infrastructure, waste disposal

I.INTRODUCTION

Defining Green Hospital

The United States Environmental Protection Agency defines a green building as, "the practice of creating structures and using processes that are environmentally responsible and resource-efficient throughout a building's life-cycle from siting to design, construction, operation, maintenance, renovation, and deconstruction. [1]This practice expands and complements the classical building design concerns of economy, utility, durability, and comfort. Green building is also known as a sustainable or highperformance building".According to the Indian Green Building Council, a green hospital building can be defined as one which enhances patient well being, aids the curative process, while utilising natural resources in an efficient, environmentfriendly manner.In India, we have a BEE (Bureau of Energy Efficiency) which works towards saving natural energy resources. [2]The Confederation of Indian Industry (CII) established the Indian Green Building Council (IGBC) in the year 2001 to promote the concept of sustainable green buildings.The role of IGBC includes developing new rating systems, certifications, conducting training programs. IGBC is licensed by US Green Building Council to provide LEED Certifications in India (Leadership in Energy and Environment Design)[3]

Similar to LEED, there are other building rating systems which have been developed globally and are followed in different countries.

• LEED- Leadership in Energy and Environmental Design (United States, Canada, China, and India), BREEAM-Building Research Establishment Environmental Assessment Methods (UK and Netherlands)
• Green Star (Australia, New Zealand, and South Africa),
• CASBEE -ComprehensiveAssessment System for Building Environmental Efficiency (Japan)
• Green Mark Scheme (Singapore)[4]

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Talking about the one followed in India, Leadership in Energy and Environment Design or LEED ratings are classified into four categories: LEED-certified, Silver, Gold, and Platinum.Platinum is the highest rating and some of the factors behind this classifications are sustainable site development, water savings, energy efficiency, material selection, and indoor environment quality.In the Indian context, Kohinoor Hospital in Mumbai is the first hospital in Asia and second in the world to achieve LEED platinum certification under Indian Green Building Council.Since Hospitals are required to run all the time, some of the factors are studied which pose complexities to change it to Green Hospitals like:

- All-time back up required for emergencies
- All hours are operational hours with no shutdown
- Protocols to control infections counters sustainability.
- High Air Changes per hours to prevent contamination
- High requirement of Energy & water as compared to other buildings
- High waste generated per bed
- Constant renovations inside the building to upgrade machinery.[5]

Components of Green Hospital

Energy savings

Since a hospital operates 365 days-ayear, 24/7, it needs heating, ventilation, and air conditioning (HVAC) systems to maintain the standards of care. This consumes 40 to 60 per cent of the total energy. Also, significant energy is used for heating water, temperature and humidity controls for indoor air, lighting, ventilation and numerous medical processes which have greenhouse gas emissions. Without any compromise on the quality of care.Small steps such as switching to compact fluorescent and lightemitting diode (LED) light bulbs, using optimum temperature for the HVAC system, using energy-efficient products, reducing the stand-by time of the medical equipment, and certain retrofit measures as suggested by Energy Consultants can bring in positive change. Also, we all have observed slogans, posters on the walls which can also lead to a big impact. An energy audit can also help in saving millions by detecting leakages in HVAC Systems and checking the efficiency of motors and compressors of electrical equipment.[6]

Greener source for creating energy

In India, most of the electricity is generated from coal, which has a direct impact on increasing carbon footprints, and the same goes for hospitals due to their heavy electricity requirement. Furnace oil, or liquified petroleum gas (LPG) is used to generate steam for processes such catering, and laundry. For backup, diesel-powered generators are used to get an uninterrupted supply of power.This can be resolved by using natural and renewable sources of such as solar, wind, and geo-thermal. Since it requires engineering, high construction and operating costs but in case of small sections, work can be done by solar energy like to sterilize medical equipment, sanitize the hospital's laundry, heat water for baths.[7]

Reduce waste management

In India, most of the clinics, hospitals, and healthcare facilities do not have the infrastructure for waste management, and most of waste goes directly to the open, and then into ground water. This becomes even more critical as 10 to 15 per cent of the waste is toxic and harmful for all the handlers and environment. Releasing this waste openly in the environment allows transmission diseases to flourish which impacts the health of human beings.This can be resolved by minimising waste through composting, recycling, and disposing of it the right way. Here, we all need a behavioural change in better purchasing (minimising packaging, using reusable rather than disposable products, and buying recycled products).Also, plastic which is the main source of pollution, must be disinfected first before the landfill. A hospital in Asia has done wonderfully well by developing a compost system which will naturally create bio-methane and change it to bio-natural gas which is then used to power the hospital and water purification systems.[8]

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Lighting

Since hospitals run throughout the year, green hospitals work towards bringing the electricity load down. This is possible by using light sensors in the passage or washrooms and other areas which can detect occupancy and installing low-energy LED lights. Also, the architecture should work to bring in maximum natural daylight to reduce the load.[9]

Saving water

Since hospitals have a huge water requirement, they must have a rain harvesting system in place and sewage treatment to recycle water for non-drinking use. The recycled water can be used for irrigation, cleaning activities, etc. In India, lots of healthcare facilities are using these approaches but we need to build at scale.[10]

Air quality

This is one of the most vital components of any green building. Cities are suffering from poor quality air due to rising pollution, meaning a green hospital must have provision for better indoor air. This can be achieved by indoor plants, natural air purifiers, etc. Since the hospital area is exposed to so many pathogens and bacteria, it becomes vital to have a ventilation system and a well-designed cleanroom to continuously provide fresh and filtered air.[11]

Research has proved that a welldesigned green building can accelerate the healing process. Hence, consultants consultants and designers are working in the direction to employ green strategies to have a positive impact on patients. Due to this, a green hospital has various attributes such as better indoor air quality, 20-40 per cent energy saving, 35-40 per cent water saving, good day lightning, no sick building symptoms, comfortable temperature and humidity control for faster recovery.[12]

II.DISCUSSION

Sustainability is a major concern for everyone. Degradation of resources and increment in the pollution are posing a question mark on the sustainability. This situation is creating a pressure on the firms to be greener. Green hospital is a hospital that improves people's health by continuously reducing environmental impacts on sustainability and meets its share of the burden to disease. The study aimed to know the concept of “Green Hospital”. The site of reputable domestic and foreign institutional electronic databases was searched to identify the patterns of green hospital. Thus, the data for this study was collected from the multiple online sources. It is found that there are various rating systems for the green buildings i.e., Green Rating for Integrated Habitat Assessment (GRIHA),[13] Indian Green Building Council (IGBC), Bureau of Energy Efficiency (BEE): Star Rating, ASSOCHAM GEM, ECBC Compliance etc. Overlap in terms of energy efficiency, water efficiency and waste management patterns were observed in all other aspects could be due to differences in location patterns and different organizations providing organizations needs to be mentioned. There are several constrains are also available for constructing the green hospitals. According to many studies, one hospital can consume as much power as a small town and can also produce medical waste that corresponds and sometimes exceeds the same level of pollution of the same town.[14]

That’s where comes the importance of the pursuit to transform hospitals into green eco-friendly facilities.The priority of healthcare previously consisted in providing the best health services to its patients and environmental protection came second but with the new understanding of the environmental protection concept, the majority of hospitals shifted to a more ecological, economic, and socially sustainable environment.For example, the Sunshine Coast University hospital in Australia was ranked fourth amongst the top 6 green buildings in the world. It is the first healthcare facility to be awarded Six-Star Green Star ratings for design and construction. The studies show that the global healthcare industry is responsible for 4.4 percent of carbon dioxide emissions each year. That’s higher than gas emissions from aviation and shipping. An average hospital uses 500 liters of water and produces several kilograms of partly hazardous waste per day. This consumption seems necessary to provide the best healthcare services for patients and ensure their safety[15]. Plastic syringes, tubes needles and much more might be contaminated with chemicals or biological materials after use. The number of

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syringes used worldwide per year can reach 16 million pieces which is why recycling is out of the question because of the high probability of contamination. The only way for hospitals is to find solutions for the proper management of toxic substances by going green.Seeing the resources consumption and the amount of waste a hospital can produce shows the need for hospitals to shift to green buildings where they practice the reduction of the environmental impact of healthcare institutions and enhance the health and wellbeing of their patients. In general, only 15% of the hospital's waste is considered hazardous and can be dangerous to others so the method of disposal should be effective and safe.[16]

The green hospitals realize the importance of the connection between the environment and human health.We see more and more hospital managements demanding architects to incorporate green concepts into hospital design. Actually, according to a report by SBI Energy, green building renovations will experience a significant increase in the few years to come and at a more rapid pace till the year 2050. For the European Union, the shift to green buildings is a way of saving natural resources and protecting the environment.Buildings are responsible for about 40 percent of energy consumption in the EU and 36 percent of greenhouse gas emissions from energy consumption[17]. But only 1 percent of buildings undergo an energy-efficient renovation each year.Hospitals come at the top of the list of buildings that must be converted into environmentally friendly, given the health, economic and social benefits that this change can have on the environment.In order to achieve their target of reducing greenhouse gas emissions by at least 55 percent by 2030, experts said that buildings must reduce emissions by 60 percent and reduce energy consumption by 14 percent[18]. The energy used for heating and cooling must be reduced by 18 percent.Thanks to the European policy and the funds provided for that, buildings are now consuming half the energy compared to 20-year-old buildings. But 85 percent of the buildings in the European Union, about 220 million buildings, were built before 2001. It is expected that about 85 to 95 percent of them will remain in place until 2050. For this, the union is working to support what it describes as "The wave of building renovation" to become more in line with the new environmental standards and also to create new job opportunities, and to improve the quality of life[19].The European Commission expects that the implementation of this strategy will improve the quality of life for people who live in green buildings, especially in hospitals, to reduce greenhouse gas emissions in Europe, and promote digitization and the reuse of recyclable materials. The Commission estimates that by 2030, 35 million buildings will have been renovated and up to 160,000 additional green jobs created in the construction sector. This strategy will give priority to renovating public buildings such as hospitals, schools and administrative buildings.[20]

The World Green Building Council divides the benefits of green buildings into three – environmental, economic and social benefits. According to a report by the Council, green buildings in Australia that received "Green Star Certification" by the Australian Green Building Council resulted in a 62 percent reduction in greenhouse gas emissions compared to the average Australian building. It was found that globally, green buildings will save up to 84 gigatonnes of carbon dioxide by 2050.Green buildings also provide a lot of economic benefits globally, at the country level and at the construction level. Some of the benefits include cost savings on utility bills, lower operating costs, higher property values for property developers, and new job opportunities. In this regard, building owners' observation as reported by Dodge Data & Analytics, is that green buildings, whether newly built or old and renovated resulted in a 7 percent increase in asset value compared to traditional non-green buildings.From a social perspective, the green building offers a number of benefits to its occupants. Studies have shown that green building workers report a 101 percent improvement in knowledge levels.In addition, employees in green buildings with well-ventilated offices reported sleeping an average of 46 minutes more each night. This was also reported by hospital patients, who reported a positive impact of the environmentally friendly features of green hospitals on their psychological and physical comfort. [21]To begin with, experts believe that "a green hospital must be sustainable wherever there is the use of resources." And that the first step to being followed in the path of becoming a green hospital is to seek to improve energy efficiency and switch to renewable energy such as photovoltaic technology. Energy-saving insulation and more efficient heating systems are other ways to save energy.Dealing with water consumption is another important aspect of green hospitals. Successful water use reduction depends primarily on changing water consumption habits starting with employees to patients. Even simple changes to a building's structure can lead to a rapid and significant impact.[22]

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III.RESULTS

On the other hand, hospital waste management is another challenging aspect. The idea is to reduce waste in general, and hazardous waste in particular. And dealing with recyclable waste so that it can be reused. For example, some types of generated waste can be converted into compost. For hospitals, this procedure means balancing between environmental protection and hygiene requirements and ensuring the best service for the patients and hospital staff.[23]

Green hospitals focus on creating sustainable mechanisms and methods that are successful in the long run. This also involves logistics. Optimal delivery service strategy according to fixed schedules and avoiding unnecessary transfers, help reach that goal. This allows hospitals to save materials, avoid waste and reduce carbon dioxide emissions. The Green Hospital's measures also include the use of environmentally friendly building materials and the reduction of meat consumption by for example; introducing a meatless day once a week."It's not just about environmental, economic and social sustainability," says expert Shawnheit Muller of Klinikum Lichtenfels.She explains: "In my opinion, the employees' knowledge and motivation remain the most valuable assets because their commitment drives the quality of health care. As with all other valuable resources, the Green Hospital helps employees to be more productive and attract talents which raises the standard of health service for patients and the hospital environment in general.The importance of the Green Hospital lies in the fact that caring for environmental integrity is no less than caring for the safety and well-being of patients. [24]In this regard, the Lichtenfels Hospital is an example of green hospitals' successful stories in Germany. It was inaugurated in the summer of 2018, after nine years of planning and construction. The designers improved the hospital building envelope with a triple-glazed window system, the use of heat recovery and geothermal energy. Thus, the Green Hospital Initiative in Bayern (Green Bavarian Hospital Initiative), provided a successful model and specific roadmap for the standards that hospitals should follow.After successfully fulfilling the required conditions and adopting all environmental standards, the Bavaria Hospital was awarded the title "Green Hospital in Bavaria".[25]

The German Federation for the Environment and Nature Conservation BUND participates in climate protection projects in hospitals throughout Germany and supports them in managing green hospitals. The so-called "energy-saving hospital" label is awarded to a hospital that adheres to the required environmental conditions. The Hubertus Protestant Hospital in Berlin was the first hospital in Germany to receive this mark. It reduced its energy consumption by 37 percent and carbon dioxide emissions by 2,600 tons. Stakeholders used to think that transforming a hospital into a green building was very expensive and that was the main obstacle that delayed the process until they discovered the contrary. The plans that promote sustainability are initially expensive and their effects on patient care may not be immediate. Preference was given to less expensive suppliers, even though a regional or local supplier was a more sustainable option.[26]

Hence, innovative solutions and assistance in planning, financing and implementing were necessary to overcome these barriers. In addition to the basic requirements for sustainable changes, the issue of mental transformation and changing habits. For example, there should always be ongoing efforts to educate and raise awareness of the fact that green hospitals also have a positive impact and significant benefits on both patient and staff health. Moreover, smart improvements in energy consumption can reduce carbon dioxide emissions and keep energy costs low, which come to about $1,700 per year per bed. This will enhance both economic growth and environmental sustainability.Aside from education and awareness, we also need formal legal commitments to achieve comprehensive implementation of sustainable strategies in the healthcare sector[27]. Reliance on local supply:

Hospital cafeterias serve plenty of food every day. The source of this food can have a significant impact on the hospital environment. Accordingly, hospitals can contract with group purchasing organizations and use more fresh, locally grown products thus reducing the cost of import and food conservation which leads to less energy consumption.

Water conservation and management:
There is an interesting example of how much water can be saved when using it, as demonstrated by Virginia Mason Medical Center in Seattle, a non-profit hospital that saves more than six million gallons of water annually by making

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several changes. The hospital replaced radiotherapy machines with better models, replaced toilets, faucets, showers, and washing machines with better alternatives.[28]

Scientific ways to consume less energy:
For example, Greenwich Hospital in Connecticut saved more than 1.7 million kilowatt-hours, reducing electricity costs by $303,000 annually and reduced its total energy consumption by 35 percent. The hospital reprogrammed its heating and cooling plants, re-engineered ventilation systems, and upgraded electric lights. This can be achieved in any hospital if proper measures are taken.

Waste disposal methods:
US hospitals produce more than 5.9 million tons of waste annually, according to Practice Greenhealth. A major challenge for hospitals is the variety of waste they produce, which makes environmentally friendly disposal tiring. Organizations must disinfect medical waste before it goes to a landfill to ensure that there is no environmental pollution. While disinfection methods, such as incineration, consume a lot of energy and are known to release harmful emissions, processes such as sterilization, chemical processing, and microwaves can vary widely in order to be environmentally friendly.

Purchasing health and safety:
Many medical types of equipment may contain toxic particles like LCD screens, fluorescent lights, wheelchair cushions, and baby bottles that can be harmful to the environment. Also, many products can contain dangerous chemicals if purchased from the wrong manufacturer. Therefore, experts suggest that hospitals should have a proper purchasing system that can help them make the right decisions in order to avoid piling toxic materials.[29]

In conclusion, studies have proven that transforming buildings in general and hospitals in particular into environmentally friendly centers benefits them in many ways.

Organizations should be able to save energy
They should really look at the green building as more of an investment than anything else. An investment that will be able to save money as well as an investment that will be able to help the environment! It is a win-win situation for everyone![30]

IV.CONCLUSIONS

Green Hospitals are Environment Friendly, utilising natural resources in an efficient manner, which also enhances patient well-being.We help design Hospitals to be ‘Green’ from planning stage itself and then through the detailed architecture and construction stages. Designed right, Green Hospitals not only save on major costs like on Energy and Water, they also help faster patient recovery, through better use of day light, easier access to the outdoors, improved hygiene and safety.Going Green for a Hospital offers significant benefits also to the Hospital Staff, Patients, Visitors to the Hospital and the Community, ensuring safety from infections, epidemics and natural disasters.Designing Green Hospitals – Important Steps

- Choosing an environmentally friendly site,
- Utilising sustainable and efficient designs, using more daylight than artificial light.
- Appropriate building materials and products,
- Incorporating green concepts during construction stage, ensuring maximum recycling and reusing of materials, reducing waste and reducing CO2 generation for cleaner air.[30]

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