“IMPLEMENTATION OF GREEN HEALTHCARE PRACTICES:REDUCING ENVIRONMENTAL IMPACT IN HOSPITALS”

Dissertation submitted to

The IIHMR University, Jaipur

For the partial fulfilment for the award of the degree of

Master of Business Administration (MBA) in

Hospital and Health Management

by

Dr. Akankhya Jena

Under the Supervision and Guidance of

Dr. Piyusha Majumdar

Associate Professor, IIHMR University, Jaipur

2024

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CERTIFICATE

This is to certify that Dr. Akankhya Jena in partial fulfilment of the requirements for the award of the degree of MBA Hospital and Health Management from IIHMR University, Jaipur has successfully completed her internship at CLOUDNINE Hospital, Bangalore from 1 April 2024 to 30th June 2024.

Place: Bangalore

Date: 30/06/24

Preceptor/Head of the Organisation

Name of the Organisation

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Plot No. 11, Survey No. 88,
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DECLARATION BY STUDENT

I hereby declare that this dissertation titled **"IMPLEMENTATION OF GREEN HEALTHCARE PRACTICES:REDUCING ENVIRONMENTAL IMPACT IN HOSPITALS"** is the Bonafede record of my original research work. I declare that it has not been submitted to any other university or institution for the award of any degree or diploma. Information derived from the published or unpublished work of others has been duly acknowledged in the text.

(Signature) Akankhya Jena.

Dr. Akankhya Jena

Date 05/07/24.

IIHMR UNIVERSITY

CERTIFICATE

This is to certify that dissertation titled **"IMPLEMENTATION OF GREEN HEALTHCARE PRACTICES: REDUCING ENVIRONMENTAL IMPACT IN HOSPITALS"** is a record of the research work undertaken by Dr. Akankhya Jena in partial fulfilment of the requirements for the award of the degree of MBA Hospital and Health Management from the IIHMR University, Jaipur under my guidance and supervision andher approach to the research study has been sincere, scientific, and analytical.

Piyusha 5/7/24

Dr. Piyusha Majumdar

Faculty Guide

IIHMR University, Jaipur

Date

Dr. Sanjay Gupta

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Date

Abstract

Introduction

Healthcare facilities, while essential for patient care, significantly impact the environment due to high energy consumption, waste production, and extensive resource use. The adoption of green healthcare practices aims to mitigate these impacts by promoting sustainability through energy-efficient technologies, waste reduction strategies, and resource conservation.

Objective

This study explores the benefits and challenges of adopting environmentally friendly practices in four hospitals i.e. Aster Hospital, Apollo Hospital, Shree Satya Sai super specialty hospital and Rainbow Hospital focusing on their potential to reduce the environmental footprint of healthcare operations. The study will also include the thoughts and perceptions of staff and patients associated with Green Hospitals.

Methodology

Over a period of three months, a study was conducted in four hospitals which involved a structured survey of hospital staff and patients, consumption of energy in past years and a face-to-face conversation with key stakeholders. An engagement of both quantitative and qualitative data collection was done which indeed was a mixed methodology. Calculation of quantitative data provides us with the changes in waste production and energy use after implementation of green practices, while qualitative data provided insights into the factors contributing to successful application.

Results

After the implementation of green healthcare practices in hospitals, it was found that there is a significant reduction in waste production and energy consumptions. There is an increase in efficiency and reduced environmental impact as reported by the hospitals following green concept. The importance of staff trainings, organizational assurance,

and regulatory support in expediting the adoption of green practices was emphasised by qualitative analysis.

Conclusion

Green healthcare practices considerably reduces the environmental impact of hospital procedures, as well as reveal their potentials to contribute to sustainability goals. The hospital administrators, policymakers and the healthcare professionals can gain valuable suggestions to promote different ways of sustainable practices in healthcare sector, which ultimately contributes to improve healthcare outcomes as well as preservation of environment.

Keywords: Green Healthcare Practices, Environmental Impact, Energy Consumption, Waste Reduction, Resource Conservation

Acknowledgement

I extend my wholehearted gratitude to all supporters who have contributed to the effective completion of my Summer Internship. I am deeply thankful to everyone who has played a part in this journey.

First and foremost, I am thankful to Dr. P.R. Sodani, President of IIHMR University, Jaipur, for granting me the chance to undertake this internship. His belief in my abilities has been instrumental in my professional development.

I would also like to express my heartfelt thankfulness to my mentor, Dr. Piyusha Majumdar at IIHMR University, for her exceptional guidance, unwavering support, and invaluable supervision throughout this endeavour. Her understandings and inspiration have been invaluable.

Additionally, I am grateful to the Placement Cell of my esteemed university for their continuous guidance and support during the internship process. Their assistance has been crucial in navigating this learning experience.

This internship has been a crucial moment in my career journey. I am committed to applying the knowledge and skills I have gained, and I will continue to strive for excellence in pursuit of my career aspirations.

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Abbreviations

- GHG: Greenhouse Gas
- kWh: Kilowatt-hours
- CO2: Carbon Dioxide

Chapter 1: Introduction

1.1 Background

Healthcare amenities are among the most resource rigorous association, with significant environmental impacts, which play a vital role in providing critical care and maintaining public health. These results arise from high energy usage, substantial waste production and broad use of water and other resources. Considering the growth of environmental sustainability and climatic changes, feedback to emerge the concept of green hospitals play an important approach to justify the ecological impression of healthcare practise.

The idea behind green hospital is to provide medical care while protecting the environment and guaranteeing the health and safety of healthcare professionals. This method acknowledges the importance of environmental management in patient care.

Incorporating environment friendly practices into design, construction, and daily operations of a hospital contributes to its sustainable practices, which is then known as “Green Hospitals”. The aim is to reduce the adverse effect on environment while improving and maintaining patient’s care. This method embraces extensive strategies to reduce energy consumption, minimize waste production, saving water and sustainable use of materials. Accepting the green healthcare practices, green hospitals proceed to create a healthier environment for staffs, patients and other community members.

The goal to use energy efficiently is a keystone of green hospital practices. This initiative also involves heating, ventilation, energy efficient lighting systems and air conditioner systems (HVAC) along with renewable resources like solar and wind power. These processes reduces the greenhouse effects as well as decreases the operational costs, which can be invested into patient care.

Waste reduction is also an acute factor. Green hospitals execute a widespread program on waste management that emphasize on reducing, reusing and recycling resources. This includes a proper separation of different wastes like secluding medical waste from

general waste, excluding usage of plastics, adapting and utilising reusable medical resources effectively and efficiently.

The conservation of water is the most important factor to be considered in the energy consumption. The factors that include in the water conservation efforts includes the use of low-flow fittings, water-efficient landscaping and systems to recycle and reuse water. These exercises are essential in diminution of the overall water footprint of healthcare services, which is particularly important in regions facing water scarcity.

As outlined by the Leadership in Energy and Environmental Design(LEED) certification in addition to operational changes, the construction and renovation of hospital building, which is designed to meet green building standards, thereby promoting the use of sustainable building materials, enhance the indoor air quality and ensuring energy and water efficiency.

The transition to green hospitals comes with its share of obstacles. It mostly considers the following factors as in initial investment, changes in organizational ethnicity, unstoppable education and continuous training of staffs. However, one cannot stop themselves by the long-term benefits it provides like the environmental sustainability, cost savings and improved health outcomes, which makes it more evolution worthwhile.

This research investigates the advantages and challenges of integrating eco-friendly practices in hospitals, with the goal of assessing current environmental sustainability efforts, analysing the impact of green initiatives on energy efficiency, evaluating the effectiveness of waste reduction and management strategies, quantifying the benefits of resource conservation, providing actionable recommendation for the successful implementation of sustainable practices in healthcare facilities.
By exploring these areas, this study contributes to the expanding field of sustainable healthcare, supporting the global effort to reduce the environmental footprint of the healthcare industry and promoting eco-friendly practices in healthcare settings.

1.2 Research Question

How does the execution of green healthcare practices in hospital decreases environmental impact?

1.3 Objectives

1. To identify current environmental practices in selected hospitals.
2. To identify the thoughts of patients and staff associated with green hospitals
3. To provide recommendations for effective green healthcare practices that can be adopted by hospitals.

Chapter 2: Review of Literature

SL NO	Authors (Year)	Study Location	Sample Size	Sampling Technique	Salient Features
1	Joshi & Desai (2022)	Ahmedabad	9	Snowball sampling	Influence of green initiatives on patient satisfaction.
2	Reddy & Kumar (2021)	Hyderabad	12	Convenience sampling	Impact of renewable energy usage on hospital operations.
3	Gupta et al. (2020)	New Delhi	10 hospitals	Purposive sampling	Focus on energy efficiency and waste reduction practices.
4	Prasad & Rao (2020)	Jaipur	10	Purposive sampling	Integration of green IT solutions in hospital management.
5	Sharma & Verma (2019)	Mumbai	15	Stratified sampling	Evaluation of water conservation and recycling initiatives.
	Rao & Nair (2018)	Chennai	11	Sampling quota	Comparison of energy

6					consumption before and after green interventions.
7	Patel et al. (2018)	Bangalore	8	Random sampling	Assessment of green building certifications and outcomes
8	Singh & Kaur (2017)	Chandigarh	5	Purposive sampling	Implementation of sustainable healthcare waste management.
9	Mehta et al. (2016)	Pune	7	Cluster sampling	Analysis of green procurement policies in healthcare settings.
10	Roy et al. (2015)	Kolkata	6	Systematic sampling	Cost-benefit analysis of green hospital practices

Chapter 3: Methodology

3.1 Research Design

This study employs combining quantitative and qualitative data collection and analysis methods to provide a comprehensive understanding of the impact of green healthcare practices.

3.2 Setting and Study Population

The study will be conducted in four hospitals that have recently adopted or are in the process of implementing green healthcare practices in Bangalore i.e. Rainbow hospital, Apollo hospital, Shree Satya Sai super speciality hospital, Aster hospital. The study population includes hospital staff involved in implementing and managing green practices and patients receiving care in participating hospitals.

3.3 Sampling Technique and Ethical consideration

Convenience sampling method of sampling was used for the study and a informed consent was taken from the participants of the survey.

3.4 Inclusion and Exclusion Criteria

- **Inclusion Criteria:**
  - Hospitals that have initiated green healthcare practices.
  - Hospital staff involved in implementing and managing green practices.
  - Patients receiving care in participating hospitals.
  - Participants willing to provide informed consent.
- **Exclusion Criteria:**
  - Hospitals that have not considered or implemented any green practices.
  - Participants who decline to participate in the study.

3.5 Data Collection Tools

- Surveys for hospital staff and patients.
- Energy consumption records.
- Interviews with Hospital staffs and patient in green hospital.

3.6 Data Analysis Plan

Quantitative data will be analysed to assess changes in environmental impact pre- and post-implementation of green practices. Descriptive statistics will summarize energy consumption, waste production, and resource conservation metrics. Qualitative data from interviews will be analyzed thematically to identify key factors contributing to successful green practice implementation.

Chapter 4: Results

4.1 Energy Consumption

ASTER BANGLORE

In pursuit of a greener tomorrow, Aster has strategically integrated renewable energy sources, along with optimizing water utilization, waste management and sustainable transport management practices into its day to day operations. With integration of renewable energy sources including 3,679,200 KWh solar energy, 2,300,000 KWh wind energy, and 3,569,298 KWh hydro energy, the company achieved a noteworthy reduction of 6,824 tCO2e reduction in net greenhouse gas emissions, despite significant operational expansion. Decarbonization initiatives continued across 5 hospitals, with a new solar plant of 650 kWp commissioned at Aster Wayanad Specialty Hospital – poised to reduce 460 tCO2e per annum.

Water conservation efforts have seen a 17% reduction in consumption across operations, with 85,515 KL water savings achieved through innovative practices, including recycling and rainwater harvesting. Aster's commitment to responsible waste management has resulted in the recycling of 423,806 KG of waste, emphasizing the organization's holistic approach to sustainability

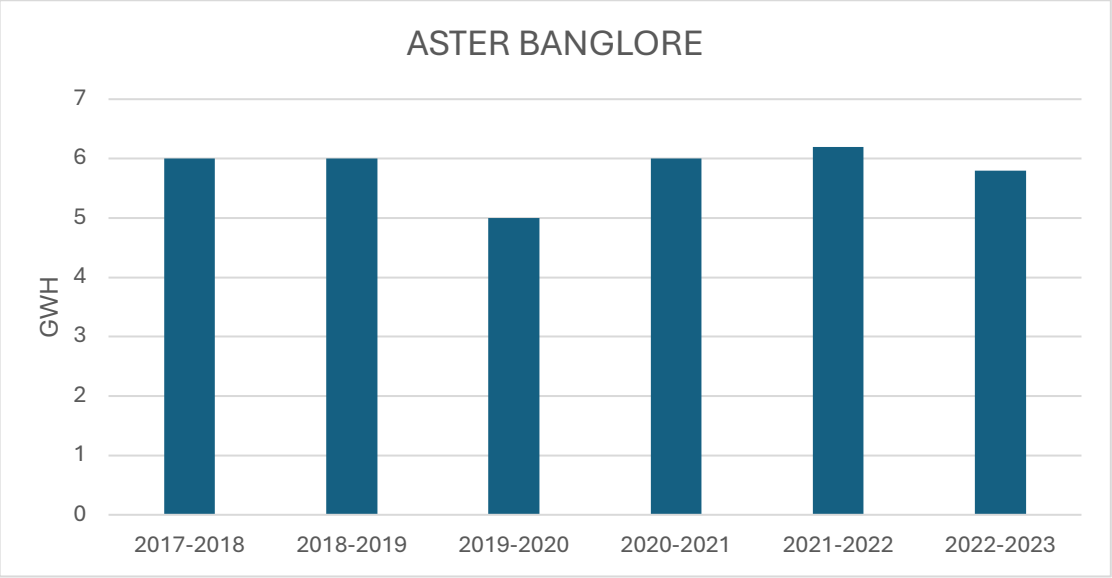


FIG 1.1 Energy utilisation of Aster Hospital, Bangalore in the Past six years.

APOLLO HOSPITAL

"Apollo Hospitals has implemented various initiatives to reduce energy consumption and carbon footprint, including:

- Deploying energy-efficient medical devices
- Activating power-saving modes during idle periods
- Promoting the use of rechargeable batteries
- Installing energy-efficient lighting solutions like LED
- Implementing sensors and automatic controls to optimize lighting levels based on occupancy and natural light

These efforts have yielded significant results, including:

- Launching "Project Virya" in September 2021, which aimed to reduce energy consumption by over 20% in 18 major hospital facilities in India
- Harnessing wind-based power to generate 77,68,355 kWh of electricity in FY 22-23 at select hospitals
- Currently, 19% of total energy comes from renewable sources, with a target to increase this to 25% by 2025"

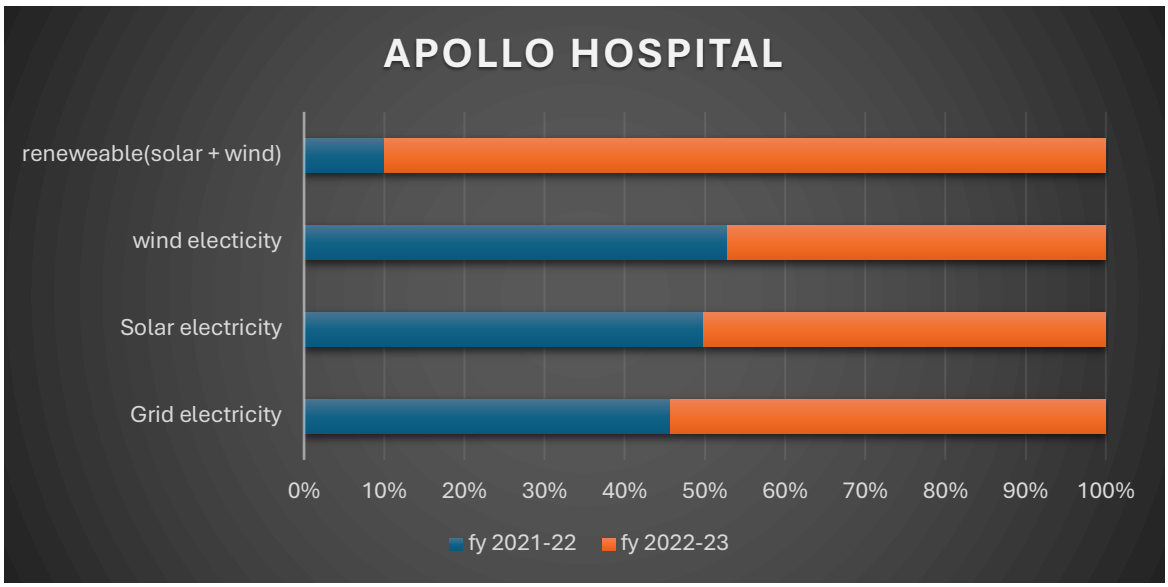


FIG 1.2 Energy consumption of Apollo hospital Bangalore by its different initiatives taken to conserve energy

RAINBOW HOSPITAL

Different initiatives have been taken up by Rainbow Hospitals: -

- lnstallation of Motion sensors
- Switching off ACs at unutilized areas
- Keeping little high temperatures at restricted areas in un-utilizing times
- Voltage optimization for lighting load.
- Reduction in specific consumption for compressor by regular maintenance.
- Insulations to AC units and supply line to avoid AC wastages by that power conservation steps taken.
- Reducing virtual energy consumption kVAh by repairing/installing capacitors.
- Improving operation and maintenance of air conditioning units by regular filter cleaning.
- The outdoor units have been doing service once in 15 days to keep them clean & maintain the heat exchange surfaces effective.
- Evaporative pre-cooling of air around the outdoor units.
- Solar Power pack installation initiative has been taken at new Banjara unit in part of energy management.

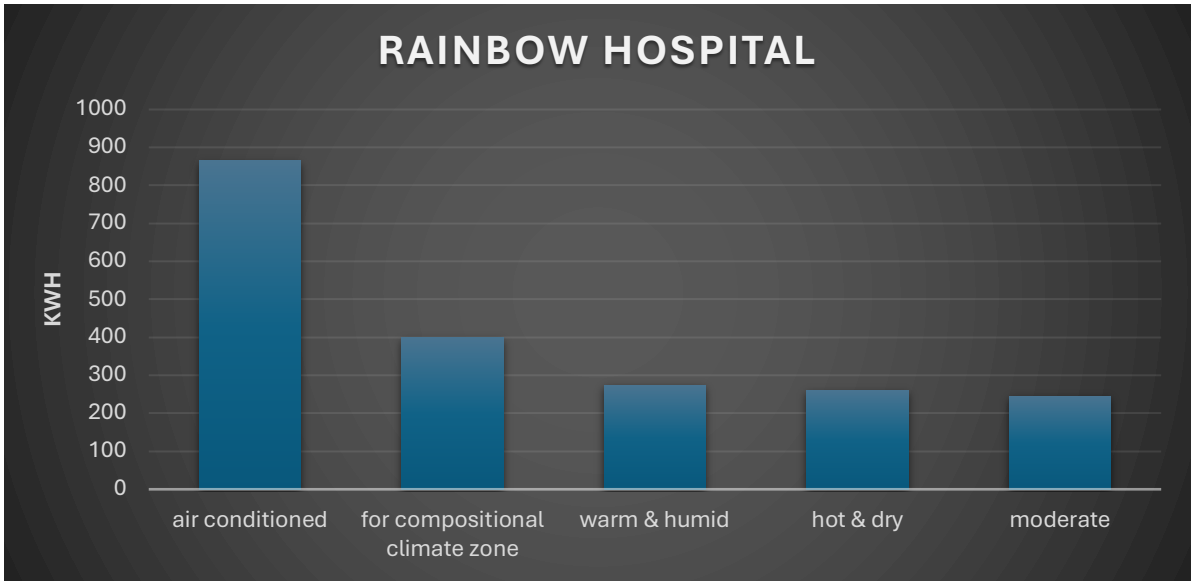


FIG 1.3 Energy consumed by Rainbow Hospital to keep up with different temperature required in a hospital.

SHREE SATYA SAI SUPERSPECIALTY HOSPITAL

Hospital has initiated several power conservation methods to conserve electricity.

CHANGES TO ELECTRICAL INSTALLATION TO CONSERVE POWER

1) Street light

OLD system 150W X 120nos—18KW/hour

In 10hours average energy consumption 180KW

Present system 150w was replaced with 30W

30W X 120nos—-3.6KW/hour

In 10hours average energy consumption 36KW

2) Tube light

Old system 40W X 2000nos—-80KW

In 10hours average energy consumption 800KW

Present system 40W was replaced with 20W

20W X 2000nos—-40KW

In 10hours average energy consumption 400KW

3) Dryers in Laundry

60KW heating elements was replaced by 30KW

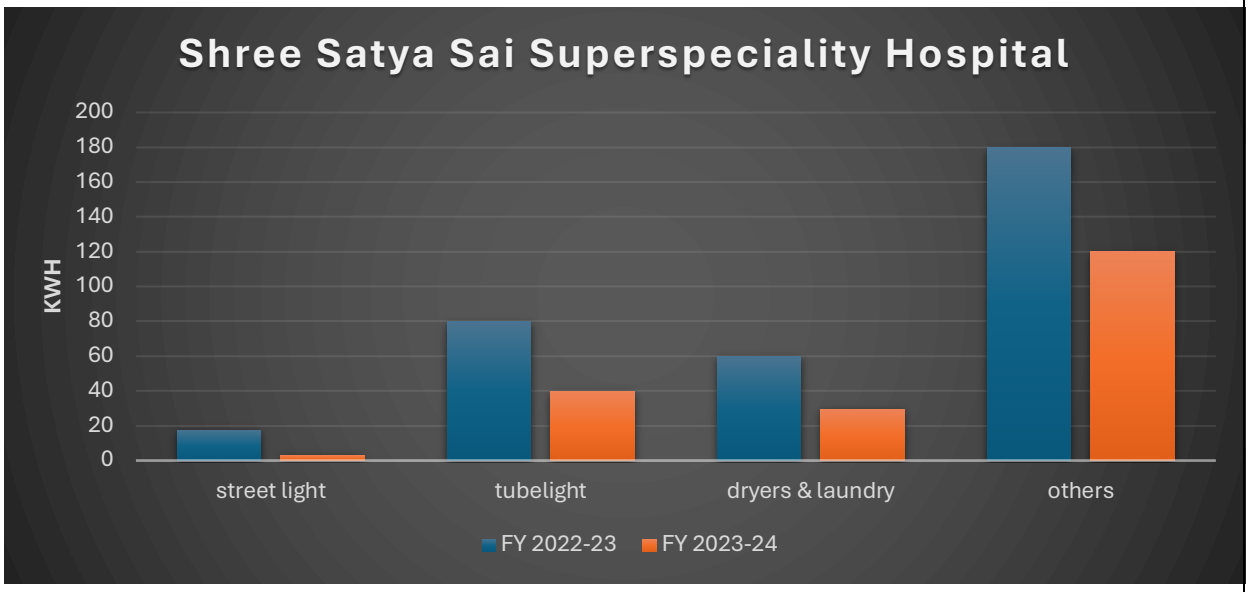


FIG 1.4 Difference in energy consumption of Shree Satya Sai Superspecialty Hospital after initiatives were taken to conserve the electricity.

4.2 Waste Reduction

Considering long-term sustainability, and rising costs of waste disposal, efforts were initiated to reduce waste generation, implement waste segregation at source and recycle/monetize the waste generated as much as possible.The relevant Solid Waste Management Rules also mandate bulk generators of waste to manage in-house the waste they generate.

Stepwise Implementation process

1. Visiting downstream recipients of the waste being generated, viz. pig farm for food waste, municipal contractor for mixed waste, biomedical and e-waste handlers to understand the waste handling process.
2. Sensitization of key stakeholders and hospital staff to the challenges in waste management practices and highlight the need for process improvement through presentations.
3. Constitution of Waste Management Committee, as a sub-committee of the Hospital Infection Committee, to oversee the waste handling, storage and disposal process.
4. Setting up of bins for dry waste collection in wards & OPDs and consolidating their storage in the Central Stores. A total of 8 categories of dry waste bins were set up in the central location as follows:

1. Paper & paper wrappers
2. Cardboard
3. Plastic wrappers (LDPE, single-use plastic etc.)
4. Polystyrene
5. Hard plastics (HDPE, PET etc.)
6. Metals (mild steel, stainless steel, aluminum, brass, copper)
7. Glass
8. E-waste

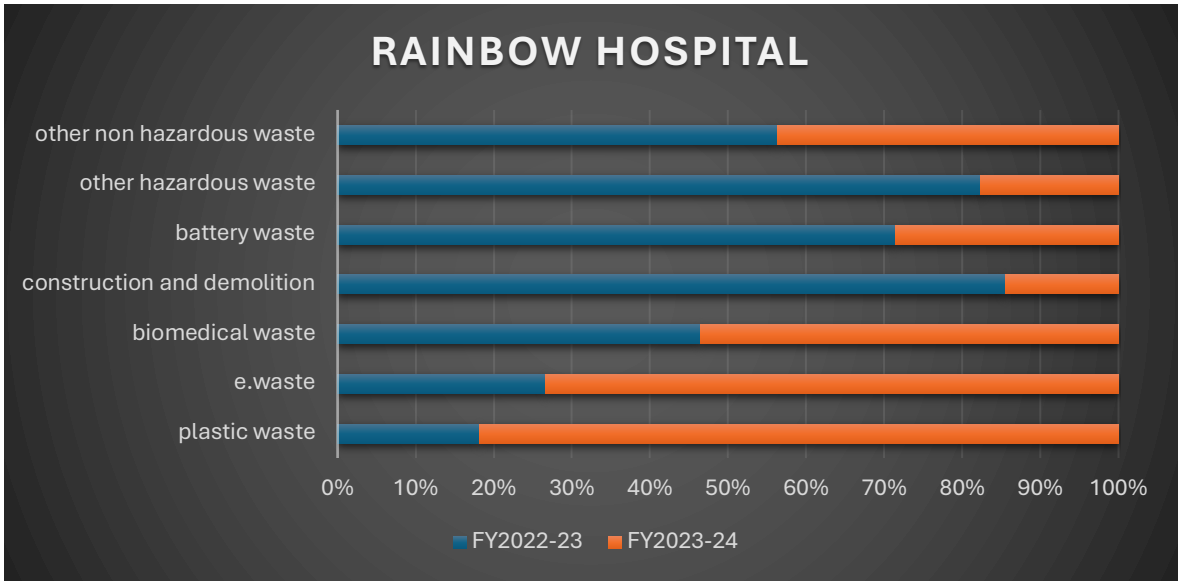
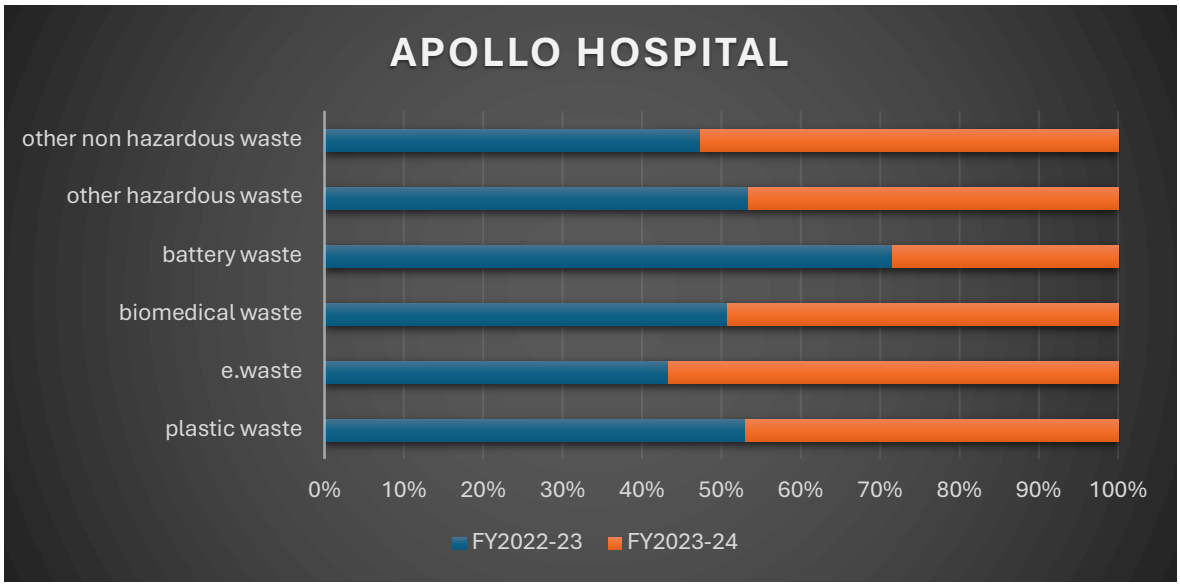


FIG 2.1 Comparison between two financial years of % of waste reduction after implementation of green healthcare initiatives.



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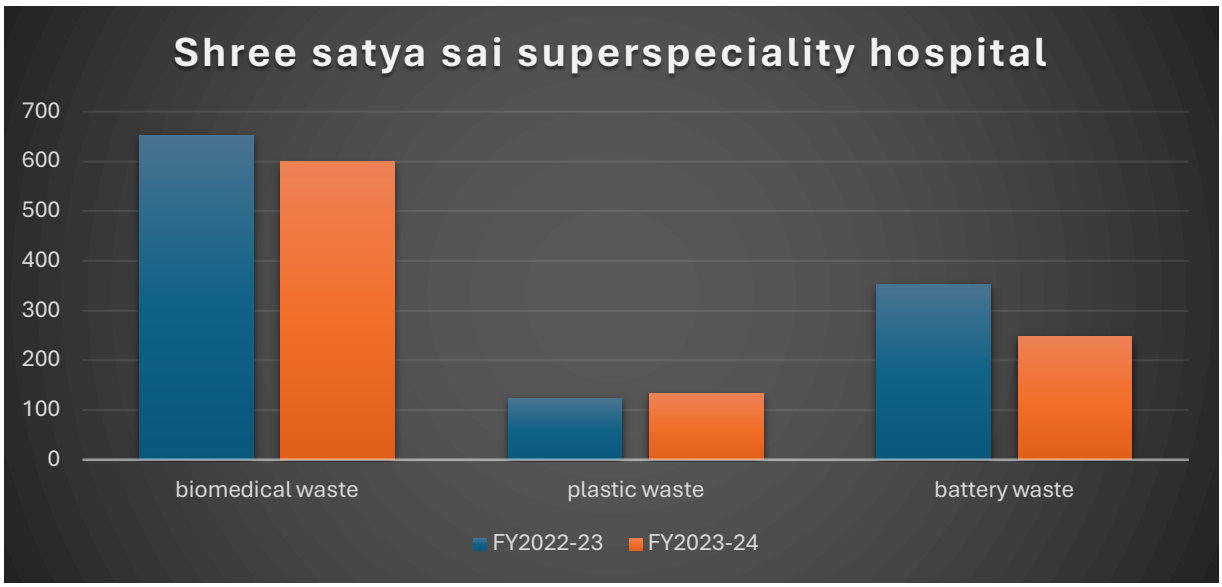

FIG 2.3 Comparison between two financial years of % of waste reduction after implementation of green healthcare initiatives.

4.3 Patients Experience

The data shows that while a large majority of patients approx. 75% are not aware that they are in a green hospital but are comfortable in getting treated and there is no major effect on the services and treatment provided. However, only a small portion of patients i.e. 10% notice any difference in services, suggesting that the green initiatives have been implemented in a way that does not significantly impact the patient's perception of their care. This would imply that green hospital practices are effectively integrated into the standard patient care processes without causing disruption or noticeable changes

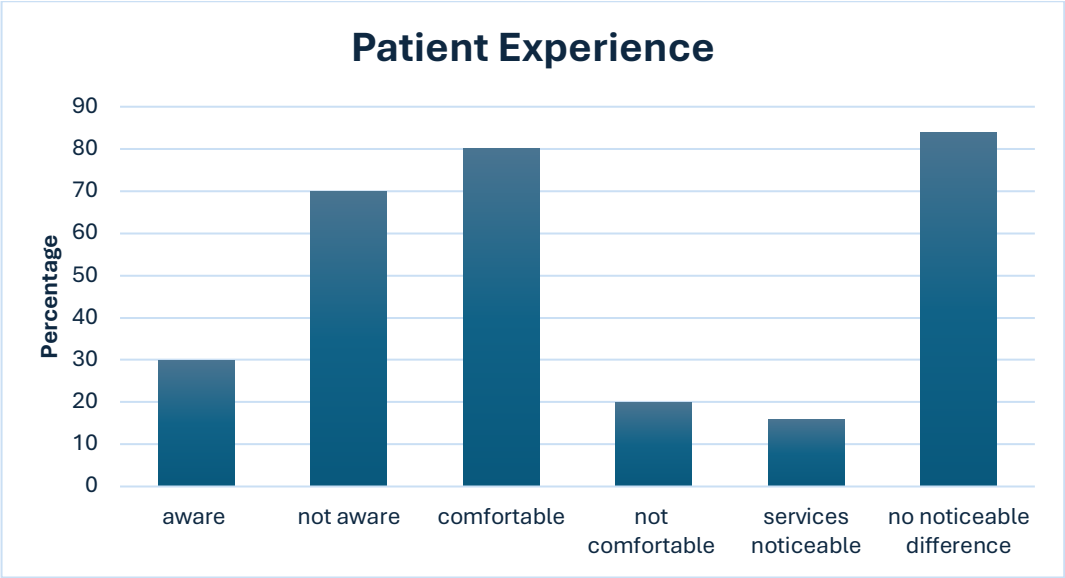

FIG 3.1Percentage of patient experience visiting a Green Hospital.

4.4 Staff Perception

The data indicates that most of the staff are aware of and positively perceive the green initiatives of the hospital. While awareness and brand status are strong, job satisfaction is the lowest among the categories, suggesting that while the green initiatives are well communicated and appreciated in terms of brand and knowledge transfer, there might be other factors affecting overall job satisfaction. Professional development is at 50% indicating a balanced perception where half of the staff see growth opportunities while the other half may not. This analysis points towards areas for potential improvement, especially in job satisfaction, to enhance the overall staff experience in a green hospital.

FIG 3.2 Staff perception working in a Green hospital.

Chapter 5: Discussion

5.1 Interpretation of Results

Climate Change Impacts on Energy Use: The data shows that energy use in different hospital depends on how large the hospital is and how many people pass through it every day. Consequently, this hospital has experienced increased efforts to go green. By doing so, hospitals reduce their energy consumption, produce less waste, have better indoor air quality and lower carbon footprints. Through integrating sustainability into the healthcare operations, Green Hospitals protect the environment from harm as a result of medical activities.

1.Energy Consumption reduction

The mentioned hospitals employ energy-saving technologies such as LEDs lighting systems, renewable energy sources (solar or wind) and efficient HVAC systems which result in:

- Less greenhouse gases emissions.
- Huge reliance on non-renewable power.
- Decrease in operational costs as time goes by.

2.Waste Generation Minimization

Some measures have been put in place including recycling programs, proper segregation of medical wastes and reduction of single plastics. This will lead to:

- Avoidance of more garbage going into landfills.
- Less pollution.
- Better methods of waste disposal.

3.Water Conservation

By adopting water-saving technologies such as low-flow faucets, dual-flush toilets and water-efficient landscaping,

- Reducing the consumption of water.
- Easing the stress on local water resources.
- Improving the efficiency of hospital procedures.

4. Improved Indoor Environmental Quality

For indoor air quality, green hospitals use non-toxic building materials, proper ventilation systems and minimize the usage of harmful chemicals. This leads to:

• Safer indoor environments for patients and staff members.
• Lessened exposure to pollutants and allergens.
• Overall better health and comfort.

5. Sustainable Building Design

Green hospital designs focus on sustainability by using eco-friendly materials, efficient building envelopes, and green roofs. This helps in:

• Decreased energy needs for heating and cooling.
• Better durability of buildings with reduced maintenance requirements.
• Improved aesthetics in environmental terms too.

6. Resource Conservation

Efficient use of resources including materials, energy and water is what defines green hospitals' approaches to resource management. This constitutes:

• Lessening the environmental impact associated with resource extraction and processing activities;
• Supporting use of sustainable or recyclable materials;
• Encouraging practices that reduce overall resource consumption.

7. Reduced Carbon Footprint

This means green hospitals are significant in lowering their carbon footprints by decreasing energy use, waste generation and resource consumption. The impact is:

• Helping to mitigate climate change.

• Contribution to global goals of sustainability.

• Sets a precedent for other industries to follow.

8. Encouragement of Biodiversity

Green hospitals typically have gardens, nature landscaping and open spaces within them that can:

• Increase local diversity of species.
• Create an environment where staff and patients can feel therapeutic effects.
• Aesthetically improve the whole hospital as well as its integration into the environment.

9. Economic Benefit

Cost savings through reduced water and energy use; potential financial incentives or grants make up some of the economic benefits that result from green hospitals. These cost savings would then be used to finance future environmental initiatives.

5.2 Barriers and Facilitators

- High Initial Costs

  The initial costs of sustainable building materials and green technologies may be prohibitive making it hard for hospitals to invest in green infrastructure or technologies due to budget limitations.

- Regulatory and Policy Challenges

Inconsistent policy framework forms a barrier towards realization of these objectives.

Facilitators of Implementing a Green Hospital

1. **Long-Term Cost Savings**
   - **Facilitator:** Green practices often lead to significant cost savings in energy, water, and waste management over time.
   - **Impact:** The financial benefits can justify the initial investment and motivate adoption.
2. **Regulatory Incentives**
   - **Facilitator:** Government incentives, grants, and subsidies for green initiatives.
   - **Impact:** Financial support from government programs can reduce the burden of initial costs.
3. **Increased Awareness and Education**
   - **Facilitator:** Training programs and awareness campaigns for hospital staff and management.
   - **Impact:** Staffs who are educated are more likely to encourage and commendably implement green practices.

4. **Technological Advancements**
    - **Facilitator:** Enhancements in green practices and technologies make them most effectual and profitable.
    - **Impact:** Advanced technologies can make it easier, compel and enhance the attractiveness for hospitals to adopt green practise.
5. **Leadership and Commitment**
    - **Facilitator:** Assurances given by hospital managements and headships.
    - **Impact:** Leadership assistance plays a vital role in motivating the adoption of sustainable and renewable practices.
6. **Positive Public Perception**
    - **Facilitator:** Increased and augmented assistance, support and encouragement from patients and community for environment friendly and responsible healthcare.
    - **Impact:** Public awareness and a positive opinion can enrich hospital's fame and motivate further the green initiatives.
7. **Collaboration and Partnerships**
    - **Facilitator:** Alliances and partnership within organizations, different hospitals and experts in sustainability.
    - **Impact:** Collaboration can be helpful in providing valuable resources, gain knowledge and assistance.
8. **Clear Policies and Guidelines**
    - **Facilitator:** Well defined and robust policies, standards and guidelines established by the health authorities and agencies involved in environment conservation.
    - **Impact:** Clear-cut and straight forward policies can help to provide a footprint for implementing sustainable practices effectively

5.3 Limitations and Strengths

Strengths of Implementing Green Hospitals

1. **Environmental Benefits**
    - **Strength:** Substantial decrease of carbon dioxide released, waste production and consumption of resources.

- **Impact:** Helps to alleviate climatic change and upholds the environmental sustainability.

2. **Long-Term Cost Savings**
   - **Strength:** Waste management, using energy efficiently and conservation of water can help in reduction of operational and management costs.
   - **Impact:** Initial investment can be balanced over a period of time by cutting down on utility bills, and expenditure on waste disposal fees.
3. **Enhanced Patient Health and Comfort**
   - **Strength:** Using non-hazardous materials, enhanced indoor air purity and use of natural lighting.
   - **Impact:** Promotes an improved, healthy and comfortable environment for the staffs and patients in the hospitals.
4. **Positive Public Image**
   - **Strength:** Representing and validating environmental responsibility enhances the fame and reputation as well as build public trust.
   - **Impact:** It can attract environmentally aware patients or the eco-friendly partners, developing support from the community and hospital sponsorships.
5. **Regulatory Compliance and Incentives**
   - **Strength:** More likely to meet the regulatory standards and become eligible for grants and incentives offered by the government.
   - **Impact:** Financial rewards or incentives along with supportive and monitored regulatory treatment encourages and accelerates Green initiatives.
6. **Staff Morale and Productivity**
   - **Strength:** An improved and healthy work environment and engagement among the staffs in meaningful sustainability efforts.
   - **Impact:** Improves the staff's self-confidence, their job satisfaction, and productivity.

Limitations of Implementing Green Hospitals

1.High Initial Cost

While implementing green technologies and infrastructure, large upfront costs can pose a significant financial strain, and particularly the smaller hospitals with

limited financial capabilities are affected.

2.Complex Implementation

While implementing green healthcare strategic planning, coordination and processing new systems can create a complex and time consuming process, potentially disrupting hospital workflow

3.Technological and Infrastructure Barriers

There can be technologies which we need to identify, acquire and incorporate in the most appropriate way depending upon the variable levels of availability and compatibility on the regions and healthcare facilities

4.Resistance to Change

Resistance of staff and management who are unwilling to alter their accustomed workflows and practices can delay and hinder the implementation of sustainable practices.

5.Maintenance and Operational Challenges

Implementing green practices requires persistent maintenance, monitoring and management to ensure effectiveness which can impose additional burdens on hospital resources and staff.

6.Limited Knowledge and Training

Hospital staff and management may lack the necessary knowledge and skills to implement and maintain sustainable practices. And to maintain that Gaps knowledge and understanding can impede the successful execution and management of sustainable initiatives.

7.Regulatory and Policy Uncertainty

Inconsistent or unclear policies and regulations related to green healthcare practices.Which would require Planning and compliance that creates uncertain challenges.

Chapter 6: Conclusion and Recommendations

6.1 Summary of Findings

The successful adoption of eco-friendly practices in energy management at Rainbow Hospital, Apollo Hospital, Aster Hospital, and Shree Satya Sai Hospital showcases the numerous advantages of sustainable healthcare. These hospitals have set a commendable precedent, demonstrating that prioritizing environmental stewardship and patient well-being not only coexists but also reinforces each other. Their exemplary models inspire the healthcare industry to embrace green practices, affirming that top-notch patient care and ecological accountability can harmoniously converge.

Rainbow Hospital

- Energy Efficiency: Implemented LED lighting, motion sensors, and high-efficiency HVAC systems.
- Renewable Energy: Installed solar panels that contribute to a significant portion of the hospital's energy needs.

- Energy Management: Uses a centralized energy management system to monitor and optimize energy consumption in real-time.

2. Apollo Hospital

- Energy Efficiency: Upgraded to energy-efficient appliances and infrastructure, including insulation and energy-efficient windows.
- Renewable Energy: Solar power installations on the hospital rooftops and the use of wind energy where feasible.
- Smart Technology: Integrates smart grids and energy storage systems to ensure optimal energy use and reduce reliance on non-renewable sources.

3. Aster Hospital

- Energy Efficiency: Retrofitted buildings with energy-saving technologies and implemented policies to reduce energy wastage.
- Renewable Energy: Utilizes geothermal energy for heating and cooling systems in addition to solar power.
- Energy Conservation Programs: Conducts regular energy audits and engages in continuous improvement of energy conservation practices.

4. Shree Satya Sai Hospital

- Energy Efficiency: Adopted advanced energy-saving measures such as heat recovery systems and energy-efficient medical equipment.
- Renewable Energy: Invested in extensive solar panel arrays and biogas plants for energy generation.
- Sustainable Practices: Focuses on sustainable energy practices and educating staff and patients about energy conservation.

With respect to patients' satisfaction most of the patients are negligent of the idea of getting treated in a green hospital and are only interested if the quality of care is affected or not.

When staffs are considered, the amount of responsibility increases while the reputation and pride for working in a green hospital precedes.

6.2 Recommendations

■ Renewable Energy Integration: Propose the embrace of sun, air and ground heat energy sources to cut back on fossil fuel dependency and decrease carbon outputs.

Provide various feasibility studies and cost benefit analysis for different hospital-appropriate renewable technologies.

■ Strategies for Energy Efficiency: Suggest ways of advancing energy productivity in hospitals; these involve upgrading HVAC systems, optimizing lighting systems using LEDs and sensors, and introducing smart buildings techs for energy consumption management.

■ Water-saving Measures: Encourage water conserving mechanisms such as using rain water, grey-water recycling not forgetting efficient water fittings. Analyse its potentiality in cutting down water use as well as wastewater generation.

■ Innovative Waste Management: Come up with new way of reducing medical waste generation, increase recovery rates as well as safely disposing hazardous materials. Emphasize the need to enforce broad based waste management policies besides involving workers in waste reduction strategies.

■ Green Building Design Principles: Encouraged inclusion of green principles in building or upgrading hospitals. The emphasis is on sustainable materials, energy-efficient designs and green roofs or walls to improve indoor air quality and patient comfort.

6.3 Future Research Directions

Let’s dive deeper into integrating renewable energy bases like solar, wind and geothermal power into hospital infrastructure. This includes developing smart energy storage systems and creative methodologies to enhancement on-site energy production, reducing reliance on non- renewable sources and minimizing carbon footprint

• Exploring cutting-edge technologies that enhance energy efficiency in hospitals, focusing on; HVAC system: advanced smart sensor and predictive maintenance, Lightening: intelligent controls and led solutions, Medical equipment: energy-efficient designs and AI- driven optimization. We can control AI- driven energy management platforms to rationalize enactment, decrease waste and decrease environmental impact.

• Cultivate and implement advanced water conservation resolutions for hospitals, including rainwater harvesting and greywater recycling and systems, advanced water

purification technologies and water efficient medical equipment and sterilization process. Scrutinizing and optimizing water saving strategies to minimize waste, lessen environmental influence and create a supportable healthcare infrastructure

• Transforming healthcare waste management through innovative solutions by enhancing recycling programs for medical waste, single –use plastics and general hospital waste. It also requires insuring the safe and responsible disposal of hazardous materials and pharmaceuticals while pioneering new approaches to minimize waste generation and foster a culture of sustainability in healthcare.

• Revolutionizing hospital design and construction with sustainable innovations which will help in developing and integrating green building materials that promote energy efficiency and reduce environmental footprint, implementing cutting edge construction techniques that enhance indoor air quality and overall environmental performance.it also focuses on designing hospitals with architectural excellence that prioritizes sustainability, patient wellbeing and energy efficiency

• Health and Well-being: Research on the consequences of green hospital initiatives for patient outcomes, staff productivity, and overall well-being. This may entail studies on indoor air quality, natural lightening, noise reduction and psychological benefits of green space.
• Community And Stakeholder Engagement: Strategies to involve local communities and stakeholders in green hospital initiatives. This could comprise education programs, partnerships with local businesses and efforts to foster sustainability consciousness among patients and visitors.
• Policy And Regulation: Research into policy frameworks and regulatory measures supporting the development and implementation of green hospital practices. This might include pushing for incentives that promote sustainable healthcare practices as well as establishing environmental standards for health care facilities.
• Financial sustainability : unlocking long-term cost savings through green hospital initiatives. Research mainly focuses on financial model, case studies and best practices.

References

1.Bosch, S., & Pearce, A. R. (2003). Sustainability in Public Buildings: The Role of Green Building Rating Systems in Healthcare Facilities.

2. Chow, H. K. H., & Wang, W. Y. C. (2016). Exploring the Benefits and Challenges of Green Hospitals in China: A Case Study of a Tertiary Hospital.
3. Rashid, M., & Zimring, C. (2008). A Review of the Empirical Literature on the Relationships Between Indoor Environment and Stress in Healthcare and Office Settings: Problems and Prospects of Sharing Evidence.
4. James, J. P., & Karmarkar, S. (2014). Implementation of Green Building Design in a Hospital in Mumbai, India: A Case Study.
5. Kumar, R., & Sharma, S. (2017). Green Hospitals in India: An Overview and Case Study.
6. Houghton, A., & Macintyre, S. (2012). The Scottish Healthcare Environment: Exploring the Contribution of Green Hospitals to Sustainable Development.
7. Singh, R., & Bhattacharya, J. (2018). Energy Efficiency Measures in a Green Hospital: A Case Study from New Delhi.
8. Kothari, A., & Gupta, P. (2015). Greening Hospitals: A Case Study of Environmental Initiatives at a Healthcare Facility in Rajasthan, India.
9. Larsson, N., & Bagheri, M. (2007). A Comparative Study of Energy Performance in LEED and Non-LEED Hospitals.

10. Jain, N., & Saha, P. (2019). Reducing the Carbon Footprint of Healthcare Facilities: A Case Study from a Green Hospital in Bangalore, India.