

DEVELOPMENT OF SUSTAINABLE HEALTHCARE MODEL FOR THE HOSPITALS IN NORTHERN INDIA

Pengembangan Model Perawatan Kesehatan Berkelanjutan untuk Rumah Sakit di India Utara

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Abstract

Background: Healthcare organizations incorporate products and services at economical prices to deliver healthcare services of good quality. All the operations performed in the organizations aimed to achieve higher level of environmental sustainability which is governed by the Sustainable Developmental Goals of 2030.

Aims: This study aims to develop a sustainable healthcare model using Analytical Hierarchy Process (AHP).

Methods: First and foremost, the authors have identified the factors associated with the sustainable healthcare system through a literature review. Based on these factors, a questionnaire was developed and administered to 25 healthcare organizations from December 2020 to March 2021. An Analytical Hierarchy Process is utilized to rank the factors and a conceptual model is developed. The Felix Hospitals substantiate this model. The authors have also applied sensitivity analysis to validate the results achieved via AHP.

Results: The AHP model demonstrates, the focus is to be on the environment first, followed by the economic and social dimensions sustainably. The validated model was substantiated by the hospital (Felix) results and sensitivity analysis too.

Conclusion: It can be concluded that sustainability in hospitals is highly depends on the environment in the first stage, and economic and social sustainability comes in the second and third stages. The same result was achieved through AHP.

Keywords: analytical hierarchy process, hospital, sustainable healthcare.

Abstrak

Latar belakang: Organisasi pelayanan kesehatan menggabungkan produk dan layanan dengan harga ekonomis untuk memberikan layanan perawatan kesehatan dengan kualitas yang baik. Semua operasi yang dilakukan dalam organisasi bertujuan untuk mencapai tingkat kelestarian lingkungan yang lebih tinggi yang diatur SDGs 2030

Tujuan: Penelitian ini bertujuan untuk mengembangkan model perawatan kesehatan berkelanjutan dengan menggunakan Analytical Hierarchy Process (AHP).

Metode: Pertama dan terpenting, penulis telah mengidentifikasi faktor-faktor yang terkait dengan sistem perawatan kesehatan berkelanjutan melalui tinjauan literatur. Berdasarkan faktor-faktor ini, kuesioner dikembangkan dan diberikan kepada 25 organisasi layanan kesehatan dari Desember 2020 hingga Maret 2021. AHP digunakan untuk menentukan peringkat faktor-faktor dan model konseptual yang dikembangkan. Rumah Sakit Felix mendukung model ini. Para penulis juga telah menerapkan analisis sensitivitas untuk mevalidasi hasil yang dicapai melalui AHP.

Hasil: Model AHP menunjukkan bahwa fokus pada lingkungan terlebih dahulu, diikuti oleh dimensi ekonomi dan sosial secara berkelanjutan. Model yang dikembangkan divalidasi dengan hasil dari penerapan di rumah sakit (Felix Hospital) dan juga dari analisis sensitivitas.

Kesimpulan: Dapat disimpulkan bahwa model keberlanjutan di rumah sakit sangat tergantung pada lingkungan pada tahap pertama, dan keberlanjutan ekonomi dan sosial yang datang pada tahap kedua dan ketiga. Hasil yang sama dicapai melalui AHP.

Kata kunci: AHP, rumah sakit, perawatan kesehatan berkelanjutan.



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Introduction

There is an exponential demand for quality healthcare systems both at present and in the future times as well. There is an enormous consumption of food and an unhealthy lifestyle, which leads to more healthcare interventions at one end and expenditure on healthcare is decreasing worldwide at the other end. However, healthcare systems face multiple challenges. Accessibility to quality healthcare services, less financial support, and a trained workforce are the few challenges faced by the healthcare system in public and private organizations. Private organizations overcome these challenges through innovation and scaling up their operations.

The sustainable healthcare model develops, upholds, or reinstates health, while curtailing destructive effects on the environment and controlling opportunities to restore and improve it, so that the health and well-being of current and future generations would benefit from it (World Health Organization). The primary aim of this study was to conduct a literature review of sustainability in the healthcare system. The second aim was to identify factors used by healthcare service providers. The research questions for this study included awareness of sustainability and the implementation of sustainability practices by healthcare providers. Economic, social, and environmental factors are given their highest priority. The public health community has warned that climate change is the greatest threat to the public health system of this century. Natural Resources Defense Council Report 2021 highlighted that climate change and pollution are going to cost US\$820 billion (Alwis and Limaye, 2021). The upcoming climate change issues and the demand for sustainable infrastructure in such organizations have forced us to think that sustainability not only brings a better place to live for all stakeholders in society. Risk jeopardizing organizations should be taken care of by various risk-mitigation strategies.

The author has described the risks associated with hospitals and healthcare systems as processes, clinical and

administrative systems, and records engaged in the identification, assessment, mitigation, and monitoring of various risks. The risk management process ensures patient safety and protects the organization's assets, accreditation, brand value, market share, and community interests (Bolnick *et al.*, 2020). This study indicates that the enterprise risk management process comprises eight domains: operational, clinical, patient safety, strategic, financial, human capital, legal and regulatory, technological, environmental, and infrastructure-based hazards. Uncertainty and risk impose adverse circumstances on all health care entities. Every healthcare organization uses a systematic and ongoing process to curtail the intensity of the risks in the healthcare system, which leads to quality healthcare for patients and financial strength for the organizations to face uncontrolled periods of change.

Hospitals–Government infrastructure comprising healthcare centers, district and general hospitals, and private hospitals containing nursing homes; mid-tier, top-tier, and super-specialized institutions are the healthcare market in India, split into five key segments. The manufacturing of drugs and extraction, processing, purification, and packaging of chemicals are included in pharmaceuticals. Laboratories offer diagnostic services based on which practitioners prescribe medicine and lines of treatment. Manufactured medical equipment and supplies used in surgical, dental, ophthalmic, and laboratory settings. Another sector, Medical Insurance, is increasing rapidly and is projected to be more than 40 billion US dollars in the near future. This covers hospitalization expenses and reimbursements to hospitals trailed narrowly by pharmaceuticals and medical instruments.

Definition of Sustainable Healthcare

Sustainable healthcare is not new, but nowadays much is talked about just for a few reasons, which can be sustainable development goals, aspiring to achieve by 2030. Maintaining the quality of care delivered by healthcare systems incorporates products, services, and

healthcare operations with higher environmental performance to make it sustainable. To maintain sustainability in the healthcare system, it is important to consider the well-being of society and the survival of businesses.

The question arises as to how a healthcare system can become more sustainable. The waste management and procurement system should be updated, and the usage of durable goods should be examined. Therefore, the option of clean energy was explored to make the system more sustainable, and new regulatory compliance should be incorporated. This would make the hospitals more environmentally friendly.

The healthcare industry has encountered critical challenges, including the availability of raw materials, qualified human and economic resources, changing demographics, and healthcare accessibility. These challenges have intensified owing to unmanageable progress. The rising costs, insufficient healthcare insurance fees, and population aging have largely affected healthcare services. The social and political environments and electoral success are directly interlinked with the healthcare sector. The health care sector plays an important role in the economies of developed countries. To have a better quality of life and affordable and acceptable social well-being, ethical principles need to be followed, which leads to sustainable progress and development in healthcare. The World Commission on Environment and Development (Yadav, Gupta and Bandyopadhyay, 2015), recognizes issues such as unnecessary deforestation, intense population growth, species extermination, the greenhouse effect, and ozone depletion, and stresses economic growth and resource overconsumption by socioeconomic aspects. In 2015, the UN member states adopted 20 global sustainable development goals (SDGs), targeted to achieve by 2030. The actions should drive sustainability if all the financial systems, banks, corporate bodies, and politics come forward to make nations sustainable. Many challenges to healthcare sustainability prevail in most countries.

Changes in demographic patterns, rising healthcare costs and lack of resources, shortage of qualified personnel, non-linear healthcare threats, and increased administrative processes are some of the predominant challenges in the healthcare sector. Handling these challenges is a commitment to ensure the quality of healthcare and contentment for all involved participants (Momete, 2016).

As per the existing literature and studies carried out on sustainability related to the triple bottom line concept, this study introduced a comprehensive framework to measure sustainability, which is outside the triple bottom line concept. Although sustainability has been studied in most service companies, very few have highlighted it in the healthcare sector. Researchers have aimed to identify these factors and their hierarchical framework to assess sustainability in the healthcare sector (Ferdosi, Rezayatmand and Molavi Taleghani, 2020).

As per the definition of WHO, "A system is sustainable that recovers, preserves the health and wellbeing of current and future generations, by curtailing the adverse effects on the environment." (WHO-Europe, 2017). Harmful and conventional waste, wastewater and greenhouse gas emissions, and water and energy overconsumption are the few healthcare activities that require immediate attention from owners and other responsible entities. Healthcare providers can thus become more profitable by adopting these four methods.

Chemical safety practice

Healthcare providers must make mindful purchasing decisions while buying products for the system. They use many hazardous chemicals in products, such as fluorescent lamps, LCDs, CRT Monitors, flame-retardant mattresses, wheelchair cushions, and even baby bottles. The purchase manager should try to avoid ordering these items and, if bought, toxic products must be recycled periodically.

Waste disposal process: disinfecting medical wastes releases noxious fumes, and auto cleaning, chemical treatment, and

microwaving are the methods that should be adopted by healthcare providers.

Save energy: although reduction of carbon output and energy saving is a difficult task if the healthcare system reprograms its internal part regarding heating and cooling plants, upgradation of air, and lighting systems.

Preserve water: an ample amount of water can be saved with water-efficient alternatives by replacing washroom toilets, faucets, showers, and purchasing high-efficiency dishwashers.

In recent years, the healthcare industry has become increasingly involved in damaging and degrading the natural environment. The quality of our environment disturbs public health, as sustainability and healthcare are complexly related. It threatens health and human society because of the scarcity of natural resources and patterns of economic and social development. India receives the highest revenue and employment from the healthcare sector. Economic growth in India is largely driven by the healthcare sector. The healthcare industry is increasing at a quick pace, estimated to reach US \$ 372 billion by 2022 from the present US \$ 193.83 billion (Triviron, 2020). Circular practices, integrated design of healthcare facilities, reduction and efficient management of medical waste, and sustainable procurement are a few practices; by adopting these, sustainability can be achieved in the healthcare industry (Pekar, 2019).

The three features of sustainability vary according to the dimensions, drivers, and practices included. Lee considered four broad sustainability dimensions in their study. The environment, customers, employees, and community orientation were the dimensions described in this study. The driving forces for the implementation of healthcare sustainability are climate change, high resource costs, lifestyle issues, and a high level of public (Catalyst, 2018).

All national/ regional and international organizations prioritize sustainable healthcare. The expenditure on healthcare providers is increasing rapidly, which is more than the increase in GDP. The

impact, in the form of better sustainability, was realized after 20 years. Two contradictory requirements are visible: increased demand for a sustainable environment and the lowest cost of healthcare services (Kruk *et al.*, 2018).

Sustainable healthcare organizations improve and provide welfare to all individuals without bias. Technological intervention in the form of telemedicine helps society, the government, and healthcare providers, because telemedicine renders patient satisfaction to the patients (Chauhan, Jakhar and Jabbour, 2022). Another study by Akinleye, *et al.* showed that sustainable-oriented practices lead to better organizational performance and satisfaction for all stakeholders (Akinleye *et al.*, 2019).

The outcome of this study shows that a “reuse activity project” helps spread awareness about sustainability (Mehra and Sharma, 2021). The authors stated that a better and more affordable health system is necessary to increase the confidence level of an actual health system. This type of health system provides equal health care services to all people. In a controlled society structure, high-quality healthcare renders less risk to lives as well (Goossens, Vemer and Rutten-van Mülken, 2020). Jones *et al.* indicated that patients should not be transferred to NHS trust and undergo phage therapy, which is considered unethical, impractical, and illegal (Adibi *et al.*, 2012).

Executive healthcare organizations have developed a framework ISO31000. This framework comprises five phases: context development, risk assessment, risk treatment, risk planning, and monitoring. All of these phases must be executed in sequence so that proper consultation can be provided to patients in a timely (Marimuthu and Paulose, 2016). Healthcare organizations face both clinical and nonclinical risks that need to be dealt with differently. High-quality services are provided to patients with the help of risk-mitigation strategies deployed by healthcare organizations. Risk mitigation strategies include risk transfer, sharing, avoiding, or accepting the risk applicable for the purpose of usage. Abidi's study

indicates that all health organizations focus on the identification of risks and better patient care (Gupta, 2017). All healthcare organizations need to concentrate on the quality services and safety of patients and should be built into the healthcare system.

This study highlights obstacles to the implementation of an effective risk management process. These hurdles include improper training of the hospital staff, underreporting and not disclosing the facts and figures, human and financial resources crisis, corrective directions, gathered data and extraction of useful information, and management trials and solutions, which could affect the efficacy of the system (Gupta, 2017)

The authors concluded that hospital at home resulted in substantial cost savings compared to inpatient hospital care, which may be due to the overestimation of inpatient hospital costs (Jones, Ferguson and Suleman, 2022). This study shows that financially sound hospitals are in a position to provide high-quality healthcare and patient safety. High-quality health services and patient safety are important aspects of economic sustainability because they lead to economic costs in health services. This study concluded that a robust financial situation is directly related to better patient care experience and improved quality and safety measures for patients (Singh, 2012). This study indicates the need to prevent and control risk acquaintances, and that healthcare systems should spend a large amount of money on identifying healthcare risk factors. The authors have also reported that there is a time lag between the identification of risks and the implementation of the policy to overcome the threat encountered due to health risks.

Healthcare organizations should also invest in promoting risk-mitigation strategies and preventing the negative consequences of ongoing risk. The authors show that India is not as litigious with regard to malpractices in healthcare that do not come in public as developed countries such as the USA. Very few incidents occur in public forums that have violated protocols. Risk Management is the process that highlights the practices and does not follow the consistency of hospitals. The

accreditation agency needs to consider this matter seriously while clearing the license under the quality assurance head. Every hospital should form a risk-steering committee to oversee the hazards and negative impacts on patients in due course of time (Trivitron, 2020).

Method

Sustainable healthcare depends on environmental, social, and economic sustainability, as revealed through an extensive literature review. The sub-criteria of the three main criteria were identified using the Analytical Hierarchy Process (AHP), and the developed model was substantiated by the Felix Hospital. The model developed in this study is applicable in the Indian context.

The authors aimed to achieve several objectives in this study. The first objective was to identify factors associated with healthcare sustainability. The second objective was to apply AHP to prioritize all factors into ranks. Third, the healthcare sustainability model is developed with the factors that have the highest weighting and substantiated with Felix Hospital data.

The responses were gathered from employees of Felix Hospital's administrative staff, nursing staff, and housekeeping staff, as they are responsible for framing and implementing healthcare practices of sustainability in the hospital (Table 1). 70% were male, and 30% were female, as total respondents. The other major profiling characteristic was that 50% were at middle level and the remaining 50% were from junior and senior levels. Middle-level employees are those who participate at the maximum in implementing sustainability in healthcare organizations. The tools used in this study are an analytical hierarchy process that ranks the three criteria and sub-criteria of sustainability. Subsequently, environmental sustainability received the highest priority. Environmental sustainability is substantiated by the waste collected and indicates that Felix Hospital put efforts to recycle the red and yellow waste, just to maintain environmental sustainability as a high priority.

Thereafter, the authors applied a sensitivity analysis to validate the results achieved through the AHP and Felix Hospital.

Table 1. Demographic profile of the respondents

Variable	n	%
Gender		
Male	162	69.83
Female	70	30.17
Age (in years)		
21-30	54	23.28
31-40	85	36.64
41-50	66	28.45
51-60	22	9.48
Above 60	5	2.16
Education		
Graduation	68	29.31
Master's Degree	118	50.86
PhD	3	1.29
Others	43	18.53
Position in the Organization		
Junior Level	60	25.86
Middle Level	115	49.57
Senior Level	57	24.57

Source: Authors Computation

Under environmental sustainability, recycling programs (RP), healthcare waste (HW), and eco-friendly facilities (EFF) are subdimensions. Felix Hospital is working steadily, and efforts are being made to

reduce the generation of waste. The Felix Hospital, which has a capacity of 122 beds, is considered here to show the total waste generated per bed. Table 2 shows that yellow (39.12% of total waste) and red waste (35.62% of total waste) can't be recycled, and efforts should be toward the reduction of these wastes to improve the environment still manageable because hospitals send them for recycling.

Conceptual Model of Sustainable healthcare

Sustainable healthcare practices are an essential part of the healthcare industry and are derived through strategic plans. The conceptual model presented in this study is based on the literature review. It has three crucial dimensions: environment, social, and economic, as well as the same mentioned in the triple bottom line concept. These three dimensions are further categorized into four subcategories (Figure 1).

The AHP method was used in this study is AHP and the weightage of the three factors was computed. The final validated model is further substantiated by a case study of the Felix Hospital in Delhi NCR. AHP helped in identifying the weight of the sub-criteria, and accordingly, the priorities were fixed.

Table 2. Felix Hospital data (December 2021 – November 2022)

Month	Yellow ¹	Red ²	Blue ³	White ⁴	Total Waste	Total waste per bed
Dec-21	301	276	170	27.5	774.5	6.35
Jan-22	465	347	125	81.5	1018.5	8.35
Feb-22	471.2	365	65	30	931.2	7.63
Mar-22	304	198	65	32	599	4.91
Apr-22	383	348	437	63.5	1231.5	10.09
May-22	270	315	210	41	836	6.85
Jun-22	285	390	234	40	949	7.78
Jul-22	301	338	269	28.6	936.6	7.68
Aug-22	728	542	336	21.95	1627.95	13.34
Sep-22	801.73	679.47	515.72	28.5	2025.42	16.60
Oct-22	410.26	592.12	243.58	40.26	1286.22	10.54
Nov-22	502.05	365.263	196.453	70.643	1134.409	9.30
TOTAL	5222.24	4755.85	2866.75	505.45	13350.3	
% of Total Waste	39.12	35.62	21.47	3.79		

Source: Felix Hospital

Note : ¹Anatomical waste, ²Infected plastic waste, ³Discarded waste, ⁴Sharp Items like needles.

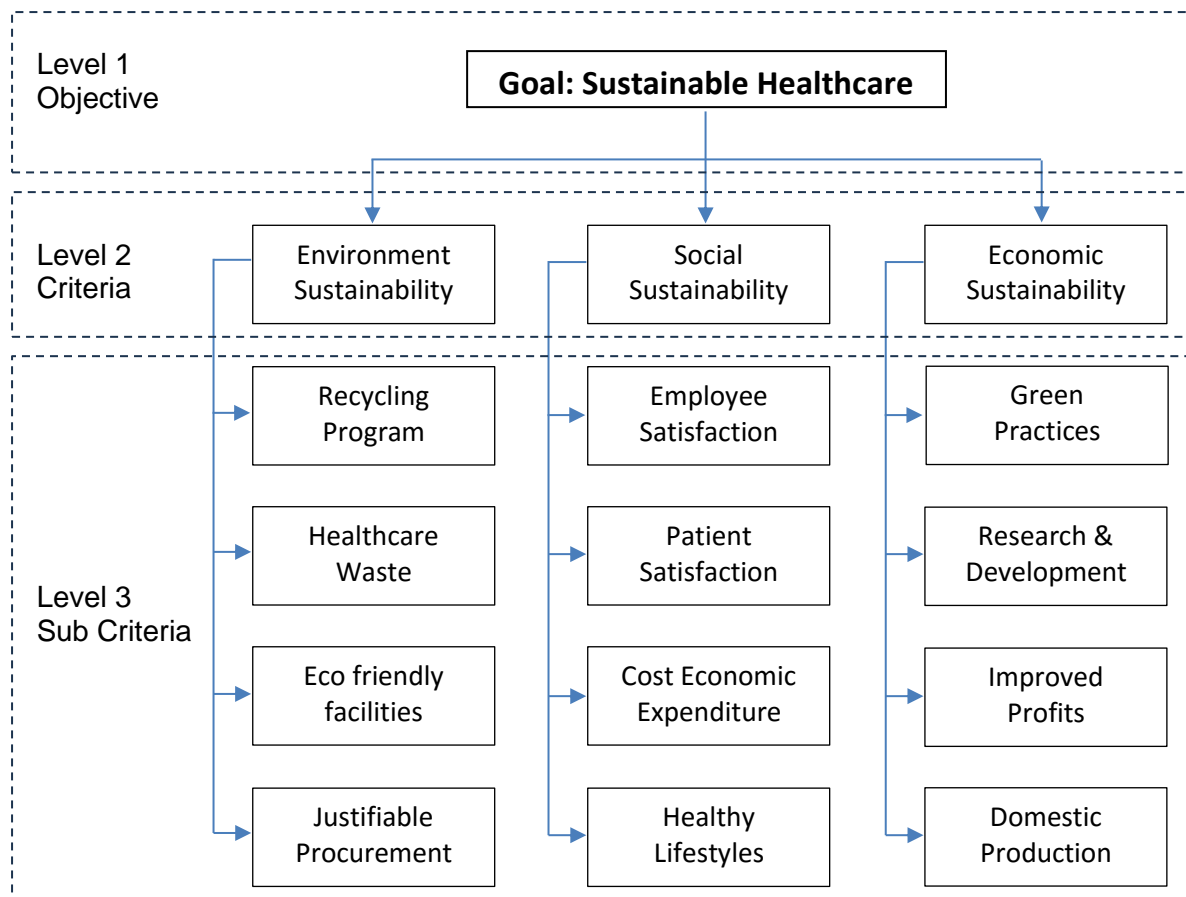


Figure 1. AHP Model of Sustainable Healthcare

Table 3. Measures of Sustainability–Local and Global Weights

Sub-Criteria (Measures)	Criteria (Dimensions)			CI	CR	Global Weight	Rank
	Environ mental	Social	Economic				
RP	0.3638	0.2530	0.3832	0.0011	0.0024	0.115	2
HW	0.2973			0.0002	0.00012	0.081	7
EFF	0.1835					0.085	6
JP	0.2239					0.113	3
ES	0.2953	0.2757		0.0023	0.0026	0.044	11
PS		0.1747				0.070	9
CEE		0.2996				0.071	8
HL		0.2500				0.069	10
GP			0.0954	0.0040	0.0054	0.014	12
RD			0.3893			0.141	1
IP			0.2264			0.086	5
DP			0.2889			0.107	4

Source: Author's Computation

Result and Discussion

First, the authors identified the factors associated with a sustainable healthcare system through a literature review. Based on these factors, a questionnaire was developed and administered to 25 healthcare organizations from December 2020 to March 2021. An Analytical Hierarchy Process was used to rank the factors, and a conceptual model was developed. Felix Hospitals substantiated this model. The authors also applied a sensitivity analysis to validate the results achieved via the AHP.

The respondents and hospitals were in the major parts of the Delhi NCR. Twelve respondents were doctors, and three were senior managers. Thus, all respondents were noticeable stakeholders in the healthcare system. The experts contacted in the study had over 15 years of experience and were familiar with their field. The judgments and responses captured had the highest credibility and reliability. They have all been involved in sustainability practices in healthcare delivery systems for many years.

Analytical Hierarchy Process

Using the proposed theoretical model, a three-level hierarchical structure for sustainability in healthcare was developed (Figure 1). The vital measures of sustainability lie in the first level, as given by the specific goal. Environmental, social, and economic factors were considered as criteria. Four sub-criteria were considered under three dimensions. The standard Saaty scale, with a value of 1 to 9, was used to describe pairwise comparisons. The researchers combined the judgment of 15 experts using the geometric mean against the individual pairwise comparison. Table 3 lists the assigned and normalized weights of each sustainability measure.

The results depicted in table 3 highlight that the environmental dimension is getting the highest priority (36%), followed by economic (38%) and social (25%) dimensions. A thorough literature review also supports this finding. At the sub-criteria level, the recycling program and justifiable procurement stand at the

second and third ranks, substantiated by the UN SDG goals, and help in reducing the negative impact on the environment and emphasizing the sustainable practices to be adopted to have a sustainable healthcare system. The recycling program concentrates on less usage of primary resources and is more dependent on renewable energy resources and optimum utilization of materials and products, without wastage. It related justifiable procurement to making the purchasing decision accrued through a less negative impact on the environment. The next important criteria are economics, and the measures associated with it are research and development (rank 1) and domestic production (rank 4). Innovation and manufacturing are predominant in India and researchers knew India as the “pharmacy of the world”. Thus, if sustained investments are diverted toward research and innovation, they may provide a solution to healthcare challenges. The healthcare industry is known for its expensive medical technology, such as the maximum items and equipment imported. Therefore, efforts and initiatives are required to make medical and equipment manufacturing self-sufficient and less import-dependent. The social dimension has come out to be the least important because it ranks lowest among all three dimensions. Healthy lifestyles have occupied rank 10 out of the 12 ranks associated with sustainability in the healthcare system. Sensitivity analysis shows that the economy captures the maximum focus of the healthcare system. Research and development along with domestic production are key sub-criteria that require healthcare providers to deal with a high level of seriousness. Researchers see the validity of the outcome of AHP through the consistency ratio, which is less than 0.1, as per the procedure; therefore, one can rely on the results of AHP.

Felix Hospital & Sustainability Practices followed in the system

The Felix Hospital is engaged in providing policies for energy-efficient and environmentally friendly hospitals with the

help of the efficient use of natural resources.

Facility Design: Unique semi-circular and rectangular hospital designs have resulted in excellent availability of sunlight in all areas of the hospital. Windows in all rooms helped reduce energy consumption during the day, apart from ensuring day/night orientation for the patients. Double-layered glass with an appropriate refractive index ensures that the heat effect from sun rays is minimal, thus reducing energy consumption.

Designed for natural sunlight and every bed in the ward, intensive care unit (ICU)/OTs (operation theatre (OT)), and other areas. The OPDs and landing space of the fire exit stairs have a glass facade to ensure natural light.

Optimum usage and conservation of energy resources

The hospital has a strategy for optimizing energy savings and usage. The Building Management System manages all Air Handling Units (AHUs), thereby ensuring their effective regulation through a central control point. It also enables efficient time scheduling of AHUs. The schedule for heating, ventilation, and air conditioning (HVAC) operation is based on this requirement. Schedule, control, and recording of the entire HVAC system managed by the Building Management System. Laundry waste condensate steam is used to heat water for patient room service using a heat exchanger. To conserve energy, they follow the schedule for switching ON and OFF lights, auto and parallel operation of chillers and DG Sets, and scheduled operation of the exhaust fans. All split AC were installed in the hospital with 3-to-5-star ratings. Motion sensors were installed in toilets and corridors. Rationalization of parking area light after 8 PM. The hospital has a policy for using energy-efficient equipment. The LED lights in the entire hospital resulted in a monthly saving of 60,600 KW of energy. Variable refrigerant flow A/C units for laboratories, OTs, and ICUs. A steam-water recovery storage tank was installed in the hospital. The Variable Frequency Drive installed in the secondary chilled water

system, which regulates the frequency of the chilled water pump as per the requirement of the chilled water AHU, saves energy automatically. The chiller Pump automatically controls the energy as per the water requirement/ shutdown AHUs. They installed a heat recovery wheel for the OT, AHU, and Treated Fresh Air. The hospital has developed a plan for the use of renewable energy to reduce its impact on the environment and solar water heating system. All high-efficiency particulate air (HEPA) filters are changed every year in all areas that are validated with the dispersed oil particulate (DOP) test. Ventilation systems were designed and maintained according to the infection control standards. Electricity consumption is monitored every month, corrective action is taken accordingly, and electricity consumption is optimal in the Felix Hospital.

Recycling of used items

Use of recyclable/reusable items as far as possible, such as paper and printer cartridges. The hospital follows a "No Mercury Use Policy." Diesel consumption has increased each year as the number of beds has increased, which is why consumption on a per-bed basis is justified.

Optimum usage and conservation of water resources

The Felix Hospital rationalizes water usage for the entire facility, which includes measurement, reduction, and verification. Separate water lines for RO, soft water, and domestic water based on the purpose of use. Pressure tuning of water-supply pipes at different levels. Strict Automation operation control of air conditioning, lighting, lifts, hot water, and generators. Flow restrictors for water taps and showers. Sensor-based urinals for water-flushing systems. STP-treated water was used for flushing in the IPD (Inpatient department) rooms. All water supply systems were metered, and consumption was analyzed on a day-to-day basis. Monthly meetings on energy and water consumption, and budgetary control of consumption.

In Felix Hospital, water consumption decreased from the year 2013 to 2017 by

27%. The hospital has a rainwater harvesting pit for capturing rainwater, recycling water, and so on. Sewerage wastewater was recycled. The hospital used STP Water for gardening, Flushing & HVAC Cooling towers. Surveillance of drinking water was performed on a six-month basis. The Felix Hospital sensitizes staff during the induction of energy and water conservation, and periodic training is organized for staff awareness.

Corporate Social Responsibility

The hospital maintains government parks (two parks) in the surrounding community, covering a total area of 450 square meters. The hospital has an ongoing educational program for the efficient use and conservation of water for all stakeholders (Staff, Patients, and Hospital users). Felix is a hospital that thinks about a society that implements the learning and norms of sustainability with the help of parks and educational initiatives.

Housekeeping Chemicals and Cleaning Agents

Housekeeping Chemicals and Consumables- Felix purchases housekeeping chemicals and consumables only from established and allowed agents. The infection control team approved cleaning and disinfection agents using a proper material safety data sheet (MSDS). All housekeeping cleaning chemicals and agents were stored under lock and key. They used samples of cleaning chemicals taken from approved vendors and were used over a period to see the effectiveness to reduce the repeated changes of vendors. They maintained the cleaning and disinfection of rooms according to the SOP.

From the data from Felix Hospital, it is evident that Felix implements sustainability in its true sense. The Felix Hospital is an example of a sustainable healthcare system in the present scenario. It is adopting clean energy and environmentally friendly policies and tracking the regulatory compliance needed to make the system much more sustainable.

Due to climate change, every healthcare unit is at risk of global temperature rise and increasing greenhouse gas emissions.

Adaptation, mitigation, and innovation are three interventions for climate change risk.

Sensitivity Analysis

The authors conducted a sensitivity analysis of the data gathered from the Felix Hospital. The base data gathered from the Felix Hospital for the sensitivity analysis are given here.

For the base case in the sensitivity analysis, the authors took the patient load as Rs. 3,000 per month. The cost incurred for inpatients and outpatients is INR 5,000 per month. As each hospital pays fees for regulatory compliance, Rs. 20,000 per month. Finally, the cost of procuring equipment and material is Rs. 150,000 per month taken under the cost head. Based on the above costs, Felix Hospital is charging Rs. 6,250 per patient, after maintaining a 25% profit margin. Finally, the net profit obtained in the sensitivity analysis was Rs. 1,193 per patient. The authors ran the sensitivity analysis on the data collected against the different scenarios, given here as follows:

In the first scenario, the costs for inpatients and outpatients increased by 10%, which led to a net profit decrease of 42% from the base case i.e., Rs. 693 per patient). In the second scenario, the cost of compliance increased by 50% and the patient load was reduced by 50%, leading to a 53% decrease in net profit (Rs. 562 per patient). the third scenario, the cost of procuring material increased by 10% and the patient load reduced to 2000 patients per month, resulting 35% decrease in net profit (Rs. 772 per patient).

These three scenarios created a clear picture of sustainability in the healthcare system. This indicates that the highest loss in net profit is due to deviance from environmental sustainability (53%), followed by shortcomings under economic sustainability (42%), and finally, a flaw in social sustainability (35%). Deviance in environmental sustainability is observed because of non-compliance with regulatory norms. Economic sustainability results from high inpatient and outpatient costs. Social sustainability is the impact of high procurement costs and low patient load. The results of the sensitivity analysis are shown in Figure 2.

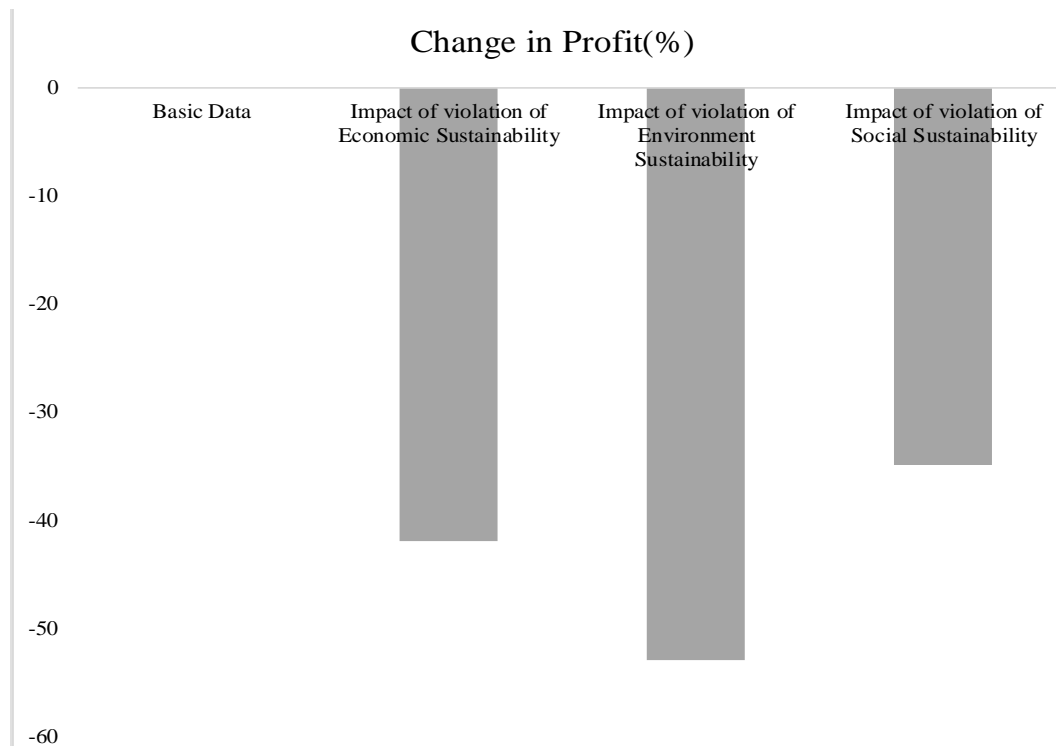


Figure 2. Sensitivity Analysis – Profitability Fluctuation in Three Scenario

Therefore, it can be concluded that sustainability in hospitals is highly dependent on the environment in the first stage, and economic and social sustainability occur in the second and third stages. The same result was achieved using AHP.

Conclusion

Through a literature review, researchers found a gap in healthcare sustainability. As per the objectives of this study, the authors determined the factors associated with healthcare sustainability. These factors are organized in the form of a sustainable healthcare model based on three main criteria (environmental, social, and economic) and sub-criteria for each main criterion. The ranks are determined using AHP. The findings obtained through AHP were validated with the findings of the actual hospital, Felix Hospital, in Delhi NCR. As per the quantitative analysis, the focus is on the environment first, followed by the economic and social dimensions of sustainability, captured through the weighting computed here. The hospital also provides services that are cost-economical to patients and validated with the help of a

sensitivity analysis. Environmental sustainability is another important dimension considered by Felix Hospital, as they have already installed a waste treatment plant to recycle the waste generated at its end. The discharges were checked in a timely manner for all quality parameters. The healthcare system deployed in Felix Hospital is ready to undertake the challenges posed by various risk factors, including the environment, safety, quality services, and economic cost. They have a full-proof team of people dedicated to the procurement of medicines, drugs, equipment, diesel, gas, and other items needed occasionally to run the hospital.

It is very difficult to implement sustainability in the service sector, whether it is healthcare, logistics, the food chain, and so on. However, the key decision makers of the healthcare sector must frame the strategies and policies around the dimensions of sustainability and focus on research and development, recycling programs, justifiable procurement, and domestic production, which has achieved the highest ranks in the AHP computations.

The Felix Hospital uses all natural resources optimally, as indicated by the

data, because the consumption of water, electricity, and diesel reduced drastically over a period. In addition, they follow sustainability in their procurement processes and waste disposal. Apart from this, corporate social responsibility is also in place to sensitize society, employees, and patients toward sustainability goals.

The recommendations of this study indicate that a similar study can be conducted in other parts of India and overseas in the future. This will add interesting facts to the implementation of sustainability in healthcare organizations, which will be worth considering by policymakers.

Abbreviations

WHO: World Health Organization; NCR: North Capital Region; IPD (Inpatient department); Sustainable Development Goals (SDG); Analytical Hierarchy Process (AHP); United Nations (UN); Liquified Crystal Display (LCD); Cathode Ray Triode (CRT); AHU's (Air handling Units); HVAC (heating, ventilation, and air conditioning); Standard Operating Procedure (SOP), RP: Recycling Program, HW: Healthcare waste, EFF: Eco-friendly facilities, JP: Justifiable Procurement, ES: Employee Satisfaction, PS: Patient Satisfaction, CEE: Cost Economic Expenditure, HL: Healthy Lifestyles, GP: Green Practices, RD: Research & Development, IP: Improved Profits, DP: Domestic Production.

Declarations

Ethics Approval and Consent Participant

Respondents were informed before the survey about the survey's objectives and purposes, and verbal consent to participate in the study was obtained from them.

Conflict of Interest

The authors declare that there are no competing financial, professional, or personal interests that might have affected their performance.

Availability of Data and Materials

Data Sharing does not apply to this article, as no new data were created or analyzed in this study.

Authors' Contribution

HG and SG conceptualized the study; UG created the methodology; HG, SG, and UG wrote, reviewed, and edited the manuscript; and HG and SG wrote the original draft.

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