5-13-2024

Strategies to Effectively Manage Hospital Energy Costs With Renewable Energy Technology

Nelli Holtz
Walden University

Walden University

College of Management and Human Potential

This is to certify that the doctoral study by

Nelli Holtz

has been found to be complete and satisfactory in all respects,
and that any and all revisions required by
the review committee have been made.

Review Committee
Dr. Bridget Dewees, Committee Chairperson, Doctor of Business Administration Faculty

Dr. Denise Land, Committee Member, Doctor of Business Administration Faculty

Chief Academic Officer and Provost
Sue Subocz, Ph.D.

Walden University
2024

Abstract

Strategies to Effectively Manage Hospital Energy Costs With Renewable Energy Technology

by

Nelli Holtz

MBA, Walden University, 2017

BA, Portland State University, 2009

Research Project Submitted in Partial Fulfillment

of the Requirements for the Degree of

Doctor of Business Administration

Walden University

May 2024

Abstract

High energy costs and hospital financial solvency have become significant problems for hospitals and community leaders. Hospital managers are concerned with knowing the best uses of renewable energy technology to reduce energy expenditures effectively. Grounded in the diffusion of innovation theory, the purpose of this qualitative pragmatic inquiry study was to explore the strategies hospital leaders use to reduce costs using renewable energy technology effectively. The participants were eight hospital managers from four large and four small hospitals in North Rhine-Westphalia, Germany. Data were collected using semistructured interviews and a review of relevant public records, documents, and literature on renewable energy technology. The data were analyzed using Yin's five-step thematic analysis process, and the following themes emerged: technology involvement, government policy impacts, and energy management concerns. A key recommendation is that hospital managers use photovoltaics to reduce energy use and costs. The implications for positive social change include the potential for other hospital administrators in Germany to use technology to reduce energy costs, improve hospital finances, and offer their patients more cost-effective and better health care services.

Strategies to Effectively Manage Hospital Energy Costs With Renewable Energy Technology

by

Nelli Holtz

MBA, Walden University, 2017

BA, Portland State University, 2009

Research Project Submitted in Partial Fulfillment

of the Requirements for the Degree of

Doctor of Business Administration

Walden University

May 2024

Dedication

I chose to do this project in honor of my son, who has been my biggest inspiration over the years. To get to this point, I had to keep going no matter how difficult things got or how far I had already come. The value of hard work and persistence, as well as the strength of education, are things I'd like my son to pick up on as he grows up.

Acknowledgments

I would want to thank my mother for her unwavering support throughout my doctoral studies at Walden University. It would not have been feasible to complete this educational path as a Doctor of Business Administration without her encouragement and understanding of my studies. She took up numerous family responsibilities and activities to free up time for me to accomplish my academics. Without her, I would be unable to complete my coursework.

Second, I would want to thank all eight volunteers who contributed their important time and honest comments to the project's findings. Without their voluntary cooperation in this project, I would not have had the opportunity to meet these outstanding leaders who are pioneering the contribution of renewable energy technology to the world. Their involvement will undoubtedly contribute to the project's success.

Finally, I would want to thank the lecturers in Walden University's Doctor of Business Administration department for guiding me through my doctoral journey. I would also want to thank Dr. Bridget Dewees, my committee chair, and Dr. Denise Land, my second committee member, for painstakingly leading me through the processes necessary to complete this research. I could not have completed my job without their support and guidance.

Table of Contents

List of Tables

List of Figures

Section 1: Foundation of the Project

Background of the Problem

Europe's business sector experienced a dramatic increase in the cost of electricity, which was exacerbated by the COVID-19 pandemic and the crisis in Ukraine (Borowski, 2022). Simultaneously, energy efficiency (EE) became a primary issue in the European Union (EU; Cámara & Jiménez, 2023). Decarbonization scenarios suggested by the Energy Roadmap 2050 and the European Green Deal included goals to reduce carbon-producing energy consumption by 50% of 2005 levels (Della Valle & Bertoldi, 2022). These goals and changes have impacted how hospitals do business. I designed this qualitative pragmatic inquiry project to explore how successful hospital leaders have responded to such goals.

Businesses face pressure, stemming from rising energy prices and decarbonization policies, to reduce electricity costs and use while maintaining customer services (Borowski, 2022). Hospitals, in particular, demand uninterrupted and high-power supplies, and the life-and-death necessity of their operations makes power use reductions difficult (Hwang et al., 2019). Renewable energy technology could save hospitals money and reduce their environmental impact.

The general business problem was that health care businesses need managers who can reduce or control energy expenses while deploying renewable energy technologies. Even though renewable energy has become popular in society, with some health care institutions using photovoltaics (PVs), also referred to as solar power, the health care

industry has failed to optimize its use of renewable energy technology, especially in larger health care organizations (Seçkiner & Koç, 2020).

Business Problem Focus and Project Purpose

The specific business problem was that some hospital managers lack successful renewable energy technology strategies to manage energy costs effectively. Therefore, the purpose of this qualitative pragmatic inquiry project was to explore the experiences of eight purposefully sampled hospital managers from four large and four small hospitals in North Rhine-Westphalia, Germany, who had successfully used renewable energy technology strategies to manage energy costs effectively.

The participants of this study needed to meet certain criteria to be selected; each of the participants had, at a minimum, the following credentials and experience:

- At least 1 year of experience working as a hospital manager responsible for implementing renewable energy technology to manage energy costs.
- Knowledge of best strategies that can assist during the implementation stage of renewable energy technology.
- Active involvement in programs that support renewable energy technology within their community.

I gained access to the participating managers due to my network ability. Data sources for this project consisted of semistructured participant interviews, publicly accessible documents, and literature about renewable energy technology.

Rogers's (1962) diffusion of innovation (DOI) theory grounded the project. DOI often leads to widespread acceptance of the new concept or tool within an organization or society. In DOI theory, Rogers explained how innovation spreads and which elements influence the diffusion of that innovation, such as, in the case of this project, the hospital managers. Using the DOI lens, I explored how renewable technology spreads through a business by highlighting the most influential people, hospital leaders, in the innovation process.

Research Question

What successful renewable energy implementation strategies do hospital managers use to implement innovation that helps manage energy costs effectively?

Assumptions and Limitations

Assumptions

An assumption is a supposition, a thought that something is true or will happen even when there is no direct evidence to support it (Oxford University Press, 2014). The assumptions in this project included (a) that all hospital managers interviewed would answer knowledgeably and honestly, (b) that I would be able to find knowledgeable and relevant participants who would agree to be part of the study, and (c) that saving energy costs and managing the use of energy remained pertinent to this industry.

Limitations

Anything that cannot or must not go beyond a certain point or level is said to have limitations (Oxford University Press, 2014). Overcoming limitations occurs when

researchers acknowledge them transparently to ensure readers can limit their interpretations and recommendations. I identified multiple limitations in this project. The rapid evolution of renewable energy technologies means the knowledge and data gathered on renewable energy technology in health care facilities may become dated quickly. Thus, this study was limited by the time in which data were collected. Further limitations included geographical boundaries: The project took place in Germany, and the findings may only be transferable to other German hospitals. Qualitative pragmatic research, by nature, uses smaller sample sizes while searching for practical and useful real-world solutions; as such, using small sample sizes is normal but means the findings are potentially transferable but not generalizable.

Transition

In Section 1, I provided a comprehensive introduction to the context of the problem and outlined the main purpose of this project. The problem of excessive energy usage in hospitals was discussed, and I suggested that implementing renewable energy technology can reduce the corresponding high energy costs. Section 1 specifically addressed the issue of high energy consumption in hospitals, and I proposed that the adoption of renewable energy technologies can help mitigate the associated high energy expenses.

Section 2 comprises a comprehensive evaluation of professional and academic literature, specifically focusing on literature related to renewable energy technologies and the conceptual framework employed in this project. In Section 2, I will also provide

suggestions for overcoming the obstacles to implementing renewable energy technology in hospitals. Section 3 will include a discussion of my duties to conduct ethical, credible, and relevant research while providing transparent means to achieve my study's outcomes, and in Section 4, I will present the findings and conclusions of the project.

Section 2: The Literature Review

A Review of the Professional and Academic Literature

In this section, I discuss and analyze previous research that pertains to the DOI theory and the use of renewable energy technology, such as PVs, in hospitals and other locations to control energy expenses. Most research on PVs has focused on smaller health care facilities, like health care centers or small, off-grid hospitals (Seçkiner & Koç, 2020). Larger hospitals still have some space to implement renewable energy technology initiatives. As a result, this literature review also allowed me to identify knowledge gaps regarding using renewable energy technologies in larger hospitals.

Literature Review Organization

The literature review is divided into three overarching topics with several subsections. The first topic discussed is literature covering the conceptual framework of Rogers's DOI theory, which is divided into the following subsections:

- five types of adopters and
- categories of innovation decisions.

Next, literature that describes and analyzes the business problem is divided into the following subsections:

- barriers to the implementation of renewable energy technology and
- the energy use in hospitals and environmental implications.

In the final part of the section, I present resolutions to the business problem in the following subsections:

- funding renewable energy technology,
- the innovation-decision process, and
- the change agents within the hospital setting.

Table 1 presents a quantitative summary of the sources used in this qualitative pragmatic inquiry research project. Most of the articles focused on the topics of sustainability, renewable energy technologies, and energy expenses in hospitals. The geographic scope of the articles spanned Brazil, Kenya, the United States, Italy, Germany, Spain, Greece, and Asian countries. The participants in the previous research were from multiple industries, including transportation, construction, health care, finance, pharmacy, and education. In the literature review, I also included studies that reviewed or analyzed impediments encountered during energy use reductions; the ecological ramifications of substantial energy consumption; DOI theory's five categories of adopters; and the three distinct innovation decisions categorized as authoritative, collective, and voluntary.

Table 1

Synopsis of Sources in the Literature Review

Reference type	Number	< 5 years	> 5 years
Peer-reviewed journal	50	46	4
Book	1	0	1
Total	51	46	5

DOI and the Conceptual Model

The theory of DOI is used to examine the patterns and rates at which new ideas, behaviors, or products spread throughout society (Rogers, 2003). More than 51,000 citations were found in the literature on DOI in the last 50 years (Iqbal & Zahidie, 2022). The prevalence of literature reviewing DOI establishes the theory's credibility and popularity in the academic literature. Rogers (2003) proposed that DOI comprises the four major components of invention, communication, time, and the social system and defined innovation as a new concept or object that a firm attempts to accept or execute; communication as the process through which people convey and receive information to build mutual understanding and knowledge; time passage as the innovation selection procedure, the types of adopters, and the adoption rate; and the social system as any collection of individuals or institutions cooperating to achieve a goal. Every new idea and product has the potential to be improved or reinvented through the DOI process or model.

Reinvention creates new value but may also disrupt the organization by creating radical changes. In the 1970s, the word *reinvention* became popular, defined as the process through which an idea or invention transforms and adapts (Rogers, 2003). For example, Niu (2020) argued that research data management services are highly correlated to the reinvention and production of numerous relevant innovations during the dissemination phase, and the results meant that one idea might diffuse into several innovations. According to these studies, reinvention during the diffusion phase improves an idea or product, might become a catalyst of new ideas or innovations, and should be

considered an intrinsic element of the diffusion process. To spread innovation, however, new idea adoption must occur. The DOI theory includes five adopter types (Rogers, 2003).

DOI Theory's Five Adopter Types

The five types of adopters are innovators, early adopters, early majority, late majority, and laggards (Rogers, 2003). Each type is characterized by thinking style and attitude to risk, among other factors. The five types of adopters influence when and if an innovation is adopted, making them significant to developing new organizational policies and processes. Lund et al. (2020) provided an example that included implementing and adopting artificial intelligence (AI) in libraries, stating that AI-powered indexing tools assign keywords automatically based on concepts identified in a document via content analysis and identify new sources of knowledge from various fields. AI in libraries is essential and helpful because it may minimize errors and inconsistencies in data and facilitate the discovery of new knowledge. Following such examples through their lifestyles helps explain the connection to thinking styles, risk aversion, and adoption phases. For example, early adopters have a great deal of opinion and leadership in the social system; therefore, they may be great at providing advice when new institutional policies or innovations must be implemented. Alternatively, laggards exhibit caution and may resist new policies. Rogers's (2003) DOI adopter classification system is asymmetrical, with three categories to the left and two to the right of "critical mass."

Table 2 shows the characteristics of adopters, while Figure 1 presents the distribution and density of each category.

2

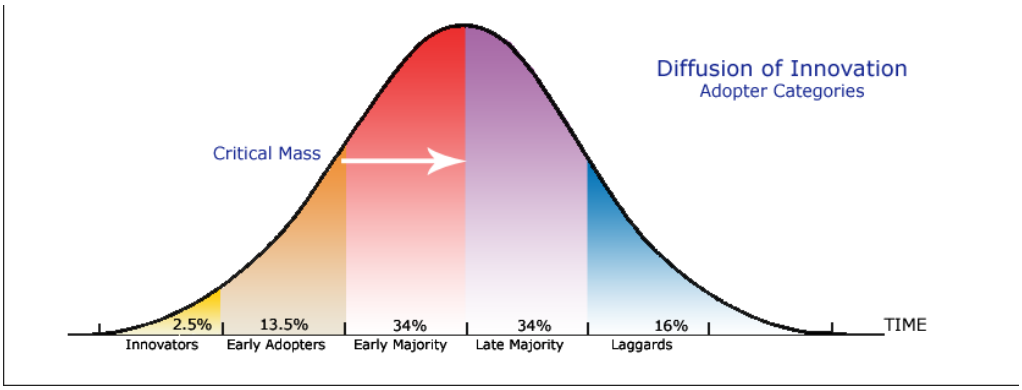
Adopter Characteristics

Adopter category	Characteristics
Innovators	Venturesome. Risk taker and gatekeeper, has financial resources for possible loss, close contact to scientific sources, and interaction with other innovators.
Early adopters	Respect. Opinion leader, enjoying colleagues' esteem and occupying a central position in communication networks for the innovation system.
Early majority	Deliberate. Thoughtful evaluator, connecting early adopters and late majority. Above average social status.
Late majority	Skeptical. Follower, due to economic necessity or peer pressure. Below average social status; in contact with others in late majority and the early majority.
Laggards	Traditional. Change avoider, extremely cautious in adoption due to precarious economic position. Contact with only local and close social networks.

Note. From “Disruptive Innovation From the Perspective of Innovation Diffusion Theory” by J. Ho, 2022, *Technology Analysis & Strategic Management*, *34*, p. 365. (https://doi.org/10.1080/09537325.2021.1901873) Copyright 2022 by Taylor & Francis.

Figure 1

DOIs by Innovator Groups



Note. From "Diffusion of Innovation Theory," by J. Kaminski, 2011, *Canadian Journal of Nursing Informatics, 6*(2), p. 2. (https://cjni.net/journal/?p=1444) Copyright 2011 by Canadian Journal of Nursing Informatics. CC BY-NC 4.0. (Reprinted with permission granted in the license: https://creativecommons.org/licenses/by-nc/4.0/).

Categories of Innovation Decisions

Rogers (2003) divided the adopters into three different categories of innovation decisions: authoritative, collective, and voluntary innovation. A person can accept or reject an optional innovation. When groups agree to adopt or reject an innovation, Rogers called that a *collective innovation decision*, and when those decision groups have power, position, or technical knowledge, these decisions are called *authority innovation decisions*.

Most firms recognize collective and authority decisions as the most frequent innovation decisions (Rogers, 2003). Currie et al. (2021) indicated that, due to the

pressures they experience, managers in higher education frequently seek innovation as an authoritative group. Technological advancements and continuously changing requirements may pressure higher education administrators to innovate, resulting in organizations that are increasingly looking for ways to innovate. Higher education is an example of an authority innovation decision process of a decision made for the entire social system by a few individuals of influence or power. Both Rogers (2003) and Currie et al. emphasized that authoritative decisions are most frequently used within an organization; however, Rogers also confirmed that collective authority decisions are also popular within an organization. The impediments to renewable energy strategy implementation and adoption, which are examined in depth in the next subsection, can be implemented and accepted as authoritative, collective, or voluntary innovation decisions.

The Business Problem

Improving EE in hospitals has long been a priority for hospital administrators. Hospitals consume more energy than any other type of building (Cygańska & Kludacz-Alessandri, 2021). Reynolds (2022) estimated that the U.S. health care systems contribute to approximately 10% of the nation's annual carbon dioxide emissions. The high energy use of hospitals needs innovative solutions, and the use of renewable energy technology could make the health care industry ecologically sustainable and reduce its carbon footprint.

Hospitals run continuously, making the implementation of energy-saving measures problematic. According to Zaza et al. (2022), annual expenditure on energy

consumption in Greek public hospitals surpassed 4% and, in some cases, reached 7% of total annual expenditures for the operation of all health care units. Numerous facilities and departments, such as intensive care, laboratory, pharmacy, and neonatal, contribute to hospitals' high energy consumption. Operating rooms demand enormous amounts of energy (Smedsrud et al., 2021). A study conducted in Germany in 2016 revealed that the electricity consumption in an operating room can range from 364 kWh/m² to 1,275 kWh/m² (Smedsrud et al., 2021).

Hospital administration faces challenges in identifying and implementing efficient measures to reduce the substantial energy expenses incurred by hospitals. Psillaki et al. (2023) recognized the difficulty in finding efficient and dependable solutions and novel approaches to reduce the environmental effect and conserve energy in hospitals known for their high energy consumption. In addition, Hwang et al. (2019) concurred that hospital administration faces challenges in implementing energy-efficient measures because of the diverse operating hours across different departments in the hospital. The clinical laboratory workforce faces obstacles in implementing sustainable policies to reduce energy consumption and minimize environmental harm due to a lack of knowledge and awareness regarding existing sustainability strategies (Molero et al., 2021). These studies demonstrate the challenges health care management faces in developing strategies integrating renewable energy technologies and other sustainability measures to decrease energy consumption in the health care sector.

Hospital radiography departments consume significant amounts of energy. Computed tomography and MRI scanner operations use energy ranging from 0.5 to 30 kWh per examination, with a peak consumption of up to 100 kWh (Heye et al., 2020). Other contributions to energy consumption include elevators, air conditioning, lighting, and ventilation equipment as well as steam, hot water, disinfection, laundry, and kitchens (Shen et al., 2019). The high energy use required by technology or equipment in hospitals contributes to saving lives and will continue. Impediments to the application of renewable energy technology make becoming energy efficient difficult.

These previous studies indicated that hospitals worldwide use a significant amount of energy. The problem exists throughout the United States and Europe. Finding solutions to the problem is imperative, which requires overcoming barriers to implementing renewable energy.

Barriers to the Implementation of Renewable Energy Technology

Dealing with obstacles when planning the implementation of renewable energy technology will require an in-depth comprehension of the hospital management's values, organizational culture, and financial capacity to invest in renewable energy technology. According to Clairand et al. (2020), some obstacles to EE include technical and nontechnical barriers. Other barriers include those that are financial, leadership related, technical related, and design team related (Ebekozien et al., 2022). These various barriers present a real threat to some leaders when trying to implement renewable energy technology strategies to manage high energy consumption within the hospital setting.

The Management Acknowledgment Barrier

When implementing a renewable energy technology, such as solar PV, management must acknowledge the barriers to EE, which can assist with overcoming the barriers to EE. Bagaini et al. (2020) conducted research in eight European countries (i.e., Belgium, Bulgaria, Estonia, Germany, Greece, Italy, Serbia, and the United Kingdom) focusing on the building and transport sectors and confirmed that economic, behavioral, and institutional factors contribute to barriers to EE implementation. One of the most important impediments they found was institutional and economic barriers. Economic barriers were also found to be the most important in limiting technology dissemination. Although PV costs have decreased over the past few years, the initial investment for a hospital can still be substantial. The World Health Organization and the EU health care system have acknowledged the importance of sustainable finance in their efforts to enhance and make the health care system more sustainable (Sepetis, 2020). According to Sepetis (2020), a sustainable hospital is inextricably linked to financial and technological innovation, which ultimately enhances the quality of care and reduces costs. Innovations in technology and finance contribute to the development of the health care system; thus, the financial and economic aspects are one of the most common impediments to the diffusion of renewable energy technology.

The Knowledge of Renewable Energy Technology Barrier

The knowledge gap has also hindered the implementation of renewable energy technology. Żywiołek et al. (2022) confirmed the lack of knowledge and trust in

renewable energy sources. Kalogirou et al. (2021) reported that the nursing community's lack of knowledge of environmentally responsible practices within the hospital is a significant barrier to implementing energy-efficient technology in hospitals. When management intends to implement energy-efficient technologies, it requires the support of the entire management and hospital community within the hospital, which also includes the support and knowledge of all staff. When staff and management understand the barriers to the implementation of renewable energy technology and how implementing the technology can save energy, real change can occur within the hospital community. Barriers to the implementation of renewable energy technology are numerous, and behavioral constraints (Żywiołek et al., 2022) and a knowledge gap (Kalogirou et al., 2021) have detrimentally impacted the implementation of renewable energy technology. As a result, understanding the advantages of renewable energy technology is a crucial hurdle that hospital administration must confront and overcome with suitable measures.

Communication as a Barrier to Energy Efficiency

DOI theory includes communication in its list of adopting factors (Rogers, 2003). According to Palm and Backman (2020), inadequate knowledge and information communication impedes achieving EE in small- and medium-sized businesses. Additionally, Fuah and Ganggi (2022) found that during the DOI in the publication of library science journals, the four DOI elements of communication channels, social systems, time, and innovation determine how electronic journals spread new ideas

through published scientific articles. Media's assistance during the implementation phase acts as a communication diffusion tool; thus, managers would benefit from considering the importance of effective communication because it is essential for those responsible for implementing renewable energy technologies to know how to reach and persuade their target audience.

Ineffective Behavior as a Barrier to Energy Efficiency

Ingrained beliefs can lead to ineffective behaviors that impede the creation of efficient energy systems. Neoclassical economics choose EE if it is considered the most rational choice and believe that there are more reasonable courses of action than investing in renewable energy technology (Della Valle & Bertoldi, 2022). Institutional obstacles influence the perception that there are better options than sustainable corporate innovation. Bocken and Geradts (2020) supported the idea that the capacity to abandon conventional beliefs is a factor that prevents sustainability within an organization. It can take a crisis to prepare leaders of an organization to consider moving to a new process or belief system.

The energy crisis that followed Russia's invasion of Ukraine and widespread energy shortages in many areas of economic and social activity has prompted hospitals to implement more energy-efficient practices (Psillaki et al., 2023). Their research demonstrated that ineffective behavior and belief systems inhibited EE implementation but that an economic or social crisis disrupted familiar beliefs, leading to hospital administrators' willingness to consider energy-efficient technology. Overcoming the

obstacles to the adoption of renewable energy technology is crucial due to the persistently high prices of energy and the substantial environmental consequences for hospitals.

Energy Use in Hospitals and the Environmental Implications

The energy use in hospitals is still very high and an integral part of the healthcare industry. A study that analyzed the EE of 100 hospitals in China concluded that hospitals in southern China use a disproportionately high amount of electricity and that upgrading the air conditioning system is the easiest and quickest way to realize energy savings in a hospital facility (Ji & Qu, 2019). According to Sandin et al. (2019), the energy demand will continue to rise, and a policy shift toward the use of renewable energy technology within the built environment is required to effect change. Innovation is regarded as a propelling force and requirement for overcoming global challenges, one of which is reducing energy consumption (Bilous, 2020). It can be presumed that innovation is a crucial component of implementing energy-saving strategies in hospitals to reduce the high costs of energy. Thus, these studies researchers noted that hospitals are large energy consumers. Hospitals have the potential to reduce their energy consumption by incorporating renewable energy technology into their business strategies, which could reduce their environmental impact.

Although hospitals are implementing energy-efficient strategies, there is still room for hospitals to become more energy-efficient and implement ecological strategies to decrease the negative effects on the environment and save energy costs. Pichler et al. (2019) noted that health care accounts for 5% of the national CO2 footprint in countries

like China and India. Since hospitals are always open, they create 4.4% of all CO2 emissions, with 50% of those emissions coming from the energy they use (Liu et al., 2022). According to a study conducted in six Indian Ocean cities, the yearly demand for cooling energy would rise between 17.1% and 25.4% by 2030, 34.6% by 2060, and 60.8% by 2090 (Aunion-Villa et al., 2021). These studies have verified that energy consumption is enormous and is projected to escalate further, exacerbating the impact of climate change.

As a result of the fluctuating climatic circumstances brought about by climate change, the community has made significant advancements in the adoption of renewable energy technology. Gusc et al. (2022) reported that Sweden and the Netherlands are leading in the adoption of sustainable alternatives, while Poland and Hungary show less enthusiasm for implementing such alternatives. The health care systems of the EU and the World Health Organization have committed to implementing Sustainable Development Goals and incorporating public environmental, social, and corporate governance regulations in hospitals (Zaza et al., 2022). In addition, hospitals have implemented green building certification to decrease operational costs (Abd Rahman et al., 2022). These studies have demonstrated that the issue of excessive energy costs has been recognized both locally and internationally.

Strategies to Solve the Business Problem

Hospitals consume a massive quantity of energy, not only because of the technology required to function but also because of other factors. One of these factors is

hospital occupancy (Liu et al., 2022). Occupancy, climate conditions, and, most notably, temperature data are associated with electricity consumption. Governments and hospital administrations are searching for cost-effective energy solutions to reduce excessive operating expenses, suggesting governments are becoming more involved in the future with hospital energy-efficient technology installation costs (Psillaki et al., 2023). As a result, these researchers found that hospital occupancy drives the amount of energy used in hospitals, but they also propose that alternate funding sources could be a solution to the initial high costs of investing in renewable energy technologies.

When hospital administration evaluates strategies for implementing EE, it may be prudent to seek alternative funding sources. Examples of alternative funding sources are grants, reimbursements, donations, shared-savings agreements, power purchase agreements, and carbon-emission offsets (Sepetis, 2019). Another example of alternative funding sources is when a third-party finances, plans, and installs energy projects under a shared-savings agreement, and the savings generated by those projects are used to pay for the initial investment in renewable energy technology (Sepetis, 2019). However, different funding sources to address the initial high level of investment in renewable energy technologies are not the only solution to the problem; the DOI procedure in hospitals provides some further options.

DOI Process in Hospitals

The current energy crisis allows for innovations and assists management in meeting stakeholder innovations regarding increased quality care through the DOI

process. DOI has been successfully employed in various industries to achieve innovation and adoption of a new product (Parthasarathy et al., 2021). Increasing hospital thermal comfort requires greater desire and openness in installing hybrid photovoltaic thermal and heat pump systems (Abd Rahman et al., 2022). Installing hybrid photovoltaic thermal (PVT) and heat pump systems in a public hospital ward lowered the average temperature from 0.5° C to 3.9° C compared to the baseline temperature (Abd Rahman et al., 2022). The current energy crisis allows for innovations and assists management in meeting stakeholder expectations regarding increased quality care. Thus, these studies confirmed that the DOI method has been employed in numerous industries, that the implementation of renewable energy technology necessitates greater openness and desire on the part of management, and that the good benefits of renewable energy technology implementation may not be undercut.

Renewable energy technologies require patience and persistence from those involved in management and advice and clarity throughout the installation process. Wang et al. (2021) suggested that using the DOI to minimize complexity during the implementation of a pharmacy residency program requires clarification and direction, which would help reduce the complexity of the invention's implementation. The dissemination of innovation theory is a chance to broaden the perspective of renewable energy technology and explore benefits and improvements to the healthcare sector. Dearing and Cox (2018) suggested that accepting a new idea necessitates an influential person in the social system. It involves communicating clearly to other members and

persuading them to adopt the new invention. These researchers suggested that the DOI process minimizes complexity during the implementation process and that the acceptance of innovations requires open-minded and influential leaders within the social system.

The Hospitals. The DOI theory has become an essential component in the spread of renewable energy technology. Few social science theories have had such a lengthy conceptual and empirical research history as DOI (Dearing, 2009). Hospitals progressively incorporate corporate sustainability and sustainable development principles into their business strategies (Borges de Oliveira & de Oliveira, 2022). The adoption and execution of renewable energy technology are critical components of hospital sustainability plans. In an experimental energy consumption study, researchers in Spain discovered that efficient energy management of health care buildings could save up to 6.88kWh/m² per year for buildings larger than 5,000m² with beds (Garcia-Sanz-Calcedo et al., 2018). Therefore, these findings indicated that the DOI hypothesis is based on a solid foundation of conceptual and empirical study and that the deployment of renewable energy technologies in hospitals leads to energy savings.

Financial and Environmental Strategies. The advantages of renewable energy technology may take time, and hospital management should be patient while waiting for the benefits after the DOI process. Based on their analysis, researchers at Jorge de Abreu Regional Hospital, providing care to more than 400,000 people, determined that the hospital would see a positive return on its investment in the PV system within 4 years and 5 months after installation, making the system financially viable (Holzbach et al., 2021).

While DOI theory might be helpful in some contexts, it is essential to remember that not all economies will see the same benefits and results from applying renewable energy technology. Johannsen et al. (2020) found that while the DOI theory works quite well in developed economies, it is less helpful in emerging countries because it is not adapted to the specific difficulties in developing economies. Therefore, these studies have verified that the installation of a PV system typically yields a favorable return on investment within a span of 4 years. However, while the DOI theory is advantageous for promoting the adoption of PV systems, its benefits may not be equally applicable in emerging countries due to their unique challenges.

The Innovation Decision Process

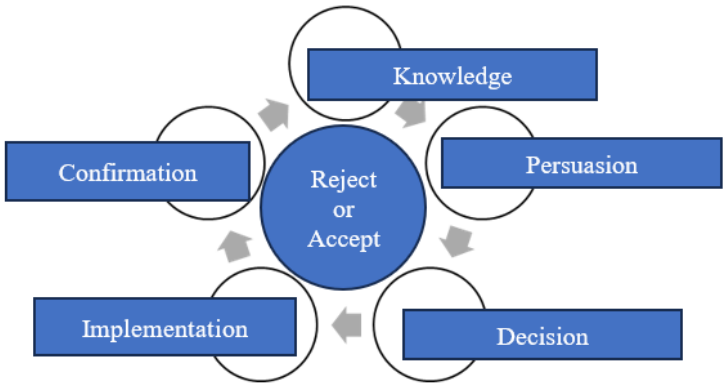
The innovation decision process is a great tool when considering the successful implementation of renewable energy technology. The innovation-decision process is a move by an individual from gaining initial knowledge to developing attitudes about an innovation. The person then decides to adopt or reject the new idea, implement the new concept, and confirm the decision (Rogers, 2003). The innovation decision process is important because it can support or reject implementing renewable energy technologies in hospitals.

Several crucial aspects contribute to the success of the innovation decision process (see Figure 2). Soeiro and Ferreira Dias (2020) concurred that the significance and repercussions of community renewable energy are crucial and necessitate careful consideration during the implementation of renewable energy to save the environment.

To effectively integrate community renewable energy, it is important to educate hospital management on the potential advantages that the program and technology can provide to the community. The DOI process has five stages.

Figure 2

Stages in the Decision Innovation Process



Stage 1: Knowledge. This stage helps to develop hospital management's grasp of how renewable technology might perform within the various departments. This knowledge can be obtained through communication channels and messages sought by administrations (Rogers, 2003). Thus, these researchers confirmed that the successful implementation of renewable energy technology is correlated with the knowledge management holds regarding the community's needs and the potential benefits of renewable energy technologies managers may possess.

Stage 2: Persuasion. Persuasion happens when a person or other decision-making unit develops a favorable or unfavorable attitude toward an innovation (Rogers, 2003). Hospital management is accountable for making favorable or unfavorable decisions about renewable energy technology. Moreover, officials in the country also

play an important role because they have the authority to support comprehensive renewable energy technology in their countries. Disseminating these renewable energy technologies is intimately related to psychological and behavioral aspects, which are part of the persuasion process. This psychological and behavioral component will impact the dissemination of renewable energy technologies and their success (Corbett et al., 2022). Thus, these studies researchers reported that psychological and behavioral aspects within the persuasion stage play a significant role during the DOI process.

Stage 3: Decision. When an individual or any other decision-making unit engages in behaviors that lead to a choice to embrace or reject the innovation, a decision occurs (Rogers, 2003). One of the most recent important decisions made is the energy package, "Clean Energy for All Europeans," which urges citizens to actively participate in the energy transition (Soeiro & Ferreira Dias, 2020). Proactively installing renewable energy technology through the DOI process can result in substantial community improvements. Therefore, these researchers have verified that the decision-making component in the innovation process is crucial and requires the active participation of all stakeholders for the successful execution of an innovation or idea.

Stage 4: Implementation. Implementation occurs when an individual or any other decision-making unit puts a novel notion into action (Rogers, 2003). The execution stage usually immediately follows the decision stage. Postponement of the implementation step may only happen if the technology or product deployed is in short supply.

Stage 5: Confirmation. Confirmation occurs when an individual seeks reinforcement of an earlier made innovation choice, yet they may retract this previous decision if confronted with contradictory information regarding the innovation (Rogers, 2003). The confirmation stage is critical during the innovation-decision process because it can protect the hospital setting from making wrong choices regarding renewable energy technology. Kyriakarakos and Dounis (2020) supported that hospitals play a critical role in society, emphasizing the importance of the confirmation stage in the hospital setting. At this stage, hospital administration must be aware of their impact on the broader societal processes and services related to renewable energy technology. Thus, previous researchers confirmed that a shift in a hospital's economic strategy is essential to embrace sustainable practices that conserve limited resources, and that's where a change agent comes into play.

Change Agents Within the Hospital Setting

Change agents are individuals who can aid in the flow of innovation that should be adopted within the hospital setting and are key in implementing renewable energy technology strategies. During the DOI process, change agents are competent communicators in innovation. Hospital management has several change agent jobs. They develop a need for change, establish an information exchange relationship, diagnose problems, and create an intent to change in clients (Rogers, 2003). They also translate intention into action, stabilize adoption, prevent discontinuance, and achieve a terminal relationship (Rogers, 2003). Due to the existing situation, sustainability, the creation of

projects for effective resource management, clean production, and new rules that apply to all business sectors that generate limitless amounts of trash and negatively influence the environment is required (Manotas et al., 2021).

In adopting renewable energy technology, the change agent, in the second stage, must build a connection based on the sharing of knowledge. The foundation of this connection must be trust and reliability (Rogers, 2003). Transformational leadership can play a significant role in the innovation dissemination process. Transformational leaders are innovative, reliable, and creative (Yang, 2022). Additionally, transformational leaders can create trust between their followers by creating emotional relations with their followers and inspiring greater values and change (Reza, 2019). Thus, according to the findings of these studies, transformational leadership is an important factor in the successful implementation of innovations because the leadership style possesses characteristics that are valuable during the implementation of a new idea. Thus, creative leaders are inextricably linked to the DOI procedure.

Diagnosing issues is the third step for a change agent in the DOI process. Tann (2021) stated that the change agent enjoys diagnosing challenges and is skilled at solving complex problems. For example, hot water used for hygiene purposes accounts for a significant portion of hospitals' overall energy use. Sánchez-Barroso et al. (2020) analyzed 25 hospitals in Extremadura, Spain, with between 15 and 529 beds, and found that all had installed solar thermal energy systems to generate domestic hot water. The study found a payback period of 4.74 years (SD = 0.26) with an annualized rate of 4.29

kWh/€ (*SD* = 0.20) and an investment of 674,423 € yielding 2,895,416 kWh/year of thermal energy (Sánchez-Barroso et al., 2020). The hospital in Spain presents a great example of a change agent who diagnosed the problem and moved on to solve it by installing solar thermal energy systems. Thus, these researchers' studies showed that diagnosing the problem is a crucial part of the actual process of solving the problem and is not separable from each other.

The drive to bring about change is the fourth stage of the change agent role sequence. Rogers (2003) stated that the *bring-about-change* stage is marked by change agents motivating the interest in innovation. During this time, a hospital's competent authority must sell the benefits of renewable energy technology to other hospital staff. Selling the idea of installing PV has been easy due to its nature and declining cost (Gurieff et al., 2020). A hospital's change agent must communicate PV's financial and ecological advantages effectively. The capacity to implement plans is crucial to the fifth phase of the change agent function.

The sixth sequence, under the change agent role throughout the DOI process, stabilizes adoption and prevents discontinuance. This stage involves the change agent to reinforce and stabilize new behavior (Rogers, 2003). For example, this can be done by emphasizing the benefits of lower energy costs through renewable energy technology. Leoni et al. (2021) stated that adopting new managerial practices or replacing existing equipment with more energy-efficient technology is critical during the change process. Thus, these studies researchers showed that it is not only about adopting new and

energy-efficient equipment but also about implementing and maintaining policies within the business that promote EE.

The final step of the change agent position is establishing a terminal relationship. It involves the change agent's ability to make those around him self-sufficient and not rely only on the change agent (Rogers, 2003). All parties' self-reliance in developing and using renewable energy technology is critical because it helps sustain the high success of renewable energy technology within the hospital environment. One integral part of the change agent during the DOI theory is to track the progress and follow up with the success of the implementation of innovation (Sartipi, 2020). Thus, implementing renewable energy technology is greatly aided by the DOI model, which considers crucial aspects, including communication, time, invention, and the social system, with assistance from the change agent, specifically focused on making all parties self-sufficient within the system.

Summary and Conclusion to the Review of the Literature

The research on renewable energy technology solutions and their absence in hospitals is significant as it offers data from multiple scholarly sources regarding its benefits and potential. Effective hospital management has the potential to achieve substantial energy savings, promote sustainable environmental practices, and play a crucial role in fostering the widespread adoption of renewable energy technology in the communities they serve. Rogers's DOI theory is suitable for this research since it elucidates the process by which an innovation disseminates, delineates the factors that

impact the DOI, and identifies the pivotal individuals involved in the dissemination of a novel concept. Additionally, the choice of a qualitative research strategy is suitable for this study since it aims to investigate the problem by seeking to determine the optimal solution. Utilizing a qualitative research approach will facilitate a comprehensive exploration of the subject at hand and enable the investigation of hitherto unexplored aspects of the phenomenon being studied.

Transition

In Section 2 of this study, I presented and analyzed previous research about how to handle the business challenges that certain hospital administrators face. Themes for potential solutions to the business problem described in Section 1 (i.e., some hospital managers lack successful strategies for using renewable energy technology to effectively manage energy costs) were provided from existing research. These themes included taking advantage of alternative funding sources, using the innovation decision process, and acting as change agents within the hospital setting. In Section 2, I also provided context and research-based definitions and use cases of the DOI process and theory as well as described Rogers's (2003) creation of and testing of that theory. The literature review included a description of how the DOI process translates intention into action, stabilizes the adoption of technology implementation, prevents discontinuance, and achieves a terminal relationship (see Rogers, 2003).

In Section 3, I will identify the research project methodology, particularly the project ethics, nature of the project, and discussion about the population, sampling, and

participants. Additionally, the interview process for data collection, including the interview questions, will be provided, as will the process for data organization and analysis techniques, including how I ensured the project had validity and reliability. Member checking, triangulation, and descriptive participant quotes will be described to increase the credibility of the study.

Section 4 will include an overview of the project and a presentation of the findings. Relevant project components, such as the application to professional practice, implications for social change, and recommendations for action, will be described. Finally, in Section 4 I will provide recommendations for further study, a summary, and a conclusion.

Section 3: Research Project Methodology

Section 3 is focused on the research project methodology. Specifically, in this section I describe how I safeguarded the participants and their data in this qualitative pragmatic research project, the eligibility criteria for becoming a participant, and the data instruments and techniques I used to collect data. The last part of Section 3 contains a discussion of the system used to keep track of data and how I analyzed the collected data.

Project Ethics

My role as the researcher in this pragmatic qualitative inquiry project was to conceptualize, design, and implement the project, including data collection. Data were collected using interviews with project participants and the review of publicly accessible website information. I also conducted data analysis and transparently presented the results. Eight hospital administrators were interviewed in person, using semistructured questions to gain insight into properly adopting renewable energy technology solutions for the cost-effective management of energy usage. The early-stage interactions and participation between me and the participants may not be underestimated. Kraft et al. (2020) stated that the first few encounters between the researcher and the participant heavily influence people's attitudes toward the study and willingness to participate; therefore, the success of a study or experiment may depend on the level of interest shown by the participants and the willingness of the researcher to show the necessary respect and transparency in the early stages of interactions.

A preexisting relationship between the researcher and the participants is not always beneficial. According to recent research by Mozersky et al. (2022), of 68 studies assessed, in 84% of cases, the participants and the researcher had no preexisting relationship. Moukarzel et al. (2020) suggested that participants feel more comfortable opening up and disclosing information to a stranger. As a result, I only interviewed hospital administrators with whom I had no prior connection.

The energy crisis in Europe inspired me to focus my doctoral research on this project area. I am dedicated to its success because I have spent the last 5 years working in the health care industry. I am familiar with and concerned about energy use in hospitals and enthusiastically strive to make constructive contributions to the health care community; therefore, this doctoral research project was directed toward the issue of elevated energy costs in Europe's health care sector, specifically in enabling self-sufficiency in energy production. Along with community care, ethical considerations and principles that guided my project played a major role in how I constructed the study.

The National Commission for the Protection of Human Subjects of Biomedical and Behavioral Research (1979) issued *The Belmont Report* to accentuate and summarize ethical guidelines for research involving human subjects to safeguard research participants, particularly in tribal communities. In this project, I ensured that the participants were respected, protected, and treated ethically and humanely throughout the project in alignment with *The Belmont Report*'s considerations and policies. I asked them

to sign an informed consent form that outlined the risks (which were minimal) and potential benefits of the study.

The data collection and analysis techniques employed in this project complied with Walden University's ethical standards. Before beginning the data collection procedures, I received Walden University Institutional Review Board (IRB) approval to conduct the project (IRB Approval No. 01-24-24-0561362). All participants were unpaid volunteers who were not exposed to coercion or other unethical practices. Individual safety is critical to any researcher's research process (Ratnam & Drozdzewski, 2021). Even in minimal-risk studies, such as mine, informed consent forms provide potential participants with information about the research procedures, possible risks and benefits, and their autonomy, or the right to decline to participate or withdraw without penalty after agreeing to participate (see Yusof et al., 2022). Fernandez Lynch (2020) advised researchers to avoid conducting studies that impede participants' ability to withdraw, and Kim et al. (2022) recommended that researchers use open and direct communication throughout the interview to reduce the likelihood of participant withdrawal. My informed consent form contained all the required and recommended information and was approved by the Walden University IRB.

To address any potential participant concerns, I provided the IRB-approved informed consent form to each participant 1 week before their interviews. The interviews only took place after the research participants signed the consent form. Furthermore, at the interview, I informed the participants about the procedures for withdrawing their

participation in the study. This occurred during two distinct phases: Before the study, I reminded them of their ability to withdraw, and again, after the interview, I allowed them to withdraw from the study. No incentives were employed during the participant interviews for this project. Each participant had the contact information for the Walden University IRB, my chair, and myself so they could ask any questions or voice concerns that may have arisen during the study. To my knowledge, no concerns arose with the participants at any time.

To protect their rights and privacy, I ensured that the identities of the participants in this study shall remain undisclosed. Ladis and Zolkefli (2021) observed that the commitment to uphold dignity and confidentiality is a moral duty. *The Belmont Report* established the notion of protecting study participants' privacy through measures such as anonymity and confidentiality (Barrow et al., 2022). To ensure participant confidentiality, I safeguarded all participant data, including protocol transcripts and informed consent forms, by storing them on an encrypted USB drive. The data and the final doctoral project documents will be safely stored for a period of 5 years in a secure location. To maintain the confidentiality of individuals or organizations, I substituted their identities with generic information in every transcript of each interview session. For instance, the code name "P1" was used to refer to the first participant, P2 for the second, and so on. The code sheet providing the names and codes is kept separate from the data and locked. After this project has been published and made available to the public for 5 years, I will erase any participant data and personal information that I obtained.

Nature of the Project

I used a qualitative pragmatic inquiry research design in this study. Bhangu et al. (2023) claimed that qualitative research can help make sense of inherently nebulous concepts, thereby assisting researchers to understand the phenomena under study and the collected data better. Elliker (2022) described some of the importance of qualitative research as its capacity to allow researchers to investigate unknown areas of research, share their results with the public, and spread knowledge. Both Bhangu et al. and Elliker explained that qualitative studies work best when an exploratory investigation of a phenomenon is needed.

Pragmatism is a philosophy and style of thinking and behaving that provides practical and often hands-on advice or solutions to problems experienced in the real world (Safabakhsh, 2023). When combined with a qualitative inquiry research design, pragmatism elevates the exploratory nature of the research method to a design better suited for problems that need strategic solutions; therefore, I deemed the use of a qualitative pragmatic inquiry approach suitable for this study. The study's goal was producing knowledge of how hospital administrators strategically apply successful methods to adopt renewable energy technologies and control high energy expenses. The qualitative pragmatic inquiry approach facilitates constructing a comprehensive analysis by drawing upon existing qualitative methodologies (Ramanadhan et al., 2021). A generic qualitative pragmatic inquiry approach emphasizes comprehending the

phenomena under investigation and helps with interpreting the world and finding answers based on what might work best for the problem or situation under research.

Population, Sampling, and Participants

The population for the study included hospital leaders in Germany. The International Trade Administration (2024) stated that in 2024, 1 in 6 jobs was related to health care, contributing to 12% of Germany's total gross domestic product. Tomaszewski et al. (2020) explained that studying the real-life context of a phenomenon leads to more knowledge; thus, I targeted hospital managers who had real-life knowledge to assist with providing valuable information within the field of renewable energy technology. For this study, participants were purposively recruited from hospitals in Germany. Purposive sampling optimizes the use of scarce resources (Scholtz, 2021). Each of the participants was required to meet the following specific criteria:

- managed a large public hospital (i.e., university clinic), with between 1,400 and 4,400 personnel and a bed capacity of 500 to 800 patients;
- had at least 1 year of experience working as a hospital manager responsible for implementing renewable energy technology to manage energy costs;
- knew at least one or two of the best strategies that could assist during the implementation stage of renewable energy technology.

I selected the participants from four bigger and four smaller hospitals in North Rhine-Westphalia, Germany. To gain access to hospital management with real-life knowledge in implementing renewable energy technology, I used my networking skills.

While I did not have previous relationships with my participants, I strove to create one by inviting them to participate and suggesting we could learn from one another. Both VandeVusse et al. (2021) and Xu et al. (2020) pointed out that participants may be hesitant to give information and contribute data, qualitative research might be difficult, and that to establish a true working relationship, all parties involved must participate voluntarily and without force. By offering to share the results of the study, I explained to the participants that they could use the information that was acquired to develop renewable energy technology in their hospitals, which would benefit their overall hospital strategy.

My chair and I made a final determination that I had achieved an appropriate sample size ($N = 8$) when I reached data saturation, which was two additional participants from my original a priori plan. The saturation of data, which is the point where enough data has been collected to draw an important conclusion about the research topic or when no new codes or themes appear, is an essential process in qualitative research because it facilitates the acquisition of reliable and valid information (Hennink & Kaiser, 2021). Research has indicated that to attain data saturation, an interview sample size ranging from five to 24 is required (Hennink & Kaiser, 2021). Additionally, Guest et al. (2020) determined that data saturation should be assessed after six interviews. Guest et al. and Hennink and Kaiser (2021) concluded that a sample size of about six participants could signal reaching data saturation. In the current study, I realized I had met the data saturation point after interviewing eight leaders of German hospitals.

Data Collection Activities

I was the main instrument for collecting data for this qualitative project. I enhanced the reliability and validity of the data collection instruments by using the member-checking process and the interview protocol to verify the collected data. Semistructured interviews were conducted with eight hospital administrators from four bigger and four smaller hospitals in North Rhine-Westphalia, Germany, who had developed strategies for managing energy expenses using renewable energy technologies. Every participant was provided with a copy of the interview protocol (Appendix A), which detailed the format and anticipated duration of the interview. Additionally, I examined publicly accessible documents and literature on sustainable energy technology that the participants offered. Semistructured interviews, thorough observations, and theory and concept assessments based on reading comprehension are all examples of qualitative data collection approaches (Sharma, 2022).

The Interview Protocol

I used an interview protocol to keep things streamlined, ensure consistency in evaluating each interviewee, and lessen the impact of any inherent biases I could have. The interview protocol consisted of an explanation of the purpose of this research project, the 11 open-ended questions that were asked during the semistructured interviews, and a description of the member-checking process after I conducted the interview. During the creation of the interview protocol, it was crucial to consider the target population and develop open-ended questions to collect rich data (see Dunwoodie et al., 2022).

According to Jacob and Furgerson (2015), an interview protocol is more than just a set of questions to ask a subject during an interview, it also covers the procedural aspects of interviewing, such as what will be said before and after the interview, how informed consent will be obtained, and what data will be collected. Both Dunwoodie et al. (2022) and Jacob and Furgerson confirmed that the development of an interview protocol needs to follow specific guidelines and consider, in particular, the interview participants. I emailed a copy of the interview protocol to each participant before their interview.

Semistructured Interviews

Semistructured interviews, with 11 open-ended questions, were the primary method for collecting data (see Appendix A) in this study. I arranged face-to-face interviews in the project site hospitals at a convenient time for the participants. Each interview was scheduled to last about 1 hour. As recommended by Mashuri et al. (2022), semistructured interviews are attractive due to their capacity to offer flexibility and adaptability while enabling the capture of comprehensive information. When conducting interviews, it is essential to consider the conditions in which they are performed, the level of attentiveness displayed by the researcher, and the interviewer's objectivity (Taherdoost, 2022). Both Mashuri et al. and Taherdoost (2022) confirmed that semistructured interviews offer benefits, such as flexibility and a vast amount of comprehensive information; however, the objectivity of the interviewer and the state of the researcher's attentiveness also determine the final reliability and validity of the collected data.

Interview Questions

1. What strategies do you use in the hospital to manage energy costs?
2. How have you implemented renewable energy technology to manage energy costs in the hospital effectively?
3. What experience do you have with implementing renewable energy technology?
4. What strategies for implementing renewable energy technology have proven to be the most successful?
5. How has renewable energy technology benefited your hospital?
6. In your experience, why has it been beneficial to seek renewable energy technology in addition to saving money and energy?
7. What are the most common misconceptions about EE for hospitals?
8. How does renewable energy technology create positive social change?
9. What are the challenges and barriers to implementing renewable energy technology strategies at your hospital, and how do you overcome them?
10. How did you manage the costs associated with implementing renewable energy technology?
11. Is there anything else you would like to add?

Data Organization and Analysis Techniques

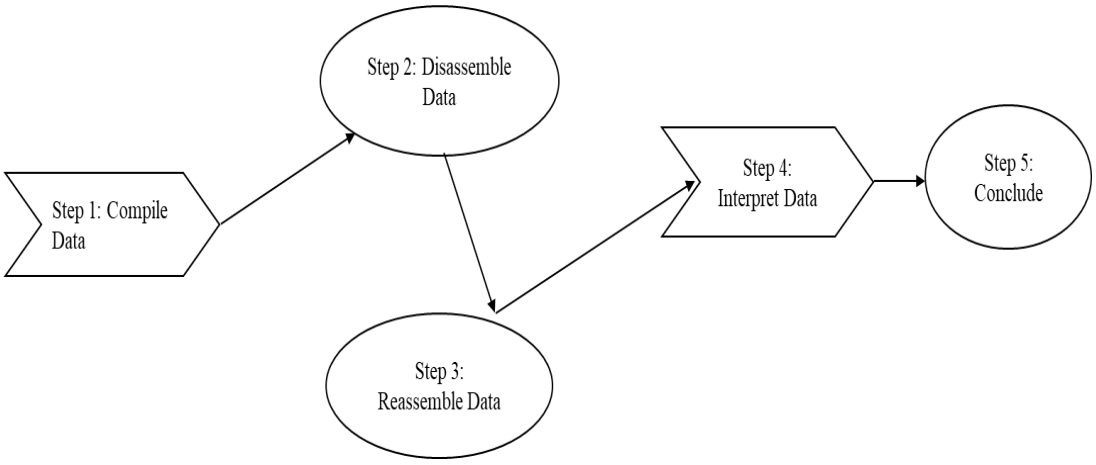
Thoroughly organizing the data collected during the interview can significantly enhance the reliability and validity of the results. Interview data were encoded and

structured using NVivo. Researchers can use NVivo's coding capabilities to effectively organize and comprehend their data through coding (Allsop et al., 2022). NVivo, a computer-assisted qualitative data analysis software tool, has a notable advantage in its capability to ingest and accommodate many formats and data kinds to produce meaningful findings by organizing this data through coding (Dhakal, 2022). Additionally, Nvivo enables researchers to organize the data, expedite data analysis, and enhance research outcome comprehension (Almusallam, 2021). NVivo assists with coding, a process which, for example, involves defining the node structure first and then coding, which expedites the overall analysis process during the research.

Figure 3 illustrates the original, intended approach for data analysis, which was based on Yin's (2018) 5-stage thematic method, where data is obtained, processed, reconstructed, evaluated, and analyzed to make conclusions. These stages were followed in order.

Figure 3

The Five-Phased Thematic Approach by Yin (2018)



First Stage

Initially, I planned to interview six managers, but following solid data saturation practices, I ultimately conducted interviews with eight participants to gather information on the strategies employed by specific hospital administrators to implement renewable energy technologies and minimize energy costs effectively. I also reviewed publicly accessible documents regarding energy technologies as part of data triangulation.

Second Stage

Yin's second stage involves processing the data. I used NVivo software to generate a documented and verifiable audit trail, as Dalkin et al. (2021) recommended, and to disassemble the data into codes. Saldańa (2013) asserted that coding is an essential component of data analysis, but it should not be mistaken for the actual data analysis. Instead, coding helps a researcher explore and discover similar words, ideas, phrases, and perceptions among the participants' transcript data.

Third Stage

This involved reassembling the acquired data. Castleberry and Nolen (2018) stated that reassembling data in qualitative research includes using recurring themes in hierarchies and matrices. I used the node function to employ the NVivo software to generate hierarchies and matrices. The coding structures in NVivo, known as nodes, are categorized as thematic and case nodes (Dhakal, 2022). This classification software enables researchers to link theme data to case data better. This process is (and was) iterative.

Fourth Stage

Data interpretation plays a crucial role in the qualitative research process as it facilitates the identification of novel themes and ideas (Yin, 2018). The data interpretation for this project occurred during the initial three steps of the thematic approach. Castleberry and Nolen (2018) stated that data interpretation in the thematic method occurs throughout the stages of data collection, deconstruction, and reassembly rather than after the analysis process. Therefore, the three first stages of the thematic method cannot be undermined when interpreting the collected data.

Fifth Stage

When making conclusions from the data analysis process, Yin (2018) emphasized identifying the target audience to assist with decisions regarding the presentation of findings. Thus, I focused on presenting the specific data, subjects, and concepts of the community that is driving the advancement of renewable energy technology in the medical field in Germany. I also reviewed how my results compared to previous literature about renewable energy to build upon the current body of knowledge.

Additionally, I used data triangulation to confirm the credibility of the findings from the analysis. Triangulation of data involves using different types of data to investigate a phenomenon and address a research problem (Arias Valencia, 2022). Moreover, data triangulation enhances comprehension by utilizing many approaches to assess the study topic, resulting in a more robust conclusion than relying on a single type of data (Heesen et al., 2019). Thus, I gathered data from various sources to minimize

research bias and ensure my results were credible and trustworthy. I used interview data, member-checked summary reports, the literature from my literature review, and reviews of publicly accessible documentation. I pinpointed the primary themes and established connections between these themes and the existing literature. Mishra and Dey (2022) suggested that incorporating intangible elements into research helps uncover previously overlooked connections. To accomplish this, I engaged in extensive research on climate change, ethical considerations surrounding renewable energy, and the potential ramifications of renewable energy technologies and energy expenses on businesses and local communities to ensure that my findings made sense for practical use in healthcare.

Reliability and Validity

In qualitative studies, reliability and validity are provided in multiple ways. In this section, I describehow the study's credibility and trustworthiness were enhanced.

Reliability

Reliability is paramount in qualitative research as it minimizes errors and biases. While reliability becomes more recognizable when findings across studies are consistent and repeatable (Golafshani, 2003; Yin, 2018), providing and explaining the methods employed to help ensure that the study is credible is an important step. Several steps were taken to make the study reliable, including member checking. According to Motulsky (2021), member checking refers to obtaining feedback from the participants regarding the data obtained or the interpretation of the collected data. An initial analysis of the collected data was shared with the eight hospital administrators who were interviewed to

verify the identification of the strategies used by administrators who effectively implement renewable energy technology to control energy costs. Each verified that the strategies made sense to them.

Dependability

Another practice employed to ensure the study's dependability and trustworthiness was using and following a preplanned and approved interview protocol. Yin (2018) noted that a study protocol helps to dispel the presumption of a poorly documented study within a case study and, therefore, is highly recommended and often required when conducting qualitative research. Further, using the same sets of questions with each participant helped keep the study aligned with the research questions, purpose, topic, and application towards the knowledge gap—member checking and using the interview protocol assisted with the process of dependability.

Dependability in research refers to the consistency of findings when another researcher does a separate investigation and arrives at the same results (Golafshani, 2003). Candela (2019) argued that member checking allows the researcher to make the study more reliable and that the process could be used as a reflective experience for the participants to carry out an individual dependability assessment. Thus, in these studies, researchers reported that the process of member checking and the use of the interview protocol assist with the dependability, reliability, and stability of findings. Another important aspect of qualitative research is the validity of the findings.

Validity

The research's credibility, confirmability, and transferability are all examples of validity. Internal validity refers to the degree to which the data-gathering technique accurately assesses its intended target (Dobakhti, 2020). Multiple methods exist to confirm the authenticity of research work. Yin (2018) identified three types of validity tests: construct validity, internal validity, and external validity. Utilizing internal or external validity during the research process may assist during the data-gathering process in establishing better validity of the research.

The research employed triangulation, which involved utilizing multiple data collection methods to enhance the study's credibility. Data triangulation is a method used to improve the construct validity of research by incorporating several measurements of the same phenomenon from various sources of evidence (Yin, 2018). Triangulation establishes credibility by giving the researcher a complete picture and reducing research bias.

I used triangulation as a method to enhance the level of reliability and validity of the research project. As Thomas and Raheem (2020) defined, data triangulation involves collecting information from many sources to validate data. The overall quality of a case study is improved when multiple sources are used instead of relying just on one source (Yin, 2018). In this project, I used data collected from interviews, documentation provided by hospital management, and past research articles about renewable energy technologies.

In qualitative research, the researcher assesses the transferability of the study's findings. Transferability pertains to utilizing one's research outcomes in a distinct context or with a dissimilar group of individuals (Stenfors et al., 2020). I addressed and enhanced the transferability of the research by providing comprehensive explanations of the study's participants, data collection techniques and procedures, and the hospitals where the research was carried out. Younas et al. (2023) emphasized the necessity of providing a comprehensive account of qualitative findings to enhance the transferability of the study. Thus, the researchers showed that transferability in qualitative research requires a dissimilar group of participants and a thick description of the collected data during the study.

The confirmability of qualitative research is another crucial characteristic of this research project. Data confirmability pertains to the degree to which disparate persons' understandings of identical data can be harmonized Kyngäs et al. (2019). To enhance the confirmability of this research project, I used quotes provided by the respondents. Quotations in qualitative research serve the purpose of accurately representing the informants' experiences, enhancing the work's readability, and elevating the overall quality of the research (Eldh et al., 2020). Thus, these studies suggest that confirmability refers to data checking throughout the data collection process. It can be done by using quotations from the participants in this research project. Data saturation also played a key role in this project because it ensured the validity of the findings.

Data saturation occurs when enough data has been acquired to achieve the appropriate conclusion. Qualitative researchers commonly employ the saturation concept to determine the optimal size of their purposive samples (Hennink & Kaiser, 2021). Once ample data has been collected and analyzed, this stage is referred to as saturation (Chitac, 2022). Data saturation was achieved by thoroughly examining all publicly accessible records from participating hospitals and reviewing pertinent articles comprehensively. Furthermore, I conducted comprehensive interviews with eight hospital administrators with expertise in minimizing energy costs by implementing renewable energy technologies. Saturation-level data is highly dependent on the overall number of participants. Hennink and Kaiser (2021) found that the number of interviews required to reach saturation ranges from five to 24, depending on the specific approach used. They made the determination using 16 different tests. According to the studies, an adequate number of participants is a vital part of reaching data saturation. In this study, data saturation was reached after the eighth interview.

Transition and Summary

The purpose of the qualitative pragmatic inquiry research project was to explore the experiences of eight hospital administrators from four bigger and four smaller hospitals in North Rhine-Westphalia, Germany, who had successfully used renewable energy technology strategies to manage energy costs effectively. Reliability and validity were critical components in making decisions about gathering and creating high-quality data that were dependable, credible, transportable, and confirmable. In Section 3, I

described the data collection and analysis processes, the plan for ensuring the study was valid and reliable, and the data saturation and triangulation processes. In Section 4, I will summarize the research results through a full presentation of the findings. Section 4 will also include pertinent components such as a discussion of how the findings apply to professional practice, the findings' implications for social change, and my recommendations for future research.

Section 4: Findings and Conclusions

Presentation of the Findings

The purpose of this qualitative pragmatic inquiry project was to explore the experiences of eight purposefully sampled hospital managers from four bigger and four smaller hospitals in North Rhine-Westphalia, Germany, who had successfully used renewable energy technology strategies to manage energy costs effectively. I collected the data through in-person interviews, which lasted 30 to 60 minutes with each of the eight participants. All hospital managers had more than 1 year of experience in their positions. In addition to conducting semistructured interviews, I collected data for this project through the review of various relevant public records, documents, and literature on renewable energy technology. Before conducting the in-person interviews, each participant reviewed and signed the informed consent form.

This qualitative pragmatic inquiry study was guided by one research question: What successful renewable energy implementation strategies do hospital managers use to implement innovation that helps manage energy costs effectively? The participants answered 11 open-ended questions. After the interview, I conducted member checking with each participant to review their responses with them using summary information. Participants validated their answers and agreed that their data matched their intended responses. After I validated the summaries, I used Nvivo14 software to align and analyze the collected data. All the collected interview transcripts were uploaded in NVivo14 and coded. Three themes emerged from the data analysis (i.e., technology involvement,

government policy, and energy management) that assisted the managers with implementing renewable energy strategies to manage energy costs (see Table 3). After identifying the three main themes, I ran a matrix coding query to identify patterns and ask a wide range of questions about them. I also analyzed the data using Yin's (2018) five-stage thematic method, methodological triangulation, and member checking.

Table 3

Main Themes

Participants	Technology involvement	Government policy	Energy management
Participant 1	36.29%	0%	0%
Participant 2	12.58%	14.625%	0%
Participant 3	2.18%	3.05%	4.51%
Participant 4	6.72%	7.53%	4.51%
Participant 5	0.55%	10.32%	11.59%
Participant 6	7.52%	9.03%	11.64%
Participant 7	5.19%	7.57%	18.44%
Participant 8	4.83%	1.22%	24.03%

Note. The % explains how frequently the participant made comments related to the themes during their interview.

The overall support and engagement between the various managers concerning renewable energy strategies to manage energy costs can be seen in Table 4. All managers besides P3 reported an overall percentage of over 20% regarding the importance and use of renewable energy strategies to manage energy costs.

Table 4

Importance of Renewable Energy Strategies Reported by Participants

Participants	Percentage
Participant 1	36.29%
Participant 2	27.2%
Participant 3	9.74%
Participant 4	30.78%
Participant 5	22.46%
Participant 6	28.18%
Participant 7	28.64%
Participant 8	30.08%

Theme 1: Technology Involvement

The initial theme that emerged from data analysis was the significance of incorporating technology in the implementation plans of renewable energy to control energy expenses effectively. The matrix coding query results for Theme 1 are displayed in Table 3. Multiple subthemes were recognized within Theme 1, including equipment and technological updates, utilization of solar systems, monitoring equipment, and the integration of AI.

EE is a fundamental aspect of the green building idea and emphasizes the need to use energy-efficient technologies and renewable energy sources to enhance the overall energy performance of a structure (Abd Rahman et al., 2021). According to Abd Rahman

et al. (2021), substituting current chillers with energy-efficient ones equipped with control logic accessories can help reduce energy consumption during operation.

Certain uncomplicated technological advancements may offer convenient and cost-effective methods to enhance the overall EE of a hospital. To transmit heat from a source to a working fluid, a heat exchanger that is efficient in terms of energy consumption is utilized (see Figure 4). A heat exchanger can significantly reduce the energy input of a process, and one way to increase the heat transfer rate of a heat exchanger is to use porous materials in it (Soloveva et al., 2022). Porous metal foams have the potential to play a significant part in lowering energy consumption because their utilization does not necessitate the utilization of external energy (Soloveva et al., 2022). However, uncomplicated technological advancements may offer convenient and cost-effective methods to enhance a hospital's EE while also updating equipment and technology within the hospital.

Figure 4

Heat Exchanger

Note. Reprinted with permission from Dr. Alexander Petrovitch (see Appendix C).

Updating Equipment and Technology

All participants mentioned the importance of updating equipment and technology to save energy costs. P1 explained that when updating new equipment, it is essential to ensure it is more energy-efficient than the old equipment being replaced:

> Part of the tendering process is to ensure that all new devices that are being purchased have a certain savings effect. However, it does not mean that new technology is always more economical. New technology might have so many new functions that compared to the old technology it will have an even higher energy

> need. This is essential to keep in mind when purchasing and updating equipment within the hospital.

P4 noted that "during regular maintenance sessions, they try to install environmentally friendly pumps which are highly efficient pumps that naturally reduce electricity consumption." P6 also described how their hospital was updating equipment, like the ventilation system and their lighting technology, which they have adapted to LED. Although this and other measures have assisted them in saving some energy costs and keeping them on a relatively constant level, the overall trend is that energy consumption is increasing within the hospital due to diagnostic and therapy developments.

The relayed participant experiences regarding updating equipment and technology to save energy costs provided additional insights. The participants mentioned that new technology often uses more energy compared to older devices; thus, while leaders recommended and understood the benefits of updating equipment and technology, they also warned that these updates do not always result in saving energy costs.

PV Use

Six participants mentioned the benefits and use of PVs within the hospital to assist in saving energy costs. Although the benefits were acknowledged, some reluctance persisted due to the high installation costs and long amortization time. P7 shared that:

> We were able to install a PV system with the help of subsidies that were launched last year. However, PV systems have not only become a sign that represents saving energy but also if a PV system is missing on the rooftop of a hospital,

> patients and other citizens will start to question the hospital's overall sustainability strategies.

A statement by P5 showed the support but also the challenge of implementing PV systems on the hospital's roof, stating that, "The hospital took advantage of the subsidies and grants which were used to install the PV system; however, the PV project turned out to be much more expensive and time consuming than expected." P1 indicated,

> Especially in the medical field, it is difficult to rely on renewable energies because we are ultimately end consumers. We query the manufacturer if, for example, they use the sun from solar panels when manufacturing new devices. However, I think the focus of manufacturers is not just on renewable components but on ensuring that the devices work reliably.

The strategies explained by P1, P5, and P7 regarding PV show that it is an important consideration for hospital leaders to include. The experiences of P7 and P5 provided ideas for how grants might assist with PV implementation. Community members have begun to expect that PV options will be used at health care facilities. The experiences of P1 helped explain that hospital managers can drive social change by quizzing the manufacturer regarding their use of renewable components when manufacturing new technology. Using PV can lead to marketing and image benefits for a hospital, although ensuring that ways to monitor use was another strategy raised by the participants.

Monitoring Equipment

The use of monitoring equipment by hospital management has emerged as a convenient and efficient technique to reduce energy expenses and enhance the overall sustainability of the building. To enhance operational efficiency in water-heating systems, the hot-water consumption patterns of customers and the temperature needs for water throughout the year can be assessed (Hohne et al., 2020). The operational efficiency of existing equipment can not only lower energy costs but also make a significant contribution to the environment. Most of the participants interviewed expressed the belief that monitoring equipment is an effective technique for managing energy expenses. P2 said, “During the weekend, the air and the cooling can be turned off without getting into hygienic problems in the unnecessary operating rooms, and on Monday, they are turned up again.”

Other strategies to monitor equipment within the hospital may include turning off unnecessary refrigerators or replacing certain ventilation filters within the hospital. P2 explained,

> We measure, control, and regulate the energy flow within equipment. It might be electricity and water monitoring. This assists with measuring energy consumption and drawing conclusions. The derived conclusion can be used to compare benchmarks with other clinics and evaluate the consumption compared to other clinics’ energy consumption.

Five participants discussed the significance of monitoring equipment and, specifically, the energy consumption of the equipment. One example came from P1 who stated, “Managing equipment is part of the hospital management system, which assists with recording the entire interaction of the technical systems and controlling and regulating them.” The managers’ experiences demonstrated the value and importance of monitoring equipment, and how comparing their systems’ outputs with other hospitals’ benchmarks also provides their essential understanding of their energy consumption and cost savings levels. AI was another topic and subtheme for technology use and can assist with monitoring energy consumption and costs.

AI

AI use was not currently in use for managing energy costs by seven of the participants. Only P2 shared the potential benefits of using AI, reporting that they felt that AI played a role in about 12% of their management processes. P2 stated,

> AI assists within the hospital by shortening the scanning time and organizing the flow of the patients much better which can assist even within the operating room. In the whole run, it assists with saving energy because the processes are running faster and more smoothly.

Effectively managing the introduction of renewable energy technology might be a crucial strategic obstacle. AI can be used to develop a sophisticated coordination system for the implementation of renewable energy technology and the detection of trends within the medical system (Bajwa et al., 2021). Zhang et al. (2022) reported that AI in

renewable energy has experienced significant growth and plays a crucial role in detecting intricate nonlinear data patterns. AI offers numerous advantages in the renewable energy industry, particularly around data analysis, which helps enhance the overall dependability of energy infrastructure. Therefore, while only one participant reported using AI for this purpose, AI may have more applicability as the options for using it increase over time.

Theme 2: Government Policy

The majority of participants expressed a strong interest in exploring subsidies and governmental policies about the development of renewable energy technology. Table 3 shows that 7 out of 8 of the participants acknowledged and experienced the effects of government policies in the implementation of renewable energy technology. Soto et al. (2022) asserted that renewable energy is among the 17 United Nations Sustainable Development Goals. While the government aids with the adoption of renewable energy technologies, hospitals typically face a cumbersome regulatory process when trying to install such technology (Soto et al., 2022).

Subsidies

Seven participants explained that they have taken advantage of subsidies to support their sustainability process within the hospital. P1 reported,

> We have taken advantage of government funding to replace large pumps within the hospital and install a PV system. However, the challenge was the time frame which was provided by the government to obtain the funding. Basically, we were informed by the state government in March or April that we were eligible for the

> funding program. However, it was clear that we had to have built, commissioned, and invoiced by the end of the year. That was basically not feasible, we knew that from the outset.

P2 stated, “To assist the implementation of renewable energy technology, they require subsidies available on a continuous basis and which are not so short term. Germany needs to become less bureaucratic to truly support the EE within hospitals.” P3 shared, “We have very short funding opportunities or long application processes. These are obstacles, because we are basically doing something like this on the side, so we need the appropriate resources to stay on the ball and the required know-how.”

The experiences of the participants highlighted the fact that while there is governmental assistance available for the adoption of renewable energy technology, the assistance requirements are bureaucratic with impractical timelines. Based on several interviews, a change in government policies may be necessary to facilitate the general sustainability of hospitals in Germany.

Theme 3: Energy Management

The third theme that emerged was energy management. This theme was encompassed by three subthemes: structural enhancements, energy stock market/energy audits, and the role of employers and employees.

Structural Improvements

Although structural improvements were part of the energy management strategy, only 4 out of the 8 participants actively invested in them. P5 stated,

> In the area of structural refurbishment, we are gradually refurbishing the building shells. In recent years, we have renovated some roofs and newly insulated them and also created new sealing levels in order to install large-scale PVs in these areas.

P4 explained, “We have insulated the hospital building and installed new windows which provide better insulation.” P3 confirmed that they were planning to get rid of 10-year-old office containers and put those employees in new office buildings that were much more energy efficient to result in more sustainability. Hohne et al. (2020) verified that health care institutions rank as the fifth largest energy consumer within the business sector, both in terms of energy consumption and their contribution to the overall energy usage in the commercial sector, which can reach up to 18%. tructural improvements within the hospital require good organizational skills and the setting of priorities.

Based on the interview data, it appears that hospital managers are eager and willing to conduct structural improvements. However, they need financial resources and government policies that support their energy-efficient improvements and renovation processes. These resources could be found in the stock market or through auditing processes.

Energy Stock Exchange and Energy Audits

According to Abd Rahman et al. (2021), energy management is crucial in public hospitals as it leads to cost reduction by conserving energy and water and employing more effective green technology. Structural enhancements serve as a connection between

energy conservation and improved patient care by providing the availability of additional resources.

Energy audits are an external or internal process that investigates the energy consumption within an organization. Energy audits may assist with creating budgets and consumption targets and assist with switching to renewable energy technology, which saves energy within the hospital. However, only three participants acknowledged the benefits and use of energy audits as a strategy to manage energy costs. P6 reported, “We have been doing energy audits for 8 years which takes place in a 4-year cycle.” P3 explained, “In the past, we have repeatedly had energy audits, i.e., those that are carried out externally.”

Energy audits will increasingly be prioritized in healthcare facilities. Dadi et al. (2022) verified that the heightened emphasis on EE at both the national and international levels has led to a greater spread and advancement of targeted criteria for energy consumption. Nevertheless, there remains a deficiency in sufficient energy performance benchmarks, particularly in Europe (Dadi et al., 2022). Energy audits not only facilitate the implementation of renewable energy technologies but also provide a profitability analysis to achieve a sustainable improvement in efficiency by providing benchmarks.

The energy stock exchange may be regarded as a tool to purchase energy at a reasonable price for hospitals. One participant reported having direct experience with tracking the energy stock exchange to purchase their energy. P3 stated, “Due to the

significant increase in costs, we are monitoring the energy stock exchange and buying directly electricity and gas from the energy stock exchange."

Based on the interview, it appears that hospital management does not commonly monitor the energy stock exchange. However, P3 explained that doing so could be a viable way to reduce the hospital's overall energy expenses. If hospital management prioritizes sustainability as a key goal, they have the option to invest in renewable energy stocks, thus contributing to the fight against climate change. For the remaining participants, however, this was not considered a best practice or strategy they employed. Instead, three participants focused on how the employer and employee relationship and roles could lead to better use of renewable energy technology.

Role of Employee and the Employer

The final subtheme concerning energy management was the role played by both the employer and the employee during the entire process of introducing renewable energy technology. From the perspective of hospital administration, employee engagement was an integral component of the energy management plan. P3 explained, "We conducted an employee survey where employees were directly involved in making energy-saving suggestions." P8 stated, "A key point in the whole process is the employee. It is also the biggest challenge to take the employees along the journey, not just those in nursing or medicine, but everyone else too." A comparison of the participants' perspectives on the significance of employee engagement is presented in Table 5.

Another significant element elicited from the interview data was that the employer had the responsibility to lead the sustainability strategy by example. P8 stated:

> We have to motivate, create awareness, and convince our employees that what we are doing makes sense. I think most of them have understood that something is necessary and just need to be made aware of it from time to time, just as we all need to make ourselves aware of the issue again and again because we also need to question our daily behavior from time to time.

Kalogirou et al. (2021) explained that the nursing community's insufficient knowledge hindered the adoption of energy-efficient technology. Based on the interviews, it is evident that both the employees and the employer have essential roles in implementing renewable energy technologies and initiatives to reduce energy expenses in the hospital. The entire process should be directed by expertise and consciousness and, of course, openness when talking with the workforce. The hospital encompasses the management and the community, consisting of supportive and knowledgeable staff.

Table 5

Importance of Employee Engagement Between the Participants

Participants	Engagement %
P3	14.24%
P5	3%
P8	6.52%

Note. P1, P2, P4, P6, and P7 did not describe this as an essential strategy.

Data Triangulation

Data triangulation was one of my validation processes to ensure that themes and findings were aligned with existing literature and publicly accessible data. The process was done using public websites and literature in the field. The following sections explain how well the findings and themes related to the known information from previous research and public information.

Technological Involvement

I uncovered publicly accessible information on a government website regarding EE in hospitals in Victoria, Australia. The Department of Health (2023) reported the implementation of advanced technology and equipment as a crucial measure in reducing hospital energy expenses. The energy-saving methods used in Victorian public hospitals encompassed installing advanced air-conditioning systems and adopting more efficient lighting solutions, such as LED technology (Department of Health, 2023). Furthermore, energy conservation strategies encompass actions such as enhancing heating, ventilation, and air conditioning systems (Abdulaziz Almarzooq et al., 2022). Out of the eight participants, six confirmed that while some of the savings were insignificant, updating technology and equipment was a primary strategy for decreasing Germany's current high energy costs.

Most studies about PV in health care primarily concentrated on smaller facilities (Seçkiner & Koç, 2020). My research centered on larger hospitals. Moazenzadeh et al. (2022) verified that solar radiation as energy could promote social transformation by

decreasing environmental pollution. As a critical note, they suggested that AI will play a crucial role in advancing this approach, a notion that only one of my participants concurred with.

Government Policies

Critical to the implementation of sustainable practices such as solar, PVs, and renewable energy are properly created government policies. Specifically, subsidies influence the adoption of sustainable hospital practices (United Nations Conference on Trade and Development [UNCTAD], 2023). Government policies can substantially impact how well renewable energy technology is promoted or adopted, particularly in underdeveloped nations (UNCTAD, 2023). The implementation of the Paris Agreement in 2015 resulted in a threefold increase in investments in renewable energy. However, it is noteworthy that most of these investments have been directed towards wealthy countries (UNCTAD, 2023).

To alleviate the financial burden of implementing renewable energy technology, the government must support hospital management through regulations and financing to promote this trend (Psillaki et al., 2023). In addition, government support typically has a beneficial impact on the overall performance of an organization (Zhang et al., 2022). Zhang et al. (2022) proposed that the government's provision of subsidies is essential for establishing a stable financial environment that facilitates the adoption of renewable energy technology. To integrate renewable energy technologies, government money is vital. However, it is crucial to have proper organizational planning and coordination to

ensure that hospitals can access the funds promptly without facing unreasonable deadlines and needless bureaucracy.

Energy Management

Energy management as a theme and an obstacle to the implementation of renewable energy technology has led to an addition to the body of knowledge in this area. The findings of Kalogirou et al. (2021) supported the notion that awareness of environmentally responsible behaviors within the nursing community is essential to success. In addition, Molero et al. (2021) supported the idea that the lack of knowledge and awareness of energy-efficient solutions constitutes a barrier to implementing sustainability policies that aim to lower the overall amount of energy consumed. It is impossible to understate the significance of the manager's function within the organization and the general knowledge production that occurs amongst the various participants within the hospital. Regular monitoring is necessary to achieve the successful deployment of renewable energy technologies. According to Palm and Backman (2020), the strategy for creating awareness will strongly emphasize the importance of communication skills.

Within the framework of the DOI theory, communication is also regarded as a significant component. Rogers (2003) hypothesized and later has shown that communication plays a guiding role in successfully implementing innovations. Information can be transmitted and received more effectively through communication, which is a process.

Correlation of Themes to the Conceptual Framework

Through my research, I identified and classified the participants into four out of five distinct adopter types based on their remarks (see Table 6). Rogers (2003) classified the adopter types as innovators, early adopters, early majority, late majority, and laggards. Using Rogers's categories and definers, I loosely classified the participants into the following categories: innovators, early adopters, early majority, and late majority. Within the group of participants, none exhibited characteristics of laggards. Rogers defined laggards as those who adhere strongly to traditional beliefs and tend to be socially isolated within their networks.

The DOI theory offered a comprehensive framework and valuable insights into how hospital management might effectively introduce renewable energy technologies in the hospital environment to promote innovation. Iqbal and Zahidie (2022) concurred that the DOI theory offers a comprehensive framework for implementing various methods to effect societal transformation. During my study and interviews, I discovered several distinctions and numerous parallels that these managers employed to integrate renewable energy technology and reduce energy expenses. Among the adopters, the most notable distinction was that while all endorsed the innovation, only three participants showed true innovation and could distinguish themselves from the rest. Rogers (2003) classified these innovator types as a cohort characterized by their adventurous nature, willingness to take risks, and enthusiasm for engaging with other innovators. P2, P3, and P8 presented these qualities and showed a nontraditional comprehension of deploying renewable energy

technologies. Several participants from the innovator group advocated for the utilization of AI or expressed a strong belief in the power of widespread networking to bring about substantial transformation within the hospital.

Table 6

Participants and the Categories of Adopters

Participants	Innovator	Early adopter	Early majority	Late majority
1			x	
2	x			
3	x			x
4				
5		x		
6				x
7				x
8	x			
Total	3	1	1	3

Note. $N = 8$. Categories of DOI innovation adoption from Rogers's (2003) theory.

Business Contributions and Recommendations for Professional Practice

My research findings could be relevant in assisting hospital managers in devising efficient strategies for adopting renewable energy technologies and reducing energy expenses. Hospital management can benefit from adopting renewable energy technologies by openly communicating their goals and setting a positive example for the entire hospital population.

To successfully incorporate renewable energy technology within the hospital, the outcomes of this research offered knowledge on how to employ the DOI theory in conjunction with technical involvement, government policy, and energy management, respectively. The results of the study found that the involvement of technology was

significant. Included in these components are: Implementing aspects of AI to manage EE is a method that will lead to success. Moazenzadeh et al. (2022) noted that AI models, also known as empirical models, such as support vector machine combined with a cuckoo search algorithm, which is a multimodel approach, are excellent predictors of the effects of climate change on solar radiation.

When the findings of this study are put into practice, leaders could have higher staff engagement, increased funding, improved awareness of the necessary actions to take within the energy implementation strategy, increased resource accessibility, and hospital sustainability. Awareness of the need for renewable energy is one of the first steps to adopting the necessary behaviors and practices toward greater sustainability. It was established by Bagaini et al. (2020) that social and institutional variables can significantly hamper the implementation of EE. Among the energy management systems that are responsible for driving innovation and social change within the community, the role of the employees and the employee who leads by example came out as significant factors. The findings of this study are pertinent and important, as they contribute to the current body of knowledge regarding how hospitals can utilize renewable energy technologies and save money on energy costs.

Implications for Social Change

The findings revealed effective and essential approaches for hospitals to adopt renewable energy technologies to reduce energy expenses. The findings additionally emphasized that the use of renewable energy technology would provide the hospital

administration with more financial resources that could be allocated towards patient care and enhancing internal hospital operations. Baur et al. (2022) asserted that to attain the German federal government's objective of producing net-zero CO_2 emissions by 2045, a need exists for greater utilization of renewable energies, improved EE, and integrating different sectors.

Renewable energy technology can minimize dependence on fossil fuels and has the potential to cut CO_2 emissions, thus benefiting the environment and moving closer to achieving the net-zero CO_2 goal in Germany. A significant consequence of renewable energy technology is its social impact on the health and well-being of the community. The adoption and utilization of renewable energy technology can potentially impact the cultural values and norms of a community. This, in turn, facilitates the acceptance of renewable energy sources and sustainability. Consequently, it enables the current generation to create healthier communities with more cost-effective health care options.

Recommendations for Further Research

The limitations of the rapidly changing technology, time, location, and sample size indicated in Section 1 persisted unchanged until the study's conclusion. Hence, four suggestions for future research stem from considering ways to overcome some of those limitations. Initially, the participants conveyed that technology is in a perpetual state of evolution and enhancement. Consequently, this implies that future studies could explore various viewpoints from other industries, which may have made faster inroads into studying these topics. Further, the study's scope was constrained by the timeframe in

which the data was gathered and the limited nature of a pragmatic doctoral survey with one researcher. While I did reach data saturation with eight participants, studies with more researchers and participants looking deeper into the solutions offered are warranted.

It is possible that the study's conclusions, derived from the available data, may overlook significant factors, practices, or ideas. Hence, conducting a longitudinal study may be essential to address the research topic comprehensively. While DOI did appear to assist in identifying where each participant fell on the spectrum of innovation, using other frameworks, such as sustainability, change management, or a technology adoption theory, could result in additional findings or findings pertinent to a broader geography. The experiment was conducted in Germany, and the conclusions may solely apply to other hospitals in Germany. Therefore, to enhance the transferability of the findings to different cultures, it is advisable to expand the scope of the study area.

Conclusion

In this study, I employed a qualitative pragmatic inquiry research approach to investigate the reasons behind the absence of effective strategies for renewable energy technologies among hospital management in managing energy expenditures. The study results show that successful adoption of renewable energy technology is characterized by three key themes: active engagement with technology, supportive government policies, and effective energy management. Within the context of technological integration, I observed the following subthemes: equipment and technology updates, utilization of PVs,

monitoring devices, and AI. These subthemes aim to conserve energy and facilitate the adoption of renewable energy technologies.

AI's use appeared particularly promising during the process of dissemination and implementation. The second topic of government policies recognizes the importance of government aid in the form of financial assistance and laws. However, it also acknowledges the potential drawbacks that can arise during this process. The previous subject highlighted that effective energy management is crucial for achieving success. The plan encompassed the involvement of employees and employers, emphasizing the importance of raising awareness to integrate renewable energy technology effectively. Further, it did appear that size mattered in this project. The larger hospitals in the study had better object structures, were more energy efficient, and had more financial support to implement renewable energy technology. Thus, the government findings could guide helping smaller health facilities implement renewable energy plans.

While the DOI theory was crucial in guiding this research into implementing strategies for renewable energy technology, recommendations for future research noted that other theories could also elicit new ideas. The DOI theory addressed the challenges indicated by various stakeholders involved in the process by providing the four essential elements of innovation, communication channels, time, and social system. These elements are necessary to successfully implement a strategy for success. The theory also allowed for categorizing types of innovators, which could give organizations a method

for creating teams of diverse innovation types that might stimulate new and better energy-saving methods.

As leaders strive to communicate the innovation's benefits, advantages, and drawbacks, the DOI framework is considered valuable and appropriate. Transparency, effective communication, and timely coordination were crucial in successfully adopting new methods. These factors facilitated the creation and transmission of shared understanding among stakeholders, helping to ensure a continuous improvement system using gradual versus sudden integration. In turn, leaders can adjust parameters, as noted and as necessary, within their created social system, leading to positive social change through energy renewal and cost savings.

References

Abd Rahman, N. M., Haw, L. C., Jamaludin, M. H., Kamaluddin, K. A., Ahmad Zaidi, T. Z., Hussin, A., Adnan, Y., & Razak, I. S. (2022). Field study of hybrid photovoltaic thermal and heat pump system for public hospital in the tropics. *Case Studies in Thermal Engineering, 30,* Article 101722. https://doi.org/10.1016/j.csite.2021.101722

Abd Rahman, N. M., Lim, C. H., & Fazlizan, A. (2021). Optimizing the energy saving potential of public hospital through a systematic approach for green building certification in Malaysia. *Journal of Building Engineering, 43*, 103088. https://doi.org/10.1016/j.jobe.2021.103088

Abdulaziz Almarzooq, S., Al-Shaalan, A. M., Farh, H. M. H., & Kandil, T. (2022). Energy conservation measures and value engineering for small microgrid: New hospital as a case study. *Sustainability, 14*(4), N.PAG. https://doi.org/10.3390/su14042390

Allsop, D. B., Chelladurai, J. M., Kimball, E. R., Marks, L. D., & Hendricks, J. J. (2022). Qualitative methods with Nvivo software: A practical guide for analyzing qualitative data. *Psych*, *4*(2), 142–159. https://doi.org/10.3390/psych4020013

Almusallam, I. (2021). *Using NVivo for data analysis in qualitative research. King Saud University.* Academic Improvement Committee at English Language & Literature Department Conference. https://doi.org/10.13140/RG.2.2.20913.10082

Arias Valencia, M. M. (2022). Principles, scope, and limitations of the methodological triangulation. *Investigacion & Educacion En Enfermeria, 40*(2), 33–46. https://doi.org/10.17533/udea.iee.v40n2e03

Aunion-Villa, J., Gomez-Chaparro, M., & Garcia-Sanz-Calcedo, J. (2021). Study of the energy intensity by built areas in a medium-sized Spanish hospital. *Energy Efficiency*, *14*(3). Article 26. https://doi.org/10.1007/s12053-021-09944-1

Bagaini, A., Colelli, F., Croci, E., & Molteni, T. (2020). Assessing the relevance of barriers to energy efficiency implementation in the building and transport sectors in eight European countries. *The Electricity Journal*, *33*(8), Article 106820. https://doi.org/10.1016%2Fj.tej.2020.106820

Bajwa, J., Munir, U., Nori, A., & Williams, B. (2021). Artificial intelligence in healthcare: transforming the practice of medicine. *Future Healthcare Journal*, *8*(2), e188–e194. https://doi.org/10.7861/fhj.2021-0095

Barrow, J. M., Brannan, G. D., & Khandhar, P. B. (2022). *Research ethics*. StatPearls Publishing.

Baur, D., Emmerich, P., & Baumann, M. J. (2022). Assessing the social acceptance of key technologies for the German energy transition. Energy, Sustainability and Society, *12*(4). https://doi.org/10.1186/s13705-021-00329-x

Bhangu, S., Provost, F., & Caduff, C. (2023). Introduction to qualitative research methods – Part I. *Perspectives in Clinical Research*, *14*(1), 39–42. https://doi.org/10.4103/picr.picr_253_22

Bilous, L. (2020). Evaluation of the feasibility of implementing innovative energy efficient technologies on the way of economic development of the region. *Eureka: Social and Humanities, 4,* 15–24. https://doi.org/10.21303/2504-5571.2020.001377

Bocken, N. M. P., & Geradts, T. H. J. (2020). Barriers and drivers to sustainable business model innovation: Organization design and dynamic capabilities. *Long Range Planning*, *53*(4). Article 101950. https://doi.org/10.1016/j.lrp.2019.101950

Borges de Oliveira, K., & de Oliveira, O. J. (2022). Making hospitals sustainable: Towards greener, fairer and more prosperous services. *Sustainability, 14*(15), 9730–9751. https://doi.org/10.3390/su14159730

Borowski, P. F. (2022). Mitigating climate change and the development of green energy versus a return to fossil fuels due to the energy crisis in 2022. *Energies, 15*(24), 9289. https://doi.org/10.3390/en15249289

Cámara, J. A., & Jiménez, V. S. (2023). The European Union facing the abyss: Legislative review in the face of the energy crisis, 2022. *Journal of Energy & Natural Resources Law, 41*(3), 335–350. https://doi.org/10.1080/02646811.2023.2177409

Candela, A. (2019). Exploring the function of member checking. *The Qualitative Report, 24*(3), 619-628. https://doi.org/10.46743/2160-3715/2019.3726

Castleberry, A., & Nolen, A. (2018). Thematic analysis of qualitative research data: Is it as easy as it sounds? *Currents in Pharmacy Teaching and Learning*, *10*(6), 807–815. https://doi.org/10.1016/j.cptl.2018.03.019

Chitac, I. M. (2022). The rationale for saturation in qualitative research: When practice informs theory. *Cross-Cultural Management Journal*, *24*(1), 29–35. https://www.ceeol.com/search/article-detail?id=1060257

Clairand, J., Briceno-Leon, M., Escriva-Escriva, G., & Pantaleo, A. M. (2020). Review of energy efficiency technologies in the food industry: Trends, barriers, and opportunities. *IEEE Access, 8*, 48015–48029. https://doi.org/10.1109/ACCESS.2020.2979077

Corbett, C. J., Hershfield, H. E., Kim, H., Malloy, T. F., Nyblade, B., & Partie, A. (2022). The role of place attachment and environmental attitudes in adoption of rooftop solar. *Energy Policy*, *162*, Article 112764. https://doi.org/10.1016/j.enpol.2021.112764

Currie, G., Henderson, A., & Hoult, R. (2021). Diffusion of innovation in an Australian engineering school. *Australasian Journal of Engineering Education*, *26*(2), 219–226. https://doi.org/10.1080/22054952.2021.1979174

Cygańska, M., & Kludacz-Alessandri, M. (2021). Determinants of electrical and thermal energy consumption in hospitals according to climate zones in Poland. *Energies*, *14*(22), Article 7585. https://doi.org/10.3390/en14227585

Dadi, D., Introna, V., Santolamazza, A., Salvio, M., Martini, C., Pastura, T., & Martini, F. (2022). Private hospital energy performance benchmarking using energy audit data: An Italian case study. *Energies*, *15*(3), 806. https://doi.org/10.3390/en15030806

Dalkin, S., Forster, N., Hodgson, P., Lhussier, M., & Carr, S. M. (2021). Using computer assisted qualitative data analysis software (CAQDAS; NVivo) to assist in the complex process of realist theory generation, refinement and testing. *International Journal of Social Research Methodology*, *24*(1), 123–134. https://doi.org/10.1080/13645579.2020.1803528

Dearing, J. W. (2009). Applying diffusion of innovation theory to intervention development. *Research on Social Work Practice*, *19*(5), 503–518. https://doi.org/10.1177/1049731509335569

Dearing, J. W., & Cox, J. G. (2018). Diffusion of innovations theory, principles, and practice. *Health Affairs*, *37*(2), 183–190. https://doi.org/10.1377/hlthaff.2017.1104

Della Valle, N., & Bertoldi, P. (2022). Promoting energy efficiency: Barriers, societal needs and policies. *Frontiers in Energy Research*, *9*. Article 804091. https://doi.org/10.3389/fenrg.2021.804091

Department of Health. (2023, November 10). *Energy efficiency in hospitals.* https://www.health.vic.gov.au/planning-infrastructure/energy-efficiency-in-hospitals

Dhakal, K. (2022). NVivo. *Journal of the Medical Library Association, 110*(2). 270–272. https://doi.org/10.5195/jmla.2022.1271

Dobakhti, L. (2020). The process of enhancing validity, reliability, and ethics in research. *Iranian Journal of Applied Language Studies, 12*(2), 59–88. https://doi.org/10.22111/ijals.2020.5978

Dunwoodie, K., Macaulay, L., & Newman, A. (2022). Qualitative interviewing in the field of work and organisational psychology: Benefits, challenges and guidelines for researchers and reviewers. *Applied Psychology, 72*(2), 863–889. https://doi.org/10.1111/apps.12414

Ebekozien, A., Ayo-Odifiri, S. O., Nwaole, A. N. C., Ibeabuchi, A. L., & Uwadia, F. E. (2022). Barriers in Nigeria's public hospital green buildings implementation initiatives. *Journal of Facilities Management, 20*(4), 586–605. https://doi.org/10.1108/JFM-01-2021-0009

Eldh, A. C., Årestedt, L., & Berterö, C. (2020). Quotations in qualitative studies: Reflections on constituents, custom, and purpose. *International Journal of Qualitative Methods, 19,* Article 160940692096926. https://doi.org/10.1177/1609406920969268

Elliker, F. (2022). Unexplored realities in qualitative research. *Qualitative Sociology Review, 18*(4), 6–16. https://doi.org/10.18778/1733-8077.18.4.01

Fernandez Lynch, H. (2020). The right to withdraw from controlled human infection studies: Justifications and avoidance. *Bioethics, 34*(8), 833–848. https://doi.org/10.1111/bioe.12704

Fuah, S. M., & Ganggi, R. I. P. (2022). The diffusion of innovations elements in library science journals. *E3S Web of Conferences, 359,* Article 03019. https://doi.org/10.1051/e3sconf/202235903019

Garcia-Sanz-Calcedo, J., Al-Kassir, A., & Yusaf, T. (2018). Economic and environmental impact of energy saving in healthcare buildings. *Applied Sciences, 8*(3), Article 440. https://doi.org/10.3390/app8030440

Golafshani, N. (2003). Understanding reliability and validity in qualitative research. *The Qualitative Report, 8*, 597–606. https://doi.org/10.46743/2160-3715/2003.1870

Guest, G., Namey, E., & Chen, M. (2020). A simple method to assess and report thematic saturation in qualitative research. *PLoS ONE, 15*(5), 1–17. https://doi.org/10.1371/journal.pone.0232076

Gurieff, N., Green, D., Koskinen, I., Lipson, M., Baldry, M., Maddocks, A., Menictas, C., Noack, J., Moghtaderi, B., & Doroodchi, E. (2020). Healthy power: Reimagining hospitals as sustainable energy hubs. *Sustainability*, *12*(20), Article 8554. https://doi.org/10.3390/su12208554

Gusc, J., Bosma, P., Jarka, S., & Biernat-Jarka, A. (2022). The big data, artificial intelligence, and blockchain in true cost accounting for energy transition in Europe. *Energies*, *15*(3), 1089–1112. https://doi.org/10.3390/en15031089

Heesen, R., Bright, L. K., & Zucker, A. (2019). Vindicating methodological triangulation. *Synthese, 196*(8), 3067–3081. https://doi.org/10.1007/s11229-016-1294-7

Hennink, M., & Kaiser, B. N. (2021). Sample sizes for saturation in qualitative research: A systematic review of empirical tests. *Social Science & Medicine, 292.* Article 114523. https://doi.org/10.1016/j.socscimed.2021.114523

Heye, T., Knoerl, R., Wehrle, T., Mangold, D., Cerminara, A., Loser, M., Plumeyer, M., Degen, M., Lüthy, R., Brodbeck, D., & Merkle, E. (2020). The energy consumption of radiology: Energy- and cost-saving opportunities for CT and MRI operation. *Radiology, 295*(3), 593–605. https://doi.org/10.1148/radiol.2020192084

Ho, J. C. (2022). Disruptive innovation from the perspective of innovation diffusion theory. *Technology Analysis & Strategic Management, 34*(4), 363–376. https://doi.org/10.1080/09537325.2021.1901873

Hohne, P. A., Kusakana, K., & Numbi, B. P. (2020). Improving energy efficiency of thermal processes in healthcare institutions: A review on the latest sustainable energy management strategies. *Energies, 13*(3), Article 569. https://doi.org/10.3390/en13030569

Holzbach, M., Carvalho, C. C., & Resende, A. S. (2021). Analysis of the economic viability of the installation of a photovoltaic system at Jorge de Abreu Regional Hospital in Sinop-MT. *Renewable Energy and Sustainable Development, 7*(2), Article 43. https://doi.org/10.21622/resd.2021.07.2.043

Hwang, D. K., Cho, J., & Moon, J. (2019). Feasibility study on energy audit and data driven analysis procedure for building energy efficiency: Bench-marking in Korean hospital buildings. *Energies, 12*(15), 3006. https://doi.org/10.3390/en12153006

International Trade Administration. (2024). *Healthcare technologies resource guide.* https://www.trade.gov/healthcare-resource-guide-germany

Iqbal, M., & Zahidie, A. (2022). Diffusion of innovations: A guiding framework for public health. *Scandinavian Journal of Public Health, 50*(5), 533–537. https://doi.org/10.1177/14034948211014104

Jacob, S., & Furgerson, S. (2015). Writing interview protocols and conducting interviews: Tips for students new to the field of qualitative research. *The Qualitative Report, 17*(42), 1–10. https://doi.org/10.46743/2160-3715/2012.1718

Ji, R., & Qu, S. (2019). Investigation and evaluation of energy consumption Performance for hospital buildings in China. *Sustainability, 11*(6), Article 1724. https://doi.org/10.3390/su11061724

Johannsen, R. M., Østergaard, P. A., & Hanlin, R. (2020). Hybrid photovoltaic and wind mini-grids in Kenya: Techno-economic assessment and barriers to diffusion. *Energy for Sustainable Development, 54*, 111–126. https://doi.org/10.1016/j.esd.2019.11.002

Kalogirou, M. R., Dahlke, S., Davidson, S., & Yamamoto, S. (2021). How the hospital context influences nurses' environmentally responsible practice: A focused ethnography. *Journal of Advanced Nursing, 77*(9), 3806–3819. https://doi.org/10.1111/jan.14936

Kaminski, J. (2011). Diffusion of innovation theory. *Canadian Journal of Nursing Informatics, 6*(2). https://cjni.net/journal/?p=1444

Kim, J., Kim, M. G., & Lim, K.-M. (2022). Participation in and withdrawal from cancer clinical trials: A survey of clinical research coordinators. *Asia-Pacific Journal of Oncology Nursing, 9(*4), 197–201. https://doi.org/10.1016/j.apjon.2021.12.015

Kraft, S. A., Duenas, D. M., Lewis, H., & Shah, S. K. (2020). Bridging the researcher-participant gap: A research agenda to build effective research relationships. *The American Journal of Bioethics: AJOB, 20*(5), 31–33. https://doi.org/10.1080/15265161.2020.1745936

Kyngäs, H., Kääriäinen, M., & Elo, S. (2019). The trustworthiness of content analysis. *The Application of Content Analysis in Nursing Science Research,* 41–48. https://doi.org/10.1007/978-3-030-30199-6_5

Kyriakarakos, G., & Dounis, A. (2020). Intelligent management of distributed energy resources for increased resilience and environmental sustainability of hospitals. *Sustainability*, *12*(18), Article 7379. https://doi.org/10.3390/su12187379

Ladis, H., & Zolkefli, Y. (2021). Healthcare students' views on protecting patients' privacy and confidentiality. *International Journal of Nursing Education*, *13*(4), 7–13. https://doi.org/10.37506/ijone.v13i4.16580

Leoni, L., Cantini, A., De Carlo, F., Salvio, M., Martini, C., Toro, C., & Martini, F. (2021). Energy-saving technology opportunities and investments of the Italian foundry industry. *Energies*, *14*(24), 8470. https://doi.org/10.3390/en14248470

Liu, A., Ma, Y., Miller, W., Xia, B., Zedan, S., & Bonney, B. (2022). Energy analysis and forecast of a major modern hospital. *Buildings*, *12*(8), 1116. https://doi.org/10.3390/buildings12081116

Lund, B. D., Omame, I., Tijani, S., & Agbaji, D. (2020). Perceptions toward artificial intelligence among academic library employees and alignment with the diffusion of innovations' adopter categories. *College & Research Libraries*, *81*(5), 865–882. https://doi.org/10.5860/crl.81.5.865

Manotas, E. N., Redondo, R. P., Contreras, J. L., Cardenas, M. J., & Palma, H. H. (2021). Renewable energies and their advantages for the sustainability of companies in the health sector. *International Journal of Energy Economics and Policy*, *11*(5), 531–537. https://doi.org/10.32479/ijeep.9975

Mashuri, S., Rasak, M. S., Alhabsyi, F., & Syam, H. (2022). Semi-structured interview: A methodological reflection on the development of a qualitative research instrument in educational studies. *IOSR Journal of Research & Method in Education, 12*(1), 22–29. https://www.iosrjournals.org/iosr-jrme/pages/vol12-issue1-Series-5.html

Mishra, S., & Dey, A. K. (2022). Understanding and identifying “themes” in qualitative case study research. *South Asian Journal of Business & Management Cases, 11*(3), 187–192. https://doi.org/10.1177/22779779221134659

Moazenzadeh, R., Mohammadi, B., Duan, Z., & Delghandi, M. (2022). Improving generalisation capability of artificial intelligence-based solar radiation estimator models using a bio-inspired optimisation algorithm and multi-model approach. *Environmental Science and Pollution Research International, 29*(19), 27719–27737. https://doi.org/10.1007/s11356-021-17852-1

Molero, A., Calabrò, M., Vignes, M., Gouget, B., & Gruson, D. (2021). Sustainability in healthcare: Perspectives and reflections regarding laboratory medicine. *Annals of Laboratory Medicine, 41*(2), 139–144. https://doi.org/10.3343/alm.2021.41.2.139

Motulsky, S. L. (2021). Is member checking the gold standard of quality in qualitative research? *Qualitative Psychology, 8*(3), 389–406. https://doi.org/10.1037/qup0000215

Moukarzel, S., Mamas, C., Farhat, A., Abi Abboud, A., & Daly, A. J. (2020). A qualitative examination of barriers against effective medical education and practices related to breastfeeding promotion and support in Lebanon. *Medical Education Online, 25*(1). Article 1723950. https://doi.org/10.1080/10872981.2020.1723950

Mozersky, J., Friedrich, A. B., & DuBois, J. M. (2022). A content analysis of 100 qualitative health research articles to examine researcher-participant relationships and implications for data sharing. *International Journal of Qualitative Methods, 21*, 1–9. https://doi.org/10.1177/16094069221105074

National Commission for the Protection of Human Subjects of Biomedical and Behavioral Research. (1979). *The Belmont Report: Ethical principles and guidelines for the protection of human subjects of research*. U.S. Department of Health and Human Services. https://www.hhs.gov/ohrp/regulations-and-policy/belmont-report/index.html

Niu, J. (2020). *Comparing the diffusion and adoption of linked data and research data management services among libraries.* University of Boras, Sweden.

Oxford University Press. (2014). *Oxford advanced learner's dictionary.* https://www.oxfordlearnersdictionaries.com/

Palm, J., & Backman, F. (2020). Energy efficiency in SMEs: Overcoming the communication barrier. *Energy Efficiency, 13*(5), Article 809. https://doi.org/10.1007/s12053-020-09839-7

Parthasarathy, R., Rangarajan, A., & Garfield, M. J. (2021). Implementation of secure health information technology innovations: An extended diffusion of innovations perspective. *E-Service Journal, 12*(3), Article 43. https://doi.org/10.2979/eservicej.12.3.02

Pichler, P.-P., Jaccard, I. S., Weisz, U., & Weisz, H. (2019). International comparison of health care carbon footprints. *Environmental Research Letters, 14*(6), Article 064004. https://doi.org/10.1088/1748-9326/ab19e1

Psillaki, M., Apostolopoulos, N., Makris, I., Liargovas, P., Apostolopoulos, S., Dimitrakopoulos, P., & Sklias, G. (2023). Hospitals' energy efficiency in the perspective of saving resources and providing quality services through technological options: A systematic literature review. *Energies, 16*(2), Article 755. https://doi.org/10.3390/en16020755

Ramanadhan, S., Revette, A. C., Lee, R. M., & Aveling, E. L. (2021). Pragmatic approaches to analyzing qualitative data for implementation science: An introduction. *Implementation Science Communications, 2*(1). https://doi.org/10.1186/s43058-021-00174-1

Ratnam, C., & Drozdzewski, D. (2021). Research ethics with vulnerable groups: Ethics in practice and procedure. *Gender, Place & Culture, 29*(7), 1009–1030. https://doi.org/10.1080/0966369x.2021.1994932

Reynolds, P. (2022). Ambitious climate goals by the numbers: Providence health and services. *IEEE Pulse, 13*(2), 23–25. https://doi.org/10.1109/MPULS.2022.3159067

Reza, M. H. (2019). Components of transformational leadership behavior. *EPRA International Journal of Multidisciplinary Research 5*(3), 119–124. https://eprajournals.com/IJMR/article/1310

Rogers, E. M. (1962). *Diffusion of innovations*. The Free Press.

Rogers, E. M. (2003). *Diffusion of innovations.* The Free Press.

Safabakhsh, E. (2023). Pragmatic or absolute establishment of philosophy. *Eidos, A Journal for Philosophy of Culture, 7*(3), 40–54. https://doi.org/10.14394/eidos.jpc.2023.0032

Saldaña, J. (2013). *The coding manual for qualitative researchers* (2nd ed.). Sage.

Sánchez-Barroso, G., González-Domínguez, J., & García-Sanz-Calcedo, J. (2020). Potential savings in DHW facilities through the use of solar thermal energy in the hospitals of Extremadura (Spain). *International Journal of Environmental Research and Public Health, 17*(8), Article 2658. https://doi.org/10.3390/ijerph17082658

Sandin, S., Neij, L., & Mickwitz, P. (2019). Transition governance for energy efficiency–insights from a systematic review of Swedish policy evaluation practices. *Energy, Sustainability and Society, 9*(1). Article 17. https://doi.org/10.1186/s13705-019-0203-6

Sartipi, F. (2020). Diffusion of innovation theory in the realm of environmental construction. *Journal of Construction Materials, 1*(4-2). 1–7. https://doi.org/10.36756/jcm.v1.4.2

Scholtz, S. E. (2021). Sacrifice is a step beyond convenience: A review of convenience sampling in psychological research in Africa. *SA Journal of Industrial Psychology*, *47*, Article 1837. https://doi.org/10.4102/sajip.v47i0.1837

Seçkiner, S. U., & Koç, A. (2020). Energy applications and studies for healthcare facilities - A systematic review. *Pamukkale University Journal of Engineering Sciences, 26*(4), 838–859. https://doi.org/10.5505/pajes.2019.36845

Sepetis, A. (2019). Sustainable health care management in the Greek health care sector. *Open Journal of Social Sciences, 07*(12), 386–402. https://doi.org/10.4236/jss.2019.712030

Sepetis, A. (2020). Sustainable finance in sustainable health care system. *Open Journal of Business and Management, 8*(1), 262-281. https://doi.org/10.4236/ojbm.2020.81016

Sharma, N. K. (2022). Instruments used in the collection of data in research. *Poonam Shodh Rachna, 1*(1). https://doi.org/10.2139/ssrn.4138751

Shen, C., Zhao, K., Ge, J., & Zhou, Q. (2019). Analysis of building energy consumption in a hospital in the hot summer and cold winter area. *Energy Procedia, 158*, 3735–3740. https://doi.org/10.1016/j.egypro.2019.01.883

Smedsrud, H. S., Xue, K., Yang, Z. R., Stenstad, L.-I., Giske, T. E., & Cao, G. Y. V. (2021). Investigation and prediction of energy consumption at St. Olavs Hospital. *E3S Web of Conferences*, *246*, Article 04003. https://doi.org/10.1051/e3sconf/202124604003

Soeiro, S., & Ferreira Dias, M. (2020). Communality renewable energy: Benefits and drivers. *Energy Reports, 6,* 134–140. https://doi.org/10.1016/j.egyr.2020.11.087

Soloveva, O., Solovev, S., Talipova, A., Shakurova, R., & Zakirov, F. (2022). Estimation of energy efficiency factor for models of porous automotive heat exchangers. *Transportation Research Procedia, 63,* 1081–1088. https://doi.org/10.1016/j.trpro.2022.06.110

Soto, E. A., Hernandez-Guzman, A., Vizcarrondo-Ortega, A., McNealey, A., & Bosman, L. B. (2022). Solar energy implementation for health-care facilities in developing and underdeveloped countries: Overview, opportunities, and challenges. *Energies*, *15*(22), 8602. https://doi.org/10.3390/en15228602

Stenfors, T., Kajamaa, A., & Bennett, D. (2020). How to... assess the quality of qualitative research. *Clinical Teacher, 17*(6), 596–599. https://doi.org/10.1111/tct.13242

Taherdoost, H. (2022). How to conduct an effective interview; A guide to interview design in research study. *International Journal of Academic Research in Management, 11*(1), 39-51. https://ssrn.com/abstract=4178687

Tann, J. (2021). The change agent in innovation. *Prometheus, 37*(1). https://doi.org/10.13169/prometheus.37.1.0044

Thomas, O. O., & Raheem, L. O. (2020). (2020). Triangulation method in management sciences research. *Annals of the University of Craiova*: *Economic Sciences Series, 1*(48), 141–154. https://ideas.repec.org/a/aio/aucsse/v1y2020i48p141-154.html

Tomaszewski, L. E., Zarestky, J., & Gonzalez, E. (2020). Planning qualitative research: Design and decision making for new researchers. *International Journal of Qualitative Methods, 19*, 1–7. https://doi.org/10.1177/1609406920967174

United Nations Conference on Trade and Development. (2023). *World Investment Report 2023*.

VandeVusse, A., Mueller, J., & Karcher, S. (2021). Qualitative data sharing: Participant understanding. *Motivation, and Consent. Qualitative Health Research, 32*(1), 182–191. https://doi.org/10.1177/10497323211054058

Wang, C. Y., Clavarino, A., & Luetsch, K. (2021). The implementation of a pharmacy residency program – A qualitative study on the diffusion of an innovation. *Exploratory Research in Clinical and Social Pharmacy, 3,* Article 100048. https://doi.org/10.1016/j.rcsop.2021.100048

Xu, A., Baysari, M. T., Stocker, S. L., Leow, L. J., Day, R. O., & Carland, J. E. (2020). Researchers' views on, and experiences with, the requirement to obtain informed consent in research involving human participants: A qualitative study. *BMC Medical Ethics, 21*(1), 1–11. https://doi.org/10.1186/s12910-020-00538-7

Yang, L. H. (2022). How transformational leadership contributes to perceived service quality by customers via the mediating effect of organizational innovation within Taiwan telecommunication companies. *International Journal of Organizational Innovation, 15*(2), 190–211. https://www.ijoionline.org/attachments/article/417/1268%20Final.pdf

Yin, R. K. (2018). *Case study research and applications: Design and methods* (6th ed.). Sage.

Younas, A., Fàbregues, S., Durante, A., Escalante, E. L., Inayat, S., & Ali, P. (2023). Proposing the "MIRACLE" narrative framework for providing thick description in qualitative research. *International Journal of Qualitative Methods, 22,* 1–13. https://doi.org/10.1177/16094069221147162

Yusof, M. Y. P. M., Teo, C. H., & Ng, C. J. (2022). Electronic informed consent criteria for research ethics review: A scoping review. *BMC Medical Ethics, 23*(1), 117. https://doi.org/10.1186/s12910-022-00849-x

Zaza, P. N., Sepetis, A., & Bagos, P. G. (2022). Prediction and optimization of the cost of energy resources in Greek public hospitals. *Energies 15*(1), Article 381. https://doi.org/10.3390/en15010381

Zhang, L., Ling, J., & Lin, M. (2022). Artificial intelligence in renewable energy: A comprehensive bibliometric analysis. *Energy Reports, 8*, 14072–14088. https://doi.org/10.1016/j.egyr.2022.10.347

Żywiołek, J., Rosak-Szyrocka, J., Khan, M. A., & Sharif, A. (2022). Trust in renewable energy as part of energy-saving knowledge. *Energies, 15*(4), Article 1566. https://doi.org/10.3390/en15041566

Appendix A: Interview Protocol

Interviewee: Time of Interview: Date:

Position of Interviewee:

The purpose of this qualitative pragmatic qualitative inquiry project is to explore the experiences of eight hospital managers from four bigger and four smaller hospitals in North Rhine-Westphalia, Germany, who have successfully used renewable energy technology strategies to effectively manage energy costs. The interviewees will consist of hospital managers that have successfully implemented renewable energy technology to effectively manage energy costs.

The questions I will ask include:

1. What strategies do you use in the hospital to manage energy costs?
2. How have you used renewable energy technology to effectively manage energy costs in the hospital?
3. What experience do you have with implementing renewable energy technology?
4. What strategies for implementing renewable energy technology have proven to be the most successful?
5. How has renewable energy technology benefited your hospital?
6. Why seek renewable energy technology in addition to saving money and energy?

7. What are the most common misconceptions about energy efficiency for hospitals?
8. How does renewable energy technology create positive social change?
9. What are the challenges and barriers to implementing renewable energy technology strategies at your hospital, and how do you overcome them?
10. How did you manage cost associated with implementing renewable energy technology?
11. Is there anything else you would like to add?

Following each interview, I will express gratitude to the participants for their involvement in this project and reiterate that there are no related incentives for participation. Nonetheless, it is important to note that each participant will receive a summary of the findings during the initial stage of interpretation. Following the initial interview, a subsequent communication will be initiated with each participant a few weeks later, wherein the interview findings will be shared subsequent to their analysis. The proposed strategy entails facilitating individual participants to offer their comments on the analysis and afterwards provide input regarding the veracity of said analysis. The participants will be provided with the opportunity to elucidate any information that they perceive to have been misconstrued.

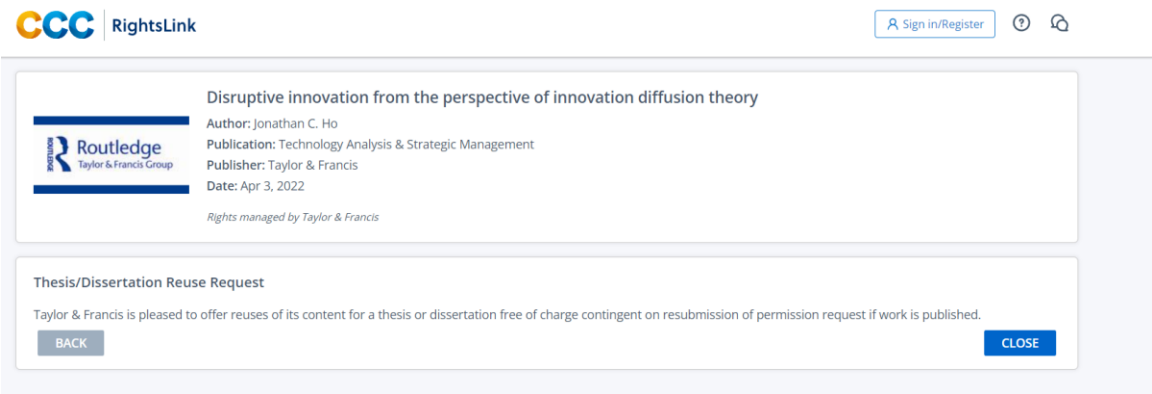
During the process of member checking, the participants will be queried regarding the potential inclusion of additional information that may contribute to enhancing the

clarity, correctness, and relevance of the analysis conducted on the interviews. The inquiries that I shall pose encompass:

1. Is everything correct based on the interpretation derived from the analysis?
2. Are there any interpretations from the analysis that you would question or dispute?
3. What additional information might be useful for the analysis?

I will thank each of the participants and remind them once again that there is no incentive with this project on how some hospital managers lack successful strategies of renewable energy technology to effectively manage energy costs; however, all participants of this project will receive a summary of the final published findings.

Appendix B: Permissions for Table 2



Note. This is the permissions documentation for reproducing Table 2.

Appendix C: Permissions for Figure 4

KREISKLINIKEN HERFORD-BÜNDE (AÖR)

Klinikum Herford

LUKAS KRANKENHAUS BÜNDE

MEDIZIN CAMPUS OWL

RUHR UNIVERSITÄT BOCHUM RUB

AKADEMISCHES LEHRKRANKENHAUS DER RUHR-UNIVERSITÄT BOCHUM

Klinik für diagnostische und interventionelle Radiologie und Neuroradiologie

Chefarzt

Dr. med. Alexander Petrovitch

SEKRETARIAT
Frau Jennifer Iderhoff
Tel. +49 (0)5221 94 24 61
Fax +49 (0)5221 94 21 67
sek1.radiologie@klinikum-herford.de
www.kkhb.de

AMBULANZEN
Privatsprechstunde
Tel. 94 24 61 Fax 94 21 61
MVZ Radiologie
Tel. 94 24 55 Fax 94 21 55

Befundanforderung
Tel. 94 25 16 Fax 94 21 67

Copyright permission

RE: Request for permission to reproduce images in doctoral research project: strategies to effectively manage hospital energy costs with renewable energy technology

Material to be reproduced: Sick-Building Syndrome (SBS) images

Copyright holder: Alexander Petrovitch, MD

Published in: unpublished

I do grant permission for my work to be used for the purpose stated above to Mrs Nelli Holtz, MBA.

Herford, 19.03.2024

Dr. med. Alexander Petrovitch
Specialist in Radiology, Interventional Radiology,
Occupational Medicine and Environmental Medicine
Chairman Clinics for Diagnostic and Interventional Radiology
and Neuroradiology

Note. This is the permissions documentation for reproducing Figure 4.