Leadership and Sustainability: A Sociotechnical Approach to Blue Wrap Waste Management in Healthcare

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On my honor as a University Student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments

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Introduction

Over the past decades, there have been significant increases in environmental challenges, such as climate change, global warming, and pollution. One of the major contributors to environmental degradation is the ever-growing accumulation of solid waste, which leads to soil contamination and the release of harmful chemicals. In the United States alone, more than 290 million tons of solid waste are generated annually. Among these, medical waste accounts for more than 6 million tons, much of which consists of plastic materials. The infectious nature of medical waste and its reliance on single-use plastics further complicate its environmental impact.

A pressing problem within medical waste management is the disposal of sterilization wrap waste. Operating rooms are the second largest source of waste generated by the U.S. healthcare system, and sterilization wrap–commonly known as blue wrap–makes up roughly 19 percent of the total waste in the surgical department (EPA, 2002). Blue wrap, made of SMS polypropylene fabric, produces a significant amount of greenhouse gas (823,000kg of CO2 over 10 years) (Babcock, 2016) and takes hundreds of years to decompose (NAH, 2024). Additionally, due to its material properties, it only allows sterilizing agents to pass through its material once, thus making it impossible to be reused.

To address this issue, several initiatives, including my capstone project, have emerged to reduce, repurpose, and remanufacture blue wrap waste. Currently, the University of Virginia (UVA) collects clean blue wrap through the Medical Equipment Recovery of Clean Inventory (MERCI) team (UVA Health, 2024). However, the recovery rate of clean blue wrap remains low, with most blue wrap still ending up in landfills. Additionally, there are recycling companies, but many of them lack transparency in their data, leaving hospitals hesitant due to a lack of clear

carbon footprint reporting or reliable data (Eburajolo, 2023). Another initiative repurposes blue wrap into tote bags, but durability and practicality concerns limit its marketability, highlighting the need for more sustainable and functional reuse strategies.

The success of these initiatives, however, hinges not only on innovative solutions but also on effective implementation. For example, external government efforts and internal hospital leadership can drive healthcare organizations to adopt sustainable waste practices and foster a sense of collective responsibility among staff, while effective staff engagement and adherence to the protocol can heavily influence the consistent and proper execution of waste management procedures. Among these various factors, I identified hospital leadership to be the primary area to focus on to ensure effective implementation. This research paper explores the impact of hospital leadership on the implementation of waste management initiatives and examines how these insights can be applied to blue wrap waste management efforts at UVA Hospital. This will not only have significant potential in improving blue wrap waste management but also in shaping broader hospital sustainability practices and strengthening hospital leadership strategies for effective sustainability initiatives.

Sociotechnical Context

Hospital leadership plays a crucial role in determining the success or failure of waste management initiatives, yet many struggle to balance sustainability efforts with financial constraints, operational efficiency, and regulatory compliance. Moreover, hospital leadership must navigate other priorities, such as patient safety, infection control, and staff adherence to protocols. Therefore, waste management initiatives often receive less attention than more immediate concerns like providing high-quality patient care and stopping the spread of infectious

diseases.

The challenge extends beyond internal leadership to more complex interconnected stakeholders, each with differing perspectives and priorities on sustainability efforts. Within the hospital system, key social groups include procurement teams and clinical staff, including surgeons and nurses. Procurement teams, such as the MERCI team at UVA Hospital, often lack sufficient resources or support to collect reusable equipment and implement larger-scale waste reduction efforts, thus supporting more robust support from hospital leadership. Clinical staff, while still concerned about sustainability, will prioritize patient care and might be hesitant to changes that can potentially complicate their workflow by introducing additional steps.

Beyond the hospital, external stakeholders, such as policymakers and environmental advocacy groups, also influence hospital leadership in making and implementing waste management initiatives. Policymakers can derive sustainability goals by implementing broader government initiatives or can enforce stricter regulations that can unintentionally hinder the recycling of medical waste. Environmental advocacy groups will push for more sustainable healthcare practices, but hospitals may face backlash if these initiatives are perceived as impractical or compromising operational efficiency. These competing interests create a complex sociotechnical landscape that hospital leadership must balance.

Literature Review

While there is a lot of research on hospital leadership, significant gaps still remain in understanding how this factor affects sustainable waste management initiatives. Especially since the issue of blue wrap waste has not yet been widely studied, there is potential to explore how leadership influences its management efforts. Therefore, this literature review aims to identify

the existing gaps and how they impact the effectiveness of sustainable waste management practices, particularly in blue wrap waste.

Many studies have shown that effective hospital leadership is the key to achieving goals, especially when addressing global environmental challenges. Green leadership is the leaders' ability to influence and mobilize the organization to reach long-term ecological sustainability goals. More specifically, it is guided by four main goals: (1) inspiring a shared environmental vision across the organization; (2) developing effective environmental management approaches; (3) fostering partnerships with stakeholders to address environmental problems, and (4) taking responsibility for environmental education activities. In practice, green leaders serve in multiple key roles as educators, innovators, and motivators. As educators, they internalize the values of environmental care to the organization by providing education. As innovators, they lead the development of creative and eco-friendly solutions. Finally, as motivators, they inspire and encourage individuals to take active roles in advancing the organization's sustainability goals. Through these roles, green leadership can drive meaningful, organization-wide environmental changes (Gultom, 2024).

For instance, Groote Schuur Hospital that implemented green leadership was able to halve the amount of coal and water used, increase recycling by 50 percent over six months, and replace polystyrene cups and packaging with certified recyclable products, meeting the targets set by the Paris Agreement (Weimann & Patel, 2016). Additionally, Susanto and Nopiyanti's study found positive direct effects of leadership, cultural values, and motivation on employee performance in green hospitals, suggesting its importance in enhancing sustainability efforts (2020).

Hospital leadership can also have indirect effects on sustainability efforts. For example,

poor leadership can cause high levels of leadership-induced stress that can negatively impact employees, creating additional challenges (Stordeur et al., 2001). Stress among employees can hinder their ability to effectively follow sustainability initiative protocols and will impact overall organizational performance, including meeting sustainability goals. Moreover, hospital leadership can indirectly affect how stakeholders view and engage with sustainability initiatives. Stakeholders' coordination and cooperation are essential for the successful implementation of sustainability changes and the minimization of unintended consequences (Ryan-Fogarty et al., 2016).

Theoretical Framework

Trevor J. Pinch and Wiebe Bijker's article, *The Social Construction of Facts and Artifacts,* discusses the SCOT theory, a multidirectional approach to technology study (1984). Unlike technological determinism, which is the idea that technology is independent of social influences, the SCOT defines technologies to be shaped not only by technical factors but also by social, cultural, and political influences. They challenged the viewpoint that technology is linearly developed by technical superiority and asserted that different social groups interpret technology differently, giving interpretive flexibility. SCOT also highlights technology in a wider social context, including cultural beliefs and political dynamics, which determine how technology is developed and integrated into society.

Building on this framework, as mentioned above in the background section, different social groups, such as healthcare professionals, procurement staff, and hospital administrators, each play a unique role in how waste reduction initiatives are interpreted and implemented. Recognizing these differing priorities of diverse social groups can impact the effective

implementation of the initiatives through leadership practices that are tailored to each group's specific role (Miamiliotis, 2023). Through the SCOT lens, the project to reduce and remanufacture blue wrap waste emerges as a socially constructed effort, driven by the perspectives and leadership across all levels of the hospital's staff.

In a wider social context, the project is deeply influenced by broader social trends, such as environmental and regulatory mandates. External government efforts, through environmental policies and health regulations, can drive healthcare organizations to adopt sustainable waste practices (Nie, 2014). Internal UVA Hospital leadership plays a role in translating these external pressures into internal practices. They can foster a sense of collective responsibility among staff, shifting organizational culture in a more sustainable way (Sapkota, 2014). This shift not only encourages a sustainable approach to waste management but also contributes to a long-term commitment to initiatives. Additionally, political dynamics and support for sustainable waste management practices, such as incentives and funding, can critically impact the realistic outcome of the project by making implementation more or less feasible (Quinn, 2024).

Overall, the SCOT theory highlights how technology is deeply intertwined with perspectives, social groups, and society. It underscores that waste management is not merely technical solutions but is shaped and sustained through complex social values and dynamics, which collectively determine the success and resilience of the project. As different stakeholders may view and prioritize waste management solutions differently, there is interpretative flexibility, but closure could occur when these stakeholders reach a consensus, solidifying specific sustainable practices as the established norm within UVA Hospital.

Methods

In order to examine the role of internal hospital leadership in the success or failure of waste management initiatives, secondary sources from case studies were used to compare similarities between successful waste management programs. Academic databases, such as Google Scholar and JSTOR, were used to find peer-reviewed literature. Since the topic specifically focuses on internal hospital leadership, the search was narrowed into keywords, such as "hospital administration/leadership and sustainability initiatives" and "impact of leadership on hospital waste reduction." Case studies from different healthcare sustainability organizations were also searched. To have a broader application and representation, the collection was not restricted in terms of geographic regions and was collected from hospitals globally, which helped identify patterns that transcend healthcare systems. Some key elements examined were different leadership structures, such as executive-driven versus distributed leadership models, and the level of leadership engagement in initiatives, which served as a framework for analysis.

For analysis, key leadership traits and institutional factors that contribute to successful waste management programs were identified. These traits were then compared with "best practices that hospital leaders can embrace" suggested by YEL2023, which is the Young Emerging Leaders program initiated by the International Hospital Federation (IHF) in 2023 (IHF, 2023). Finally, these findings were further contextualized within the blue wrap waste management at UVA Hospital. The proposal of leadership-based solutions was suggested to UVA Hospital to enhance blue wrap waste management in a way that aligns with the successful strategies identified in this paper.

Results

The first case study examined the role of hospital leadership at the Royal Brisbane and

Women's Hospital (RBWH) in Queensland, Australia (Irianti, 2016). It primarily used a qualitative inquiry through interviews with hospital personnel and a seven-day observational study to evaluate their successful implementation of waste management systems, including waste collection, segregation, and the 3Rs program (Reduce, Reuse, Recycle). They were known to be the first hospital in Queensland to use an integrated waste tracing system, energy consumption reduction, and waste recycling system. One of its notable initiatives was its sharp waste reduction and safety program through an effective 3Rs program that significantly increased the efficiency as the waste was segregated color-coded and reduced the costs of provision of sharps containers. A key leadership approach at RBWH was the adoption of a distributed leadership model instead of a traditional centralized executive-driven leadership structure. The Waste and Environmental Unit within the hospital was responsible for providing regular consultation and supporting decisions about the proper segregation of waste. They further ensured that hospital personnel, including the clinical staff such as nurses and doctors, were actively engaged in the initiatives. A particularly effective strategy was their unique approach to staff education with a clear and memorable slogan: "*know which bin to throw in*". This slogan, promoted by leadership, was available throughout the hospital facilities, encouraging all staff members to become familiar with the new containment procedures and reinforcing compliance with on-site policies. The study also revealed that it helped foster collective responsibility among staff for the consistent implementation of waste management practices. Throughout the study, the importance of the hospital leadership's role in providing on-site policy and procedures with necessary facilities, regular training, and an induction program was emphasized.

Another case study conducted at Farabi Hospital in Iran focused on leadership adaptability in hospital waste management improvements (Azami-Aghdash et al., 2023). Before

the intervention, the average knowledge of hospital waste management standards was low, and there was a high percentage of general waste, suggesting hazardous and non-hazardous materials were often mixed. Moreover, the incineration of high volumes of waste, especially that of waste bags due to improper separation, caused odor, smoke, and air pollution, which led to danger to public safety and complaints. The intervention included staff training and awareness programs, such as educational workshops and training sessions, and educational materials, like guidebooks, were provided to reinforce learning. Additionally, clinical staff received in-service training in waste separation and disposal. These interventions of the research have led to a significant increase in waste separation and collection compliance and a decrease in waste bags used and total waste volume. This study showed the importance of leadership adaptability, which is the ability of leaders to recognize existing deficiencies, embrace new research and technologies, and adjust organizational practices accordingly to improve. The case study clearly stated leadership commitment, evidenced by the allocation of resources towards staff training and educational initiatives, to be one of the major contributors to the accomplishment. By acknowledging existing shortcomings and embracing innovative solutions, hospital leadership could integrate new research and evidence-based decision-making into waste management initiatives.

The final case study at St.Mary's Regional Medical Center in Maine further exemplified the strong commitment of hospital leadership and a collaborative approach to sustainability (Practice Greenhealth, n.d.). Initially, the hospital faced challenges in regulated medical waste and fluid waste management, which significantly increased both weight and disposal cost. To address this issue, the hospital leadership partnered with the Practice Greenhealth Program, which is a national initiative that provides sustainable resources and best practices for healthcare institutions. The intervention started with interviewing hospital personnel and various

departments, as well as infection control. It implemented an educational campaign targeting staff in the endoscopy and operating rooms, which were responsible for nearly 60 percent of the hospital's regulated medical waste. This campaign not only raised awareness but continuously motivated staff members and monitored the progress, providing both in-person and virtual support to answer any questions in implementing the new waste stream process. As a result, the hospital achieved a 30 percent reduction in regulated medical waste and successfully implemented closed fluid management technologies across the facility. Their case study clearly showcased the pivotal role of hospital leadership that initiated the enrollment of the Practice Greenhealth Program and maintained ongoing collaboration, ensuring not only the immediate waste reduction but also the long-term success of the initiatives.

Discussions & Proposed Solutions

To guide the analysis of leadership strategies in the case studies, this discussion uses the YEL2023 framework. Recognizing the healthcare sector's paradoxical role as both a promoter of public health and a major contributor to climate change, YEL2023 emphasizes the urgent responsibility of healthcare leaders to implement sustainable practices within their organizations. The framework outlines ten key best practices for hospital leaders to transform broad climate change goals into practical leadership decisions. These practices address leadership responsibilities such as integrating sustainability into quality metrics, allocating resources for environmental initiatives, and fostering a culture of innovation and education. A summary of the ten recommended leadership practices from YEL2023 is presented in the following table.

Table 1

Ten Best Leadership Practices for Sustainable Hospitals

Point	Description
1	Support the healthcare workforce to embrace sustainable practices
2	Establish an organizational culture of sustainable healthcare
3	Embrace technology and innovation that supports environmental sustainability
4	Adopt environmentally conscious regulatory frameworks
5	Implement optimal waste management practices
6	Optimize supply chain management
7	Maximize system efficiency and embrace sustainable practices
8	Reduce high-emissions healthcare-related travel
9	Rethink the concept of green hospitals
10	Enhance patient awareness

Note. Adapted from YEL2023 best practices for hospital sustainability

In analyzing the three case studies, a notable commonality emerges in supportive leadership that fosters staff involvement and promotes sustainable organizational culture, which closely aligns with Point 1 (supporting healthcare workers) and Point 2 (establishing organizational culture) of the YEL2023 report. Moreover, all three hospital leaderships have successfully embraced innovation (Point 3) and implemented optimal waste management practices (Point 5). However, each institution demonstrates unique priorities. RBWH places a stronger emphasis on Point 2 with its unique slogan approach and Point 5 with the 3Rs program. On the other hand, Farabi Hospital focuses more heavily on Point 1, especially through its extensive staff training, and Point 3 by integrating new action research into its waste

management efforts. Similarly, St.Mary's Regional Medical Center emphasizes Point 1 through its targeted staff training and hands-on support for healthcare workers, as well as Point 3 by collaborating with external sustainability programs like Practice Greenhealth and adopting the new fluid management technologies.

These strategies can be applied to blue wrap waste management at UVA Hospital through a structured, leadership-driven approach. Currently, at UVA Hospital, there is no policy or guidance on segregation or recycling blue wrap. All blue wrap is discarded with other medical waste, leaving nurses solely responsible for its disposal. UVA Hospital leadership can implement structured training programs, as seen at Farabi Hospital and St.Mary's Regional Medical Center, to equip staff with the necessary knowledge and proper blue wrap segregation technology. Moreover, establishing a dedicated blue wrap waste management team, similar to RBWH's model, could ensure accountability and foster a hospital-wide culture of sustainability. Additionally, UVA Hospital leadership should be supportive of innovation that explores alternatives to blue wrap, such as reusable sterilization containers and possibly collaborating with external sustainability initiatives to improve its efficiency. This recommendation is based on the success observed at St. Mary's Regional Medical Center, where adoption of new innovations like fluid management technologies through external collaboration significantly advanced their sustainability efforts. By embracing technological innovation, UVA Hospital can similarly accelerate its progress toward reducing reliance on disposable blue wrap.

Some of the key points from the YEL2023 that were not fully utilized or demonstrated in the case studies include Point 6 (optimizing supply chain management) and Point 10 (Enhancing patient awareness). Therefore, applying these strategies to blue wrap waste management at UVA Hospital could mitigate the existing gaps in sustainability efforts. To achieve Point 6, UVA

Hospital leadership should first assess the carbon impact of blue wrap to identify areas where supply chain emissions can be reduced. Moreover, they could implement policies that prioritize purchasing from suppliers who have sustainable practices in place, such as using biodegradable or recyclable packaging for blue wrap. For Point 10, UVA Hospital leadership can integrate sustainability messaging into patient communication, such as appointment reminders, pre-surgical information, and newsletters, which can encourage them to support the hospital's sustainability efforts. In addition to patient communication, UVA Hospital leadership can display informational posters in common areas to visually highlight their sustainability commitment. These displays could not only educate patients and encourage behaviors that minimize environmental impacts but also foster a sense of organizational collectiveness. By visibly promoting the importance of blue wrap waste reduction, these posters can inspire both patients and staff to actively engage in reducing waste. Hospital staff can be reminded of their collective responsibility to implement these initiatives, creating a culture where sustainability is a shared goal across all levels of the institution, reinforcing Point 2 of YEL2023 as well.

Conclusion

The increase in global awareness of environmental sustainability has brought significant attention to medical waste management, particularly blue wrap waste, which remains a challenge for hospitals globally. Hospital leadership plays a critical role in shaping sustainable healthcare practices and implementing new initiatives. This study, through the literature review of three hospital case studies—Royal Brisbane and Women's Hospital, Farabi Hospital, and St. Mary's Regional Medical Center—demonstrates how hospital leadership can align with the principles outlined in the YEL2023 report to support sustainable healthcare practices. The findings from

this study give valuable insights that can be applied to blue wrap waste management at UVA Hospital by various leadership-driven approaches, such as implementing structured training programs and creating blue wrap-dedicated waste management teams. However, despite these strategies, a gap remains in fully understanding and navigating the complex network of social groups within and outside of a hospital. Therefore, further research is needed to bridge these gaps and foster collaboration among stakeholders, ultimately reaching closure. By addressing these, healthcare institutions can significantly reduce ever-increasing blue wrap waste and move closer to achieving a more sustainable healthcare environment.

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