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Recycling hospital glass waste by crushing and incorporating into construction materials at Baptist hospital Mutengene.

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Abstract

Introduction

Hospital waste is any material, substance, or by-product that is discarded or no longer useful, which is generated during the diagnosis, treatment, or immunization of human beings or animals, as well as in research activities about medical care.

Project Design

The project design included a needs assessment, a feasibility study, the establishment of the collection system, and the crushing unit. Also, we have quality control, partnerships for the initiative, and the handling and transportation of materials. Monitoring and evaluation of the processes, compliance with regulations as well as a sustainability plan are indispensable in the project design. Another key aspect of this design and implementation strategy will be documentation and reporting. Intentionally engaging the community of health care workers who are the primary stakeholders, is central to the success of the project.

Project results

One of the noteworthy outcomes of the project was the innovative use of recycled glass aggregate in the creation of pavement tiles. These tiles, crafted from recycled materials, represent a sustainable and environmentally friendly alternative for hospital walkways. By repurposing glass waste into functional and aesthetically pleasing tiles, the hospital contributes to the beautification and enhancement of its infrastructure while simultaneously addressing waste management challenges. Throughout the project implementation phase, necessary records were maintained to track the quantity of glass waste processed and recycled. These records serve as a valuable resource for monitoring progress, evaluating the effectiveness of the recycling efforts, and informing future decision-making processes.

Conclusion

Recycling glass waste for the production of aggregate presents a many-sided solution to the challenges of waste management and sustainable construction.

Recommendations

The government and stakeholders should draft environmentally friendly policies concerning the recycling of non-biodegradable waste materials to ensure environmental safety.

Keywords: *Recycling hospital glass waste by crushing, Construction materials, Baptist hospital multigene.*
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Background

Hospital waste is any material, substance, or by-product that is discarded or no longer useful, which is generated during the diagnosis, treatment, or immunization of human beings or animals, as well as in research activities about medical care. This material or substances can be in various forms including solid, liquid, or gaseous. The solid hospital waste includes glass material. Hospital glass waste is a type of healthcare waste that consists of glass materials that are

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used or generated in medical facilities. These include vials, ampoules, and bottles. These are non-biodegradable disposable materials, which if not properly handled, pose a significant risk to the health and safety of patients, staff, waste handlers, and the general public (Diaz et al., 2005; Soliman and Ahmed, 2007). When these glass items and bottles are not properly reclaimed, they end up in landfills, taking up valuable space with a significant contribution to global environmental pollution (Deepak, 2022). Jiang et al; (2009), revealed that this category of waste constitutes up to 11% of medical waste burden, with tube vials and ampoule bottles contributing to 61.9% of this. According to an evidence-based needs assessment carried out in this hospital in 2022, within a period of six months from January to June, 1603.5kg of glass waste was generated. This makes up a very significant volume of the overall waste burden of the hospital. Thus its handling needs to be considered carefully. However, there is a gap in the handling of glass bottles. The disposal of waste from hospitals, especially glass waste, represents a major challenge and recycling provides a positive impact on the environment by reducing the amount that must be disposed of, and preserving natural resources. With a number of considerations, the hospital decided to devise a means of handling this category of waste. These considerations include the fact that the glass used to produce ampoules is of poor quality (Gaiser, Cheek, and Gutsche, 2004). Also, there is no defined plan for handling glass waste and recycling in this region. Furthermore, bearing in mind the fact that safely disposing of glass pieces is a responsible thing to do and is also a laudable move to stop people from getting hurt and protect the environment, the hospital decided to build a crusher that will crush the glass bottles, the ampoules, and other glass waste into material that can be used in construction. This crushed glass is used to make floor and pavement tiles. This project is ongoing.

As sustainable practices within the healthcare sector have become increasingly vital in addressing environmental concerns, this essay will explore the project's innovative approach to recycling hospital glass waste, specifically focusing on the crushing of vials, ampoules, bottles, and even broken window glass for repurposing in construction applications. This has environmental and economic impacts as well as potential benefits to healthcare and construction. This essay will look at the literature review which will give evidence to the problem that gave birth to this project. It will look at the change process and its management. It will also focus on the project design, project implementation, monitoring, and evaluation and will look at the results of the change project. A conclusion and recommendation will be given before the appendix.

Project Background

In the healthcare industry generally and particularly in this Mutengene hospital, the regular procedures generate a significant amount of waste, some of which is glass, principally from packaging of drugs, and various other sources like bottles from which drinks have been removed. These unwanted materials usually were stored on-site for lengthy periods in bags and heaps and later taken away to a sister institution and ended up in landfills. The healthcare sector greatly relies on glass (Guadagnino, Guglielmi, and Nicoletti, 2022), though not considering the negative environmental impact of these non-biodegradable materials when dumped as is (Adekomaya and Majozi, 2021). Although glass is inert and non-toxic, it requires considerable energy for production. The disposal of this material in landfills aggravates the industry's greenhouse gas emissions (Komilis., Ham, and Stegmann, 1999; Larsen, Merrild, and Christensen, 2009). Furthermore, the slow decomposition of glass in landfills perpetuates its environmental impact over extended periods (Jantzen, Brown, and Pickett, 2010). Therefore, implementing sustainable waste management practices within hospitals is imperative to mitigate these consequences.

Beyond environmental concerns, the mismanagement of glass waste represents a missed opportunity for resource utilization. Glass is highly recyclable, and by establishing robust recycling programs within healthcare facilities, hospitals can contribute to a circular economy. Recycling glass reduces the demand for raw materials, conserving energy and mitigating the environmental toll associated with the production of new glass. Additionally, recycled glass can be transformed into various products, further extending its utility (Pahlevani and Sahajwalla, 2018; Qin, Hu, and Li, 2021).

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To address this issue comprehensively, hospitals need to prioritize waste reduction strategies, implement effective recycling programs, and foster a culture of sustainability within their operations. By doing so, the healthcare sector can align itself with broader environmental goals, minimize its ecological footprint, and harness the potential of waste as a valuable resource. So, understanding the ecological importance and the potential for resource recovery from hospital glass waste management, our project targets to put in place a sustainable solution by recycling hospital glass waste in Baptist Hospital Mutengene for use in construction.

Project Objectives

To reduce waste by diverting glass waste from landfills, thereby minimizing the environmental footprint of the hospital.

To reveal the hidden potential of hospital glass waste as a valuable, recoverable resource.

To integrate recycled glass waste into construction processes to promote sustainable eco-friendly building practices.

To raise awareness about the environmental impact of hospital glass waste and the benefits of recycling it for use in construction.

Components of the project

System of collection of glass waste

The system for collecting glass waste in the hospital involves the gathering of vials, ampoules, and various bottles, which constitute the focus of this waste management project. These items are generated from varied points within the hospital, including hospitalization wards, operating rooms, injection rooms, and wound care units, as well as specialized care areas such as the dentistry and the ophthalmology units. A critical aspect of the collection process is the sorting phase, which occurs at the point of waste generation.

At each point of generation of this waste, a meticulous separation of waste categories takes place. Specifically, vials, bottles, and ampoules are intentionally segregated into dedicated bins during the sorting process. This practical approach ensures that glass waste is efficiently separated from other types of waste at the origin, thereby facilitating the continuation of the management process. (Verma, and Agarwal, 2021).

Once the segregation is completed, the next step involves the daily waste pickup. The facility-keeping staff, who are responsible for cleaning and waste pickup, play a central role in this phase. They carefully, transport the segregated glass waste to the hospital's designated waste treatment area, following the hospital guidelines for waste pickup and transportation. By implementing this systematic approach to glass waste collection, segregation, and transport, the hospital not only ensures the proper disposal of glass waste but also contributes to overall waste management efficiency (Seadon, 2010). So, this process aligns with sustainable waste practices and underscores the hospital's commitment to environmental responsibility in the healthcare sector.

Glass Crushing Unit

The reflection on how to handle the growing glass waste led to this innovative, environmentally conscious idea of building a locally engineered and sustainable glass-crushing machine. The collaboration of the mechanics and the metal workshop artisans of the technical services department of the hospital came out with the design of the crusher. After settling on the design, they sourced the different components and then built the system. These workers fabricated and adapted a receptacle for the glass input, ensuring efficient and safe processing (Bar, n.d.). The channel for collecting the resulting aggregate was also intelligently fashioned. So this unit is a small glass crusher made in the hospital. This machine is powered by a reliable 220-volt supply from our local power.

Integration with construction

The collaboration between the waste management department and the building construction department is very important because such association leads to attaining one of the aims of this project which is the transformation of waste into valuable resources

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(Kalkanis, et al., 2022). With a focus on sustainability, the waste management department with its expertise, collects and processes the waste glass, while the construction experts seek to integrate the aggregate resulting from glass crushing into various construction materials (Ogundairo et al., 2019; Arabi et al., 2019; Mohajerani et al., 2017). They put up their architectural insight, exploring innovative ways how to incorporate the glass aggregate into works like pavement tiles, blocks, and floors within the hospital premises. The putting of recycled waste materials from the hospital, back into the hospital infrastructure, is the testimony of collaboration between the departments and a positive forward move towards a greener and more environmentally conscious future.

Expected outcomes

Implementing a project to transform hospital glass waste into aggregate that can be assimilated into construction materials, presents many benefits. The expected outcomes of implementing this project at this hospital are varied. These include addressing environmental concerns, enhancing resource efficiency, fostering community engagement, and opening avenues for economic opportunities.

One very significant expected result is waste reduction. By crushing the glass waste from the hospital, there will be a significant reduction in the volume of materials sent out for disposal in landfills. This is contributing to mitigate the issue of limited landfill space. Therefore, contributes to minimizing all the environmental risks associated with the disposal of glass waste in landfills.

Also, this project is expected to contribute significantly to resource conservation by judiciously using waste resources and not allowing them to interfere with natural environmental processes like rejuvenation. This repurposing of waste products may help to lessen the reliance on other natural materials, thereby preserving natural resources. This reflects a commitment to environmental stewardship. This is in line with sustainable development goals, especially goal 7 which ensures access to affordable, reliable, sustainable, and modern energy for all (McCollum, et al., 2017). This is also a testimony of corporate social responsibility.

Again, using aggregate from waste for backfilling (Al-Taie, et al., 2023) will mitigate the need for traditional backfill material, which results in reduced environmental disturbance associated with the extraction and transportation of the usual backfill materials.

This project will also lead to significant energy savings. The energy that would have otherwise been used to extract and process other construction materials will be saved. This will also lead to a reduction in greenhouse gases that would have otherwise been released into the atmosphere during the whole of that process. This is in effect, lowering the carbon footprint of the hospital and healthcare institutions in general.

Another very important outcome will be in the area of community engagement. This project will foster community involvement by creating awareness of responsible waste management and sustainable construction practices. Engaging the staff of the hospital will increase awareness among them as they will gain a deeper understanding of the importance of this justifiable practice, thereby fostering a sense of environmental consciousness. The awareness campaigns will lead to positive changes in waste disposal habits among the staff of the hospital who will better understand the reason why they should be responsible in the areas of waste segregation and disposal. This is an aspect of behavior change. The staff will actively participate in this recycling program thereby contributing to the success of this positive initiative. This community involvement will also stimulate knowledge sharing within the staff community, creating an environment that is supportive of staff exchange of ideas and best practices relating to waste reduction and sustainable construction. These collaborative efforts will involve staff of all the different departments working in collaboration and strengthening the sense of community and shared responsibility. Through this innovative waste management approach there can be a promotion of a positive workplace culture with staff feeling the need to contribute to environmentally friendly initiatives. This project will also provide educational opportunities as awareness campaigns will be carried out with the increasing number of workshops and seminars which empower the staff with knowledge and skills to actively participate in sustainability efforts.

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Another expected outcome of this project will be the potential economic benefits. The use of glass aggregates for construction definitely holds a promising economic opportunity (Chukwudi, and Ogunedo, 2019). In the hospital, it has already created a job and is definitely going to create more jobs. Also, the glass aggregate can be sold out to people who are doing construction and this can be beneficial to the hospital. The technical services department of the hospital in the near future will use this as a revenue generation scheme by selling tiles that are made from recycled glass waste material. So the opportunities do not only contribute to financial gains for the hospital but also position the hospital as a leader in environmentally responsible healthcare practices potentially inspiring similar initiatives in other communities.

Project Design and implementation strategy

The project design included a needs assessment, a feasibility study, establishment of the collection system, and the crushing unit. Also, we have quality control, partnerships for the initiative, and the handling and transportation of materials. Monitoring and evaluation of the processes, and compliance with regulations as well as a sustainability plan are indispensable in the project design. Another key aspect of this design and implementation strategy will be documentation and reporting. Intentionally engaging the community of health care workers who are the primary stakeholders, is central to the success of the project.

Needs assessment

Before the project was initiated, there was a needs assessment conducted to identify key lapses in the waste management process so as to effect constructive and positive change (Kaufman, and English, 1979; Altschuld, and Lepicki, 2009; Gupta, 2011). In that light, in 2022, a needs assessment on the management of non-chemical solid waste in the hospital was carried out. From this assessment, glass waste volume was seen to be significantly high. This category of waste is made up of glass vials, bottles, and other broken glass from the hospital. This assessment revealed that about 3.43% of all the solid waste produced in the hospital in the period from January to June 2022 was glass waste. Also, the assessment revealed that there were efforts made in handling the other components of solid waste generated in the hospital but for the glass waste. The practice was that this waste from time to time was taken to another facility but most of the time the waste was placed in bags and kept in the waste treatment area for long periods. These bags would shatter and the glass would be in heaps around the area and sometimes they were taken and dumped at the landfills. So this needs assessment identified a great need to develop a workable approach to properly managing this class of waste.

Feasibility study

A feasibility study is a first and most important thing before undertaking a project design as it ensures practicality and viability, setting the groundwork for success (Koo, and Fischer, 2000). So the feasibility study conducted on collecting, transporting, and processing hospital glass waste within a hospital setting indicates that the proposed system is indeed feasible. The full analysis took into consideration some factors such as logistics, cost-effectiveness, and environmental impact. The collection and transportation processes were found to be efficient, ensuring timely procedures without interfering with routine hospital client care operations. Also, the processing of glass waste is very practicable, with the availability of staff, the right technology the necessary facilities, and the ever-present need for aggregate. This feasibility assessment, therefore, suggested that implementing this easily structured approach to managing glass waste in this hospital was workable and was in alignment with standard waste management practices which have to be sustainable. Apart from the environmental impact of fostering an eco-friendlier hospital environment, there are also potential economic profits to this project. So, efficient waste management can lead to cost savings for the hospital, as this process reduces the need for purchasing new materials like aggregate. Additionally, potential revenue streams may develop from selling the crushed glass.

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Handling of glass waste before crushing.

The first step in establishing a collection system involves conducting a thorough waste audit within the hospital premises. This is to identify sources of glass waste, including glass containers, vials, windows, and other discarded items (Rajalakshmi, Amzad, and Asif, 2023). Informed of the outcome of the audit, designated collection points were set up across different hospital departments to ensure efficient segregation, especially in all the medication and care points in the hospital. The collection system is meticulously planned to streamline the gathering of waste materials. So in all these areas, clearly labeled collection boxes are strategically placed. These boxes are consistently and frequently picked up by the waste-collecting staff. This is done once a day when all waste is collected in the waste treatment area. The collection system is regularly inspected by the infection prevention focal person for the hospital in order to address any malfunctions, damages, or improper activities in the collection process. Training sessions are conducted in the hospital to raise awareness about the importance of proper glass waste disposal which has to begin with proper segregation and appropriate transportation to the treatment site. Before glass can be crushed, it must undergo pre-treatment. This is to ensure that the glass waste is properly cleaned. Here, there is the removal of labels, rubber stoppers, metallic seals, and any non-glass materials. Additionally, drug residues are drained from the glass waste, and the bottles, ampoules, and vials are rinsed to eliminate substances that can affect the products that will be produced from glass waste.

The crushing process

In the waste processing area of the hospital, the institution has invested in a specialized glass crusher capable of breaking down glass into smaller, manageable pieces. The crushed glass can then serve as aggregate in various construction materials (Orhorhoro, and Oghoghorie, 2017). This step is crucial for maximizing the utilization of glass waste. This machine has an enclosed chamber which was intentionally built to contain glass fragments during the crushing process. So, this design minimizes the risk of airborne glass particles during the process and enhances the overall safety of the operator. Also, this enclosed chamber ensures noise reduction which mitigates the impact of the crushing process on the surrounding environment and guarantees compliance with noise regulations. To reduce the risks of fine glass particles blown into the air, the operators use appropriate masks and respirators at all times for personal protection.

Quality Control

Quality control measures are integrated to uphold standards throughout the project lifecycle (Flyvbjerg, 2013; Rose, 2005). Parameters like the feed size which is the amount of glass waste placed in the crusher, and throughput which is the quantity of aggregate gotten per time of operation were determined. Most importantly, the continuous run time of up to five hours was determined to ensure that the machine is not overused. Also, the construction experts of the Technical Services Department control the size distribution of the aggregate to determine if it is fit for the purposes for which it will be used. Therefore implementing quality control measures will see to it that this project results in a sustainable and reliable end product.

Project partnerships

Successful community projects require effective collaborative partnerships (Frantzeskaki, Wittmayer, and Loorbach, 2014; Kolk, Van Tulder, and Kostwinder, 2008; Eitan, and Fischhendler, 2021). Establishing a strong collaboration with the hospital waste management team will ensure a smooth integration of glass waste collection and processing within the hospital premises. Also, collaboration with the hospital construction team is crucial for incorporating the recycled glass aggregate into the different construction projects in the compound thereby promoting building practices that are said to be sustainable. Furthermore, this partnership is extended to other hospitals in the town and one sister healthcare institution in another region. With the advent of this project, these hospitals generate glass waste, and transport it to the Mutengene hospital for recycling, as a contribution towards responsible waste management. This partnership leads to the sharing of best practices, sharing of resources, and knowledge, and the creation of a collaborative network that

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promotes positive initiatives and building a regional synergy in the aspect of resource recovery from waste. This can lead to adopting this approach even in the general community where glass waste is also a big issue as the culture of recycling is not developed in local communities.

Material handling and transportation

The aggregate that ensues from the process is transported on wheelbarrows a few meters away to where the aggregate is used in making pavement tiles. So there is no need for specific transport for now. However, the crushed glass shortly will be transported in a secure fashion to whichever construction site where needed. This will be in containers that will prevent particles from being blown into the environment.

Construction integration of glass aggregate

With the evidence of the workability and the plus that this recycled material can have on construction, (Adesina and Das, 2020; Adnan, Shen, Ibrahim and Jamaluddin, 2013; Jiang, Ling, Mo, and Shi, 2019), the construction department of the hospital is implicated in integrating it into construction materials. Pilot demonstrations were done by the construction experts. These included producing pavement tiles with glass aggregate only and with a mixture of glass aggregate and regular aggregate at different proportions. The results of these pilot runs were said to be very good. So, the pilot demonstrated the effectiveness and beneficence of the project. Eventually, there will be collaboration with other construction companies.

Market Research

When the project develops to a larger production of this material, market research will be carried out. Here the market demand for sustainable construction materials will be assessed. The project will explore the potential buyers and partners in the construction industry.

Public awareness

Public awareness initiatives are implemented to engage and inform stakeholders (Hesselink et al., 2007; McGregor, and Gabhainn, 2018). So, implementing a waste management project to crush glass and use aggregate in construction necessitates a strong public awareness initiative. Educating hospital staff, patients, and visitors about the glass waste collection initiative is pivotal. Also, emphasis should be laid on the environmental impact of repurposing glass waste and encouraging active participation, to foster a sense of responsibility toward waste reduction. In this light, therefore, the hospital is organizing informative campaigns to educate the local community, which is made up of healthcare staff, patients, caregivers, and visitors about the ecological benefits and positive impacts of this initiative. Various means of communication are used. These information campaigns aim to galvanize the community and foster a sense of shared responsibility and environmental stewardship. The public awareness initiative contributes to building a community that actively participates in and celebrates sustainable waste management practices within the hospital premises.

Monitoring and Evaluation

Monitoring and evaluation is a systematic process used by organizations to track and assess the progress, effectiveness, and impact of projects and policies (Estrella and Gaventa, 1998; Shapiro, 2007; Crawford, and Bryce, 2003). So, setting up a good monitoring and evaluation mechanism will track the progress of the project and ensure effectiveness and sustainability. This will include a system to continuously gather information and keep track of the amount of glass waste collected, the volume of glass aggregate produced, and the reduction in landfill waste, as well as the efficiency of the crushing procedure and the quantity of the aggregate used in construction. So this information will be regularly reviewed, alongside the objectives of the project to provide valuable insights into the project's success and enable further decisions.

Regulatory Compliance

Regulatory compliance ensures the adherence of individuals, organizations, or systems to laws, standards, or guidelines put in place by the government or some regulatory bodies. So it is expected that this

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project aligns with local and global legal requirements and safety protocols. The European Union waste management legislation, including the Waste Framework Directive (2008/98/EC) and the Landfill Directive (1999/31/EC) aims at virtually eliminating landfill disposal of recyclable glass, improving the collection of building glass waste, and increasing recycling rates and eventually banning landfill deposit of economically recyclable glass waste (Tamanna, 2020). Although local regulations were not accessed, all the components of this project are geared towards meeting the objectives of the international regulations and standards for waste management by eliminating landfill disposal of recyclable glass, and the resulting product meeting regulatory requirements for construction materials.

Sustainability Plan

A sustainability plan is an organization's strategy and actions to address environmental, social, and economic challenges while promoting the long-term viability and resilience of an activity or a project (Chari and Kehoe, 1990; Hitchcock, AtKisson, and Willard, 2012; Johnson, Hays, Center. and Daley, 2004). A sustainability plan is devised to ensure long-term impact. The sustainability plan for hospital glass waste management, involving the recycling of glass into aggregate for construction materials, is rooted in a commitment to environmental responsibility and resource efficiency. The plan encompasses a comprehensive approach, starting with efficient collection methods and transportation of glass waste to the recycling facility. Furthermore, through advanced crushing technology, the glass waste is transformed into good-quality aggregate, aligning with construction standards and regulatory requirements. Also, the project emphasizes stakeholder engagement, fostering awareness and collaboration among hospital staff and the construction teams. Again, resource efficiency is prioritized, with a focus on minimizing waste sent to landfills and promoting circular economic principles by integrating recycled materials into construction projects. Continuous monitoring, detailed documentation, and regular reporting are integral components, allowing for data-driven insights, performance evaluations, and the adaptation of strategies for ongoing improvement. This sustainability plan not only addresses environmental concerns but also creates a positive impact on the community, contributing to a resilient and eco-conscious healthcare infrastructure.

Documentation and Reporting

This is the process of recording and communicating information about the various activities and outcomes of the project. Documentation and reporting mechanisms guarantee transparency and knowledge sharing (Becker and Pomplum, 2006; Newton, 2008). Therefore, maintaining meticulous documentation and comprehensive reporting is integral to the success and transparency of this project which is focused on resource recovery by crushing medical glass waste to obtain aggregate which is used in construction. So a well-structured record-keeping system will document key aspects such as the quantity of glass waste generated, the efficiency of the crushing process, and the volume of recycled glass aggregate utilized in construction projects within the hospital premises. Detailed reports will not only capture the environmental impact, such as reduced landfill usage and energy savings but also provide insights into the economic aspects, including cost savings and potential revenue generation. Regularly updating these records ensures a historical achievement of the project's progress, allowing for evidence-based decision-making, performance appraisals, and the identification of areas for continuous improvement. Also, transparency in reporting fosters trust among stakeholders, including hospital staff, construction teams, and environmental authorities, highlighting the project's commitment to sustainability and responsible resource management.

Community Engagement

Community engagement is a vital aspect of the hospital's glass waste management project. The project seeks to foster a sense of shared responsibility and collaboration within the local community of health workers. By organizing workshops, and informative sessions, the hospital aims to raise awareness about the environmental benefits of recycling glass waste and its integration into construction materials. Engaging with all cadres of staff of the institution, creates an open

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dialogue, allowing for the exchange of ideas, concerns, and feedback. So the project's success hinges on building trust and understanding within the community, showcasing the positive impact of sustainable practices on both the environment and the well-being of those living in the vicinity. This community-centered approach not only ensures the project's acceptance but also strengthens the hospital's role as a responsible and environmentally conscious institution.

So, by following these steps, the project will efficiently collect hospital glass waste, process it into construction materials, and contribute to sustainable building practices.

Change management theory

Many scholars have proposed different theories of change and the theory that informed the implementation of the project the focus of this essay, is Kotter's Eight-Step Change Model. This framework is widely used for managing organizational change. It was developed by John Kotter, a Harvard Business School professor, and a renowned leadership and change expert. This was first published in 1996 in his book titled "Leading Change". This theory presents 8 steps for managing and implementing change effectively.

The first step is creating urgency which is the state of being very important and requiring immediate attention. Creating urgency for the project was imperative due to the accumulating volume of glass waste, which not only posed aesthetic concerns but also had detrimental effects on health and the environment when disposed of in landfills. The urgency was generated by highlighting the potential health and environmental risks associated with the current disposal methods, such as air and soil pollution from glass degradation, as well as the principles of waste management which obliges every waste producer, to responsibly and safely dispose of their waste, plus financial costs of waste management. Additionally, emphasizing the positive impact of recycling, including reduced landfill usage, decreased pollution, and potential cost savings through efficient resource utilization, further drove the need for immediate action. Generating awareness about these environmental benefits and cost-saving opportunities among stakeholders and the broader community was crucial for raising support and commitment to implementing the recycling project promptly and effectively.

The next step is building a guiding coalition. Building a coalition of influential individuals within the organization who support the change initiative helps garner support and overcome resistance. In the context of implementing this comprehensive strategy for recycling hospital glass waste into construction aggregate, bringing together a diverse partnership of stakeholders was paramount to ensure comprehensive support, expertise, and alignment across various functions in the organization. Among the key persons were members of the administration, the primary decision-making body within the organization, which plays a pivotal role in championing the project, allocating resources, and fostering a culture of sustainability and innovation. Their leadership and strategic vision are instrumental in setting the tone for the entire organization and gaining buy-in from key stakeholders. Another key part of the coalition is the members of the infection prevention team, who are the main actors in waste management, whose expertise in mitigating health risks and maintaining sanitation standards is essential for ensuring the safety and efficacy of the recycling process. Their insights into infection control protocols and best practices inform the development of procedures to minimize contamination risks associated with handling and processing glass waste. Furthermore, involving the housekeeping team was vital as they were the ones charged with picking up the glass waste as well as all other waste from the different points of generation. Their assignment and knowledge were invaluable in streamlining the waste management processes, and optimizing resource utilization, leading to the success of this project.

Supervisors from different units play a crucial role in championing the project within their respective departments, nurturing a culture of cooperation, and ensuring consistent adherence to relevant protocols and guidelines. Their leadership and communication skills are instrumental in mobilizing frontline staff, addressing concerns, and driving engagement throughout the implementation process. Additionally, collaboration with the technical services department brings specialized expertise in construction and infrastructure management, enabling the design and

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implementation of sustainable solutions tailored to the hospital's unique operational requirements. Technical services staff do provide invaluable support in assessing the feasibility of incorporating the products of this recycling process into the construction materials for the many projects that are ongoing in the facility, especially the pavement of walkways. Moreover, partnering with representatives from the divisional delegation of environmental protection is essential for navigating regulatory requirements, securing necessary permits, and fostering cooperation with external stakeholders such as regulatory agencies, waste management facilities, and environmental advocacy groups. Their expertise in environmental compliance, risk assessment, and sustainability planning can help ensure that the recycling project aligns with regulatory standards, meets environmental objectives, and maximizes long-term benefits for both the organization and the community. With clearly established roles and responsibilities, the guiding coalition through collaboration, communication, and commitment to shared goals, catalyzes innovation, continuous improvement, and positive impact of this project.

The next step in Kotter's theory is the creation of a vision for change. Establishing a clear and compelling vision helps guide the change effort and aligns all who are involved toward a collective goal. So, though not written, the vision of the hospital is to innovatively practice sustainable healthcare by transforming the management of all waste, especially hospital glass waste which up to the time of this project, was not handled appropriately. This vision is a future where every discarded glass item within the facility becomes a building block for a more environmentally friendly community. This processing of healthcare glass waste into good aggregate, will not only reduce the burden on landfills but also contribute to the creation of robust, eco-friendly building materials. This vision aligns with the institution's overall vision of providing quality services at all levels, which includes a corporate commitment to optimal environmental stewardship, innovation, and community well-being. Inspiring and engaging all stakeholders from frontline staff to administrators, regulatory bodies, and local communities, will transform waste into opportunity. With all adhering to this vision, the role of the hospital in sustainable development will be redefined, demonstrating that all actions taken can leave an enduring positive impact on the environment and the coming generations. With a clear vision established, the next step is properly communicating the same to the team.

The effective communication of the vision ensures that all members of the organization understand the reasons for change and their role in achieving it. Communicating a vision of recycling hospital glass waste into construction aggregate to management, staff, service beneficiaries, and the community requires a multifaceted approach utilizing various forms of communication. For management, formal presentations, and strategic meetings are effective in conveying the vision's alignment with organizational goals and its potential for long-term cost savings and environmental impact. Staff engagement is fostered through departmental meetings, and updates, providing opportunities for dialogue, feedback, and recognition of contributions to the initiative. Service beneficiaries are reached through patient education sessions, emphasizing the health and environmental benefits of the recycling program. With this community involvement, we ensure widespread understanding, enthusiasm, and commitment to our vision of quality services sustainability, and community well-being.

The next step in Kotter's approach is removing obstacles. Identifying and addressing barriers to change, whether structural, procedural, social, or cultural, is essential for successful organizational transformation. Structural barriers often manifest as rigid hierarchies, outdated systems, or inadequate resources that impede the implementation of new initiatives. Procedural barriers may include cumbersome processes, conflicting priorities, or lack of clarity in roles and responsibilities, hindering progress and creating resistance to change. Social barriers, such as interpersonal conflicts, power dynamics, or resistance from influential individuals, can undermine collaboration and alignment, making it challenging to mobilize support for change efforts. Cultural barriers, rooted in deeply ingrained norms, beliefs, and values, may present the most significant challenge, as they often shape organizational identity and behavior. Addressing these barriers in this project, hinged on the comprehensive approach that involved engaging stakeholders at all levels, adopting open communication and trust, and creating a supportive

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environment that encourages contributing, learning, and adaptation.

To overcome structural barriers, the organization constantly assesses its existing infrastructure, processes, and resource allocation mechanisms to identify areas for improvement and readjustment. In this project, there was a reassignment of staff and budgetary allocation. Additionally, procedures were streamlined, with roles and responsibilities clarified, which clearly minimized the possibility of resistance to change.

Procedural barriers can be addressed through a combination of training, communication, and stakeholder engagement strategies. Providing staff with the necessary skills, knowledge, and resources to adapt to new processes and technology was crucial for fostering a culture of continuous improvement and innovation. Moreover, communicating the rationale behind procedural changes, soliciting feedback, and involving employees in decision-making processes helped build trust, ownership, and commitment to change efforts.

Social barriers often require a focus on building relationships, fostering collaboration, and addressing underlying tensions or conflicts within the organization. The facilitation of open dialogue, the promotion of empathy and understanding, and the creation of opportunities for interdisciplinary teamwork and collaboration are factors put in place to overcome social barriers. Additionally, engaging with influential individuals in the staff community who can champion change efforts helped to overcome any resistance and increased the willingness to align with the positive energy for transformation.

Cultural barriers represent the most complex and challenging aspect of change management, as they often involve deeply ingrained beliefs, values, and behaviors that shape organizational identity and norms. Addressing cultural barriers requires a long-term commitment to cultural transformation, starting with leadership alignment and role modeling of desired behaviors. This project is just an opportunity for growth and innovation, with no potential threat to the status quo in the organization. Therefore, there was little or no potential for cultural barriers to the implementation of the project.

So, identifying and addressing barriers to change required an approach that considered structural, procedural, social, and cultural factors. Engaging stakeholders, encouraging open communication, and creating a supportive environment played a crucial role in this approach to meaningful transformation with strategic objectives and values.

The next step is to create short-term wins. Celebrating and showcasing early successes builds momentum and reinforces the belief that change is possible. Creating short-term wins is crucial for building momentum and reinforcing belief in the possibility of change, especially when implementing a project like building a crushing machine and instituting a system of collecting glass waste to crush into aggregate for construction materials. Early successes serve as tangible evidence of progress and help to energize stakeholders, increase buy-in, and sustain momentum throughout the change process. One approach to generating short-term wins is to start small, focusing on achievable goals that demonstrate immediate impact and value. For example, in the context of the glass waste recycling project, short-term wins were at all steps. Just having all the stakeholder's buy-in to the process was a first win. Then management disbursing the required funds for the acquisition of components and successfully building and testing the crushing machine, showcasing its effectiveness in transforming glass waste into usable aggregate was another win. These wins are celebrated with the staff members and management, through internal communications. This helps to create a sense of accomplishment and excitement, while also raising awareness and generating positive publicity, enabling visibility for this worthwhile initiative.

Additionally, instituting a system of collection for glass waste within the hospital facility, provided another opportunity for early success. By implementing clear protocols and procedures for segregating and collecting glass waste, and effectively communicating these changes to staff members through training sessions, and staff meetings, the organization quickly demonstrated its commitment to sustainability and waste reduction. Tracking and reporting metrics, such as the amount of

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glass waste diverted from landfills and the volume of aggregate produced, further, reinforce the impact of these early wins and help to sustain passion and engagement among interested persons.

Likewise, showcasing the tangible benefits of the project through everyday applications helps to build credibility and impetus. For instance, by incorporating recycled glass aggregate into construction materials for a small-scale building or infrastructure project, such as sidewalks, landscaping features, or non-structural elements, the organization demonstrates the viability and adaptability of the material while also contributing to local infrastructure improvements. Publicizing these applications highlights the environmental and economic benefits of the recycling initiative and also inspires confidence in its potential for broader adoption and impact.

Throughout the process of creating short-term wins, the successes of individuals and teams involved were recognized and celebrated. This was done through formal acknowledgments of their contributions, as well as informal gestures of appreciation. By reinforcing a culture of recognition and positivity, the organization nurtures a sense of ownership and pride among interested persons, further fuelling their commitment to driving change and achieving long-term success in sustainability initiatives like glass waste recycling.

To proceed with the change process according to Kotter, another step will be building on the change achieved by using momentum from initial successes to drive further change and continuously improve processes and systems. As the implementation of the project handling hospital glass waste by crushing it into aggregate for construction in Baptist Hospital Mutengene began to demonstrate tangible benefits and generate positive outcomes, it was essential to capitalize on the momentum by leveraging on the positives, identifying new opportunities for improvement, and fostering a culture of innovation and continuous learning. One approach to building on the change is to conduct regular assessments and evaluations to identify areas for optimization and refinement, based on feedback from the staff and performance evaluations. By gathering data and insights on the effectiveness and impact of the recycling project, Baptist Hospital Mutengene leadership identifies opportunities for improvement and innovation, prioritizing initiatives for further development, and allocating available resources effectively to support ongoing improvement efforts.

Moreover, building on the change requires a commitment to collaboration and partnership, both within the organization and with external stakeholders. By engaging staff members, departmental leaders, and other key stakeholders in the process of identifying opportunities for improvement and implementing solutions, the hospital harnesses the collective expertise, creativity, and commitment of its workforce to drive continuous improvement and novelty. Additionally, as the project progresses, collaborating with external partners, such as waste management companies, recycling facilities, and environmental organizations, can provide access to additional resources, expertise, and opportunities for collaboration, enabling Baptist Hospital Mutengene to stay at the forefront of sustainable healthcare practices and make a meaningful impact on the environment and community.

Furthermore, building on the change involves fostering a culture of continuous improvement, where staff members are encouraged to explore new ideas and approaches to waste reduction and recycling. By creating channels for staff members to share ideas, feedback, and best practices, such as the PMEL (Planning, monitoring, evaluation, and learning) system surveys and suggestion boxes, the hospital taps into the creativity and ingenuity of its workforce, identifying innovative solutions to complex challenges, and drive meaningful change. Additionally, recognizing and rewarding staff members for their contributions to sustainability and continuous improvement helps to foster a culture of innovation and motivation, encouraging ongoing engagement and commitment to the recycling project and other sustainability initiatives. Moreover, building on the change requires a commitment to transparency, accountability, and communication, ensuring that all who are involved are informed about the progress, the challenges, and the opportunities related to the recycling project. By providing regular updates, reports, and presentations on the status of the initiative, as well as opportunities for dialogue, feedback, and

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input, Baptist Hospital Mutengene engages staff in the change process, building trust and credibility, and raising a sense of ownership and accountability for sustainability goals.

The last step in Kotter's 8-step theory to change is anchoring the changes in corporate culture. Embedding the changes into the organization's philosophy ensures that they become part of everyday practice and are sustained over the long term. Embedding changes brought through the implementation of the project of crushing hospital glass into aggregate for construction into the organizational culture of Baptist Hospital Mutengene requires a complex and sustained approach that engages stakeholders at all levels and integrates the new practices into everyday routines and behaviors. In the beginning, it was essential to establish clear goals and objectives for the initiative, articulating how the recycling project aligns with the hospital's mission, values, and strategic priorities. By communicating the rationale behind the project and its potential benefits in terms of cost savings, environmental sustainability, and community impact, leadership created a sense of urgency and purpose among staff members, causing them to buy in and be committed to this important change process.

Moreover, as the project is an ongoing and long-term project, embedding changes into the organizational culture requires ongoing communication, continuous education, and training to ensure that all staff members understand their roles and responsibilities in implementing and sustaining the new practices. This may involve conducting regular workshops, training sessions, and informational campaigns to raise awareness about the importance of waste reduction, recycling, and sustainable practices, as well as providing staff with the necessary skills, knowledge, and resources to participate effectively in the initiative.

Furthermore, integrating the recycling project into existing processes and systems for long-term sustainability and effectiveness involves revising policies and procedures to incorporate waste reduction and recycling guidelines. By aligning the recycling project with the hospital's mission and values, empowering staff members to take ownership of the initiative, integrating sustainability into existing processes and systems, and providing leadership support and direction, Baptist Hospital Mutengene can ensure that its recycling efforts become a permanent and integral part of its organizational culture, contributing to a healthier, more sustainable future for the hospital and the community it serves.

Managing resistance to change

Managing resistance to change in this project of glass waste recycling was addressed in the change process. Kotter's eight-step change framework that informed the change process incorporates a strategic and inclusive approach to managing resistance. These include fostering open communication and transparency about the benefits and objectives of the recycling initiative. Engaging key stakeholders, including hospital staff, administrators, and community members, in discussions about the project's goals, environmental impact, and potential benefits helps alleviate concerns and build support. Additionally, providing education and training sessions to demonstrate the importance of glass waste recycling and how it aligns with the hospital's sustainability goals helps overcome resistance. Actively involving employees in the planning and decision-making process, seeking their input, and addressing their concerns, also increase buy-in and commitment to the project. Celebrating small successes and milestones along the way further reinforces the positive impact of the initiative and encourages continued participation. Overall, a proactive and inclusive approach that prioritizes communication, education, and stakeholder engagement is key to managing resistance to change effectively in the glass waste recycling project at Baptist Hospital Mutengene.

Project Results

Though the processes will have to as an ongoing project, we can outline some results as of now. In July 2023, the glass recycling project at Baptist Hospital Mutengene achieved significant milestones with the completion and installation of a reliable glass-crushing machine. This machine boasts a continuous run time exceeding four hours, ensuring efficient processing of glass waste on-site. Complementing this technological advancement, adequate training for hospital personnel

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involved in the program was conducted, covering various aspects of the glass waste recycling process. Staff were educated on sorting glass waste, transportation procedures, preparation of waste for crushing, and the intricacies of the crushing process itself. This initiative not only equipped employees with the necessary skills and knowledge but also fostered a culture of sustainability within the hospital community.

One of the noteworthy outcomes of the project was the innovative use of recycled glass aggregate in the creation of pavement tiles. These tiles, crafted from recycled materials, represent a sustainable and environmentally friendly alternative for hospital walkways. The utilization of recycled glass aggregate not only reduces the environmental footprint of the hospital but also demonstrates a commitment to promoting sustainable practices and circular economy principles. Additionally, by repurposing glass waste into functional and aesthetically pleasing tiles, the hospital contributes to the beautification and enhancement of its infrastructure while simultaneously addressing waste management challenges.

Throughout the project implementation phase, necessary records were maintained to track the quantity of glass waste processed and recycled. These records serve as a valuable resource for monitoring progress, evaluating the effectiveness of the recycling efforts, and informing future decision-making processes. By documenting the quantity of glass waste recycled, the hospital can demonstrate its commitment to environmental stewardship and accountability. Furthermore, these records provide insights into the project's impact, enabling stakeholders to assess its success and identify areas for improvement. Perhaps the most notable environmental outcome of the glass recycling project is the elimination of glass waste disposal to landfills from Baptist Hospital Mutengene and the two other allied health institutions. Through the establishment of efficient glass waste recycling processes and the utilization of recycled materials for pavement tile production, the project effectively diverted all glass waste generated by the hospitals away from landfills. This accomplishment not only reduces the environmental burden associated with landfilling but also minimizes the potential risks of pollution and habitat degradation. By implementing sustainable waste management practices, the hospitals have demonstrated their commitment to environmental preservation and contributed to the conservation of natural resources. This environmental result signifies a meaningful step towards achieving a more sustainable and resilient healthcare infrastructure while promoting a cleaner and healthier environment for the community. Overall, the glass recycling project at Baptist Hospital Mutengene has yielded tangible results, ranging from the successful construction and installation of a glass crushing machine to the training of personnel and the innovative use of recycled materials in pavement tile production.

Conclusion

Recycling glass waste for the production of aggregate presents a many-sided solution to the challenges of waste management and sustainable construction. Through innovative initiatives such as the glass recycling project at Baptist Hospital Mutengene, significant progress has been made in transforming glass waste into valuable resources for construction applications. By completing the construction and installation of a glass crushing machine, training personnel in efficient recycling practices, and utilizing recycled glass aggregate for pavement tile production, the project has demonstrated the feasibility and efficacy of simple recycling systems.

Furthermore, the environmental benefits of the project are substantial and extensive. By diverting glass waste from landfills and repurposing it into construction materials, the project not only mitigates the environmental impacts associated with traditional waste disposal but also reduces the demand for new materials, thereby conserving natural resources and lowering greenhouse gas emissions. Moreover, the elimination of glass waste from landfills contributes to the preservation of ecosystems, minimizes pollution, and enhances overall environmental quality.

In essence, the recycling of glass waste for aggregate production represents a paradigm shift towards more sustainable and circular approaches to waste management and construction. Through collaborative efforts and innovative solutions, projects like the one at Baptist Hospital Mutengene pave the way for a greener, more resilient future, where waste is viewed not as a

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burden, but as a valuable resource to be reclaimed and repurposed for the benefit of both society and the environment.

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List of Abbreviations

W W F	Worldwide Fund for Nature
UNEP	United Nations Environmental Program
SDG	Sustainable Development Goals
PMEL	Planning, Monitoring, Evaluation and Learning

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Author contribution

Jane Frank Nalubega collected data and drafted the manuscript of the study

Author Biography

Gwagsi Everett is a student of BSc (Hons) in Health and Social Systems Management A program validated by the University of Manchester, UK.

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