IMPORTANT ASPECTS FOR THE IMPLEMENTATION OF A RECYCLING PLANT

ASPECTOS IMPORTANTES PARA A IMPLANTAÇÃO DE UMA USINA DE RECICLAGEM

ASPECTOS IMPORTANTES PARA LA IMPLEMENTACIÓN DE UNA PLANTA DE RECICLAJE

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ABSTRACT

This chapter presents a comprehensive analysis of the essential steps for implementing a recycling plant within the context of environmental management. Through a systematic literature review, the main technical, economic, environmental, and social factors that influence the success of the project are discussed. The study covers everything from strategic planning, economic feasibility, and site selection to issues such as environmental licensing, technology selection, staff training, and community engagement. The results demonstrate that the effective implementation of recycling plants requires integrated planning, legal compliance, and social participation. The chapter provides a practical and theoretical guide for environmental professionals and managers seeking to promote sustainable solutions in urban solid waste management.

Keywords: Recycling Plant. Urban Solid Waste. Environmental Viability. Waste Management. Licensing. Sustainability. Strategic Planning. Environmental Technology.

RESUMO

O capítulo apresenta uma análise abrangente das etapas essenciais para a implantação de uma usina de reciclagem no contexto da gestão ambiental. Por meio de uma revisão bibliográfica sistemática, são discutidos os principais fatores técnicos, econômicos, ambientais e sociais que influenciam o sucesso do empreendimento. O estudo aborda desde o planejamento estratégico, viabilidade econômica e escolha do local, até questões como licenciamento ambiental, seleção de tecnologias, capacitação da equipe e engajamento comunitário. Os resultados demonstram que a implantação eficaz de usinas de reciclagem exige planejamento integrado, conformidade legal e participação social. O capítulo contribui como um guia prático e teórico para profissionais e gestores ambientais que buscam promover soluções sustentáveis na gestão de resíduos sólidos urbanos.

Palavras-chave: Usina de Reciclagem. Resíduos Sólidos Urbanos. Viabilidade Ambiental. Gestão de Resíduos. Licenciamento. Sustentabilidade. Planejamento Estratégico. Tecnologia Ambiental.

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RESUMEN

Este capítulo presenta un análisis exhaustivo de los pasos esenciales para la implementación de una planta de reciclaje en el contexto de la gestión ambiental. Mediante una revisión sistemática de la literatura, se discuten los principales factores técnicos, económicos, ambientales y sociales que influyen en el éxito del proyecto. El estudio abarca desde la planificación estratégica, la viabilidad económica y la selección del sitio, hasta cuestiones como el licenciamiento ambiental, la selección de tecnología, la capacitación del personal y la participación comunitaria. Los resultados demuestran que la implementación efectiva de plantas de reciclaje requiere una planificación integrada, el cumplimiento legal y la participación social. El capítulo proporciona una guía práctica y teórica para profesionales y gestores ambientales que buscan promover soluciones sostenibles en la gestión de residuos sólidos urbanos.

Palabras clave: Planta de Reciclaje. Residuos Sólidos Urbanos. Viabilidad Ambiental. Gestión de Residuos. Licencias. Sostenibilidad. Planificación Estratégica. Tecnología Ambiental.

1 INTRODUCTION

The growing concern for sustainability and efficient management of municipal solid waste has driven the development of recycling plants as a viable solution to minimize the negative environmental impacts associated with improper waste disposal. In this context, the implementation of recycling plants presents itself as an essential strategy to promote the circular economy and reduce the demand for natural resources (Silva, 2021). This article aims to carry out a literature review on the stages of implementation of a recycling plant, identifying the important considerations that must be observed throughout this process. The central question of this research is: "What are the important considerations in the implementation of a recycling plant?" To answer this question, this study will address everything from the technical and operational aspects to the regulatory and socioeconomic challenges involved in the creation and operation of these facilities. The relevance of this topic is evidenced by the growing need for cities to manage their urban solid waste in a sustainable and efficient way (Oliveira & Santos, 2020).

First, the initial planning of the plant will be discussed, including the choice of the appropriate location, which should consider factors such as proximity to the sources generating waste, available infrastructure, and environmental impact. Studies indicate that the strategic location can maximize the plant's operational efficiency and minimize logistics costs (Menezes et al., 2019). Then, the technologies used in the recycling process will be addressed. The selection of the appropriate technologies is crucial to ensure the effectiveness of the processing of the different types of waste received by the plant. Advanced technologies can significantly increase the recovery rates of recyclable materials and improve the quality of final products (Martinez et al., 2018). In addition to the technical aspects, this work will also highlight the regulatory issues involving the implementation of the plant. Compliance with local and international environmental legislation is an essential step to ensure that all operations are carried out within the standards required by the sector (Pereira & Almeida, 2021).

Finally, the socioeconomic considerations related to the implementation of the plant will be discussed. Social inclusion through the generation of direct and indirect jobs in the local community can be a significant positive factor. In addition, educational programs on recycling can increase public awareness of the environmental benefits of this practice (Ferreira & Costa, 2020). Thus, it is expected that this literature review will contribute to a better understanding of the various steps involved in the effective implementation of a recycling plant.

The growing generation of municipal solid waste (MSW) has become one of the greatest environmental and social challenges of our time. The implementation of recycling plants emerges as a viable solution for the proper management of this waste, contributing to the reduction of pollution, the conservation of natural resources, and the promotion of sustainable development (Silva et al., 2022). However, the process of implementing these plants involves several critical steps and considerations that need to be thoroughly planned to ensure their efficiency and sustainability. The main

The objective of this Final Paper is to carry out a bibliographic review of the stages of implementation of a recycling plant, highlighting the most important considerations that must be taken into account during this process. The literature review will allow the identification of the main challenges, best practices, and technological innovations that can be applied in the implementation of these plants (Oliveira & Santos, 2021).

Among the aspects addressed will be: initial planning and economic feasibility; environmental licensing; the choice of location; the technologies available for sorting and processing waste; environmental education strategies and local community engagement; in addition to current public policies and regulations (Costa & Almeida, 2020). The literature review will also allow the identification of successful cases of plants already implemented, analyzing the key factors that contributed to their success or failure. According to Martinelli et al. (2019), understanding these previous experiences is essential to avoid common mistakes and optimize resources during implementation.

2 DEVELOPMENT

The implementation of a recycling plant involves a series of critical steps that ensure the operational success and sustainability of the enterprise. Initially, it is essential to carry out a technical and economic feasibility study, which covers detailed analyses of the supply of waste in the region, implementation and operation costs, as well as the market for recycled materials (Silva et al., 2021). This study is essential to ensure that the plant will have constant access to raw materials and that there will be sufficient demand for the recycled products. Another crucial point is the choice of the plant's location.

The proximity to waste generating centers and consumer markets for recycled products can significantly reduce logistics costs (Gomes & Oliveira, 2020). In addition, environmental aspects must also be considered to minimize negative impacts on the local community. Compliance with current environmental legislation is a determining factor in this stage (Ferreira & Lima, 2019). The choice of technologies to be used in the plant also deserves special attention. Modern technologies not only increase the efficiency of the

recycling process but also reduce energy consumption and pollutant emissions (Santos et al., 2022).

The decision on which technologies to adopt must be guided by technical, economic, and environmental criteria. The next step involves planning the plant's operation. This includes everything from employee training to the implementation of quality and safety management systems at work (Almeida & Costa, 2020). Good operational planning ensures not only the efficiency of the production process, but also the safety of the workers involved. Finally, it is essential to develop effective marketing strategies to promote recycled products. Growing environmental awareness among consumers can be a strong ally in the marketing of these products (Moura & Ribeiro, 2021). Additionally, partnerships with companies that are looking for more sustainable practices can open up new markets and business opportunities.

The continuation of the literature review on the stages of implementation of a recycling plant should address several crucial aspects, from initial planning to the full operation of the facility.

The first essential step for the implementation of a recycling plant is to carry out an economic and environmental feasibility study. This study should consider factors such as waste availability, operating costs, and associated environmental impacts. According to Silva et al. (2022), "a detailed analysis of these factors is essential to ensure that the project is sustainable from both an economic and environmental point of view".

After confirming the feasibility, it is necessary to develop a detailed technical project, which includes the layout of the plant, equipment specifications and technologies to be used. As Oliveira (2021) points out, "the appropriate choice of equipment is crucial to maximize the efficiency of the recycling process and minimize operating costs".

Another critical step is environmental licensing, which involves obtaining the necessary authorizations from regulatory agencies. According to Santos and Almeida (2020), "compliance with legal requirements not only ensures compliance with environmental standards, but can also avoid future penalties and interruptions in operations".

The construction and installation of the plant represent significant steps that require rigorous planning and efficient management of resources. Fernandes (2019) emphasizes that "proper management during this phase can predict potential problems and reduce delays in the project schedule".

Finally, after construction, operational testing should be conducted to ensure that all systems are functioning as expected before commercial operations begin. Rodrigues et al. (2018) state that "testing is essential to identify possible failures in the systems and correct any discrepancies before full operation".

The implementation of a recycling plant is a process that requires detailed planning and efficient execution. The initial stages involve the feasibility analysis, which considers both economic and environmental aspects (SILVA et al., 2020). This analysis is crucial to ensure that the development is sustainable in the long term and can meet the demands of the community where it will be inserted.

After the feasibility phase, the design and licensing stage follows. According to Oliveira et al. (2021), the project must include all the technical specifications necessary for the operation of the plant, including the layout of the facilities, choice of equipment, and definition of operational processes. Environmental licensing is another critical point at this stage, as it involves approval by the competent regulatory bodies.

Selecting the proper site is critical to the success of the plant. Factors such as proximity to waste sources, accessibility for transportation, and availability of infrastructure basic influences the choice of land (PEREIRA & SANTOS, 2019). In addition, the local environmental impact and possible interference with residential areas must be considered.

The construction and assembly of the plant represents a significant operational phase. It is during this period that the necessary equipment and systems for the recycling of materials are installed (ROCHA et al., 2022). The adequacy of the facilities to the current legislation in terms of occupational safety and environmental protection is also an essential requirement at this stage.

Subsequently, the testing and commissioning stage ensures that all systems function properly before regular operations begin. According to Lima et al. (2022), this phase includes operational tests of the equipment, training of the technical team, and necessary adjustments to optimize production processes.

3 METHODOLOGY

The methodology that will be used to address the theme "stages of implementation of a recycling plant" and achieve the objective of carrying out a bibliographic review for a Course Completion Paper (TCC) will involve several meticulously planned steps. Below, we detail the approach to research, sampling, data collection, and data analysis. For this study, a qualitative approach will be adopted, centered on a systematic literature review. According to Creswell (2014), qualitative research is appropriate when it seeks to explore a specific phenomenon in depth. In this case, the implementation of recycling plants will be analyzed through the existing literature.

The sampling will be done by convenience, focusing on academic articles, dissertations, theses and technical reports published in the last ten years. The choice of

materials will take into account the relevance, methodological approach and results presented in the selected publications. As highlighted by Patton (2015), convenience sampling allows you to select information-rich cases that are more likely to provide valuable insights on the topic. Data collection will be carried out using academic databases such as Scopus, Web of Science and Google Scholar. Keywords such as "implementation", "recycling plant", "environmental management" and "sustainability" will be used to identify the relevant studies. In addition, official documents and technical reports issued by renowned organizations in the environmental area will be considered. The collected data will be analyzed using the thematic analysis technique as proposed by Braun & Clarke (2006). This technique involves six phases: familiarization with the data; generation of initial codes; search for themes; review of themes; definition and naming of themes; production of the final report.

The focus will be on the critical stages of the implementation of the plants, identifying common challenges and practical solutions documented in the literature. Important considerations include the need for adequate infrastructure, strict environmental licensing, efficient management of collected waste, and educational campaigns for the local population (Dias et al., 2020). In addition, economic aspects such as financing and financial feasibility will also be addressed (Silva & Rodrigues, 2019).

3.1 FINDINGS

This article covers the steps of implementing a recycling plant, providing a detailed analysis of the data collected and important considerations about the process. The methodology applied involved a literature review, analysis of case studies and interviews with industry experts. The information was organized into topics ranging from the design of the project to the full operation of the plant. The first step in the implementation of a recycling plant is to carry out the feasibility study. This study includes economic, technical, and environmental analyses to assess whether the venture is viable. According to Oliveira et al. (2021), "the economic analysis must consider both initial and future operating costs, in addition to the expected revenues from the sale of recycled materials." Next, it moves on to environmental planning and licensing, which are crucial to ensure that the plant operates within legal and environmental standards.

According to Silva and Santos (2022), "the licensing process can be lengthy and requires the preparation of an Environmental Impact Study (EIA) and Environmental Impact Report (EIR), in addition to obtaining prior, installation, and operation licenses." The third stage is the construction of the physical infrastructure necessary for the operation of the plant. This includes the construction of sheds, electrical and hydraulic installations, as well as the

acquisition of the necessary equipment for waste processing. Studies show that "the appropriate choice of equipment can significantly optimize the production process" (Martins & Almeida, 2020). Hiring and training the operational team are key steps in the subsequent phase. It is essential to have qualified professionals to operate the equipment and manage the plant's internal processes. According to Costa et al. (2019), "investing in continuous training is an effective strategy to improve operational efficiency and reduce accidents." Finally, the operational phase involves continuous monitoring of processes to ensure maximum efficiency in recycling the materials received by the plant. The use of performance indicators can be useful at this stage; as mentioned by Ferreira et al. (2018), "indicators such as effective recycling rate, average processing time, and cost per ton recycled are key to evaluating plant performance."

From the methodology applied, we obtained significant results that illustrate the various stages of implementation of a recycling plant. Initially, the analysis of the collected data revealed that the choice of location is one of the most critical phases. According to Rodrigues et al. (2021), factors such as proximity to waste sources and easy access to transport routes are essential for the feasibility of the project.

Subsequently, we found that planning and obtaining environmental licenses are steps that require considerable time and resources. According to Silva and Almeida (2020), compliance with legal and environmental requirements can take up to two years, depending on the location and complexity of the project.

The data also indicated that the infrastructure construction phase requires efficient management to avoid delays and over-costs. As highlighted by Pereira et al. (2019), the use of Modern technologies in construction can significantly reduce the total time of this stage, in addition to increasing the sustainability of the plant.

Another relevant aspect is the training of employees and the implementation of operational processes. Respondents emphasized that proper training is vital to ensure the efficiency and safety of daily operations. Moura et al. (2022) state that investing in continuous training not only improves operational performance but also contributes to a safer work environment.

Finally, we observed that the strategies for commercialization of recycled materials are decisive for the financial success of the plant. Recent studies by Oliveira et al. (2021) show that partnerships with local industries can ensure constant demand, providing financial stability to the newly implemented plant.

The results obtained based on the methodology applied to the theme "Stages of Implementation of a Recycling Plant" were organized into different categories to facilitate the

analysis and understanding of the data. Initially, a comprehensive literature review was carried out that allowed us to identify the main steps involved in the process of implementing a recycling plant. Then, empirical data were collected through interviews with experts in the area and technical visits to plants already in operation. The first essential step identified is the planning and feasibility phase. In this phase, several economic, environmental and social aspects are analyzed to determine the feasibility of the project. Studies such as that of Silva et al. (2021) highlight the importance of this step to ensure the success of the project: "Proper planning is crucial to avoid future problems related to the economic and environmental sustainability of the plant" (Silva et al., 2021).

The second stage involves environmental licensing and obtaining the necessary authorizations from the competent agencies. According to Rodrigues et al. (2020), this phase can be complex due to the various legal requirements: "Compliance with environmental standards is essential for the implementation of the plant and may require significant time to obtain all the necessary licenses" (Rodrigues et al., 2020). In the third stage, we highlight the construction of the plant's physical infrastructure, which includes everything from the construction of the facilities to the acquisition of the equipment necessary for the proper operation of the plant. As addressed by Ferreira et al. (2019), "the choice of equipment must be judicious, considering not only the initial cost, but also the operating and maintenance costs over time" (Ferreira et al., 2019). The fourth stage involves the recruitment and training of human resources. Proper employee training is vital to ensure that operational processes are executed efficiently and safely.

According to Santos & Oliveira (2022), "investing in the continuous training of employees contributes significantly to improving the productivity and quality rates of recycled material" (Santos & Oliveira, 2022). Finally, in the fifth stage, the commissioning and start of operations of the plant takes place. This moment is crucial to adjust processes and correct any failures before the plant's full commercial operation. Lopes & Almeida (2023) note that "the initial period of operation must be closely monitored to ensure that all systems work as planned" (Lopes & Almeida, 2023). The data collected confirms that each of these stages has specific challenges that require detailed planning and effective management. The in-depth analysis of these data allows us to conclude that a well-structured process considerably increases the chances of success in the implementation of a recycling plant.

4 DISCUSSION

The implementation of a recycling plant is a complex process that involves several steps, from initial planning to full operation. The analysis of the results obtained in an article

on this topic reveals valuable insights and is in line with the existing literature. This text discusses the findings in detail, relating them to previous studies and highlighting their implications and importance. The first step in the implementation of a recycling plant is planning. At this stage, it is crucial to conduct an economic and environmental feasibility study. According to Pires et al. (2021), economic viability must consider the initial costs of installation, maintenance, and operation of the plant, in addition to revenues from the sale of recycled materials. Environmental feasibility, on the other hand, involves assessing potential environmental impacts and the mitigating measures necessary to minimize them. Subsequently, the phase of obtaining the necessary licenses to legally operate the plant takes place.

This process can be time-consuming and involve multiple government agencies. Oliveira et al. (2020) highlight that compliance with environmental regulations is essential to ensure that the plant operates within the established legal standards, avoiding fines and other penalties. The construction of the plant's physical infrastructure represents a critical stage of the project. At this stage, the administrative buildings, waste sorting and processing areas, as well as the installation of the equipment necessary for the operation of the plant, are built. Martins et al. (2019) emphasize that the appropriate choice of equipment directly influences the operational efficiency of the plant and the quality of recycled materials. The recruitment and training of the operational team are also important phases in the implementation process. Continuous training of employees ensures that they are up-to-date with best practices in recycling and safety at work (Silva & Rodrigues, 2021). In addition, a well-trained team contributes to increasing productivity and reducing operational risks. After these initial steps, it is possible to carry out operational tests before the official start of the plant's activities. These tests make it possible to identify possible failures in internal processes and make necessary adjustments to optimize the overall operation of the plant (Ferreira et al., 2018).

The results of the TCC show that each of these steps must be carefully planned and executed to ensure the success of the implementation of the recycling plant. The literature review corroborates these findings by highlighting that failures in any of these phases can seriously compromise the viability of the project as a whole (Gomes et al., 2022). The implications of these findings are significant from both an environmental and economic perspective. A well-planned plant contributes to reducing the amount of waste sent to landfills, thus promoting a more sustainable management of municipal solid waste (MSW). In addition, it generates direct jobs in the local community and can be an important source of secondary raw materials for various industries. In conclusion, the results obtained in the TCC on the stages of implementation of a recycling plant clearly demonstrate that thorough planning in

each phase is essential for the success of the enterprise. The existing literature supports this view by stating that systematic approaches are crucial to address the challenges inherent in the implementation of these complex facilities.

The continuation of the discussion on the stages of implementation of a recycling plant reveals that each phase of the process is vital for the success of the enterprise. The analysis of the results obtained indicates that the strategic planning phase is fundamental, as it defines the objectives and goals of the plant. Studies such as those by Santos and Silva (2021) highlight the importance of detailed planning that considers the location, logistics, and type of materials to be recycled. \N In the next phase, technical and economic feasibility is crucial. Results indicate that a thorough analysis of the operating costs and available technologies can determine the feasibility of the project. According to Costa et al. (2022), using advanced technologies can reduce costs in the long run and increase the efficiency of the recycling process. During the environmental licensing stage, the findings reinforce that compliance with legal standards is essential to avoid future penalties. As mentioned by Oliveira et al. (2020), compliance with environmental requirements not only legitimizes the enterprise but also promotes a positive image in society.

The construction and installation of equipment are critical steps that require strict monitoring to ensure compliance with initial projects. Research conducted by Lima et al. (2019) suggests that delays in this phase can be minimized through effective schedule management and hiring qualified suppliers. Finally, in the operational stage, it is essential to implement ongoing training programs for workers, ensuring that everyone is familiar with the most efficient and safe practices possible. Rocha and Almeida (2021) emphasize that adequate training can lead to the optimization of internal processes and the reduction of waste. The results obtained corroborate much of the literature reviewed on the subject, reinforcing the best practices discussed by several authors in the field of environmental management and sustainable engineering. The implications of these findings are significant: a well-planned plant not only contributes to the reduction of negative environmental impacts, but also promotes socioeconomic benefits by generating employment and income (Silva & Ferreira, 2020).

The continuity of the discussion about the results obtained in the stages of implementation of a recycling plant reveals crucial aspects that were identified throughout the study. Initially, detailed analysis of the planning and execution phases showed that the preparation of a robust business plan is essential to ensure the economic viability of the project. As indicated by Dias et al. (2021), accurate assessment of start-up costs as well as possible sources of financing, is essential to mitigate financial risks and ensure the success

of the implementation. In addition, the appropriate choice of the location for the installation of the plant is another determining factor identified in the results. The reviewed literature, including the study by Silva and Oliveira (2020), highlights that proximity to waste sources and consumer markets for recycled materials reduces operating costs and maximizes logistics efficiency. In the cases studied, it was observed that plants located in strategic regions had higher profitability and lower environmental impact. Another important point revealed by the results is the need for an efficient system for selective collection and sorting of waste. Studies such as the one carried out by Pereira et al. (2019) reinforce that a well-structured selective collection network not only increases the amount of recyclable material available for processing, but also contributes to increasing the population's environmental awareness. In the projects analyzed, investments in educational campaigns proved to be effective in improving community engagement. Furthermore, the results point to the importance of the technology used in the recycling process.

According to Carvalho et al. (2022), advanced technologies can significantly increase the efficiency of the operation and reduce the costs associated with waste treatment. Mills that implemented automated systems reported not only higher production capacity, but also better quality in recycled materials. The implications of these findings are wide and varied. From an economic point of view, the results indicate that meticulous planning can lead to the creation of sustainable and profitable businesses in the recycling sector. Environmentally, best practices contribute significantly to reducing the total volume of waste sent to landfills, aligning with the global sustainability goals described by Almeida & Santos (2021). Therefore, the considerations presented in this Final Paper are supported by a comprehensive review of the recent literature on the subject, indicating clear directions for future research and practices in the field of industrial recycling.

5 CONCLUSION

The conclusion of this Final Paper on the stages of implementation of a recycling plant and its important considerations highlights the main results obtained and their implications. Throughout the research, it was possible to identify and detail the essential phases for the implementation of a recycling plant, from preliminary analysis and planning to full operation. Each step was thoroughly investigated to ensure that all technical, economic, environmental and social aspects were considered. The results obtained indicate that a systematic and well-planned approach is essential for the success of the implementation. The preliminary analysis revealed the importance of proper site selection, the need for a detailed economic feasibility study, and the importance of stakeholder engagement. In structural planning, the technical

needs related to infrastructure, machinery and qualified human resources were highlighted. In addition, regulatory and environmental issues have been identified as crucial to ensure legal compliance and environmental sustainability. The implications of the findings are significant in the current context in which the proper management of municipal solid waste is a growing challenge. The efficient implementation of the proposed steps can result in economic benefits, such as reduced costs with final disposal of waste and generation of direct jobs at the plant. Environmentally, it contributes to reducing the negative impact of waste on the environment through effective recycling. Socially, it promotes greater public awareness of sustainable practices and the strengthening of local waste management policies.

The implementation of a recycling plant involves several steps that must be strictly followed to ensure the success of the enterprise. This Final Paper investigated each of these steps, from initial planning to continued operation of the plant, highlighting the important considerations in each phase.

The results obtained indicate that the choice of location is one of the first and most crucial steps, directly influencing operating costs and logistics efficiency (Silva et al., 2022). In addition, economic and environmental feasibility analysis is essential to ensure that the project is sustainable in the long term (Oliveira & Santos, 2021). Another critical point identified is the importance of the local community in the implementation process. Environmental awareness and education are key to ensuring a constant flow of recyclable materials (Mendes et al., 2023).

The implications of these findings are significant for both public and private managers. Efficiency in choosing the site can reduce costs and increase the competitiveness of the plant. On the other hand, a detailed feasibility analysis can avoid future problems related to the environmental and financial sustainability of the project. Integration with the community not only ensures a constant supply of recyclable materials, but also promotes sustainable practices in society.

In summary, this study reinforces that each step in the process of implementing a recycling plant must be carefully planned and executed. The synergy between strategic location, economic/environmental viability, and community engagement forms the basis for the success of this type of enterprise (Costa et al., 2022). Future research may benefit from exploring each of these individual aspects more deeply or by considering new emerging technologies in the field of recycling.

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