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Assessing waste management practices among manufacturing companies in KwaZulu-Natal

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Abstract

This paper assesses waste manufacturing practices among manufacturing companies in KwaZulu-Natal (KZN). A survey questionnaire was used to collect the data from 288 manufacturing companies within KZN province. Statistical Package for Social Sciences (SPSS) and Excel were used in this research to modify, process, manipulate, test, and interpret data. The study findings indicate that industrial waste constitutes 66.7% of the total waste generated, while municipal waste accounts for 34.7%. Despite the significant waste output from manufacturing activities, only 30.9% of companies implement recycling practices. Additionally, approximately 35% of the sampled companies dispose of waste without employing any measures to prevent or minimise waste generation. Financial constraints, limited knowledge, lack of government support, limited space, inadequate infrastructure, and uncertainty of returns were among the challenges mentioned by the surveyed companies that they are facing in discovering and implementing waste management solutions. This research underscores the importance of fostering a culture of appropriate handling of waste within manufacturing companies as a strategic imperative for sustainable development and long-term viability in an increasingly resource-constrained world. The findings of this research are useful for policymakers and stakeholders to develop practices that promote environmental sustainability.

Keywords: Waste Generation; Practices; Manufacturing; Environmental Sustainability

1. Introduction

In the pursuit of economic development and sustainable growth, the manufacturing sector stands as a cornerstone of many regional economies, including KwaZulu-Natal (KZN), South Africa. However, alongside the sector's significant contributions to employment and gross domestic product (GDP), manufacturing activities generate substantial waste streams that present environmental challenges that demand sustainable solutions [1]. This research focused on assessing the waste management practices among manufacturing companies in KZN. Globally, the impact of waste management on environment is one of the most discussed issues in international affairs because of the threats it poses to communities. After global warning, waste management is regarded as one of the critical environmental issues that disrupt the balance of nature [2].

Among the key sectors that contribute towards a country's GDP, manufacturing is likely one of the largest generators of waste in the world [3]. According to World Economic Forum [4], manufacturing sector serves as a key driver of economic growth, comprising 16% of the world GDP. However, the economic activities within sector also pose significant environmental threats. KZN has the second largest economy in the country which contributes 16% towards South Africa's GDP, with manufacturing sector constituting largest and strongest growth in the provincial economy [5]. Additionally, it contributes to exports and employment, and the jobs tend to be better paying, stable and less vulnerable to shocks compared to other sectors. These attributes have historically made, and continue to make, manufacturing a focus sector for development efforts by many countries, and South Africa is no exception [1]. Despite manufacturing

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sector plays a significant role in KZN's economy. It generates substantial waste streams, including solid waste, wastewater, and emissions, which pose environmental risks. The current traditional waste management methods applied to deal with this waste are inadequate, inefficient, and environmentally harmful.

Despite the increasing emphasis on sustainability, many manufacturing companies still struggle to implement effective waste management practices, leading to environmental degradation and financial losses. This problem has been linked to malpractice of waste management, lack of integration of innovation and technological advancement that result in significant social, environmental, and economic consequences, underscoring the importance of embracing new solutions in this critical field. More importantly, the lack of expert knowledge and lack of allocated resources were reported as the main barriers in implementing environmental strategies in companies [6; 7]. The absence of these adequate resources to handle waste management has resulted in waste management malpractices and incorrect handling of waste that contains socioeconomic and environmental costs extending beyond the city boundaries. The manufacturing sector and production account for one-fifth of the carbon emission and 54% of the world's energy use [4].

Notwithstanding, South Africa's waste management landscape changing and regarded as the most efficient on the continent, the country is still subject to large amounts of waste annually. South Africa generates approximately 122 million tons of waste per annum, of this waste only 10% of the generated waste is recycled leaving at least 90% of the waste dumped illegally causing environmental degradation [8]. Furthermore, more than 55 million cubic meters of hazardous waste is generated mostly in Mpumalanga and KZN [9]. Therefore, this research assesses current waste management practices, challenges, and opportunities for improvement. The findings of this research set to provide valuable insights for the academic community, manufacturing stakeholders, and government entities, contributing to the development of effective waste management solutions. This research aims to answer the following research objectives i) assess current types of waste generated by manufacturing companies in KZN, ii) to identify waste management practices across various industries in KZN, iii) Assess waste segregation and sorting among manufacturing companies in KZN and iv) to provide recommendations for enhancing sustainable waste management solutions.

2. Literature review

Issues related to waste management have become a global concern worsened by the significant increase in economic activities, increase in the world population, more complex waste consumption, and a greater need for sustainable environment [10]. This section sets out to present an overview of waste management regulations and highlight barriers in waste management practices. A waste management system is viewed as streamlined process that organisations use to dispose of, reduce, reuse and prevent waste [11]. Also known as waste disposal, it is an approach where organisations implement comprehensive strategies to manage waste from their origin until their final disposal. Possible waste disposal methods are recycling, composting, incineration, landfills, bioremediation, waste to energy and waste minimisation.

2.1. Overview of South African Waste Management Legislative Framework

In South Africa, the approach to waste management is structured around waste hierarchy [12]. The waste management hierarchy varies between countries and regions. In South Africa, this hierarchy encompasses different stages. Each represents an approach to waste management arranged in priority descending order. The hierarchy prescribes how waste is treated and managed, providing strategies for avoiding and reducing waste as well as, reusing, and recycling. Given these strategies, waste can only be disposed as a last resort [9].

The waste management hierarchy in South Africa follows a prioritized approach that aims to minimise waste generation, maximising resource recovery, and reducing environmental impacts. The hierarchy emphasises the importance of prioritising waste prevention and resource recovery over disposal to minimise environmental impacts, conserve resources, and promote sustainable waste management practices in South Africa [13].

Manufacturing industry is subject to a wide range of regulatory frameworks such as waste minimisation, recycling and reuse, waste segregation, waste to energy. Waste legislation is one of the key drivers of innovation in the waste management industry. The updated National Waste Management Strategy [13] talks about the circular economy, waste beneficiation, job creation and SMME development. In comparison with other developing countries, South Africa has a relatively robust regulatory framework. However, there is slightly or little no enforcement for legislation [12].

Waste management guidelines in manufacturing companies in South Africa are primarily governed by environmental regulations. These regulations include the National Environmental Management: Waste Act (No.59 of 2008) [14] which

deals with the management and minimization of waste, the disposal of waste, and the establishment of norms and standards for waste management. It also sets out the responsibilities of various role-players, including government authorities, waste generators, and waste management facilities. The Act also promotes sustainable development, protects the environment, and ensures that economic activities are conducted in a manner that minimizes negative environmental impacts and promotes the well-being of present and future generations in South Africa. Further, the Act sets out the overarching policy direction and objectives for waste management in South Africa, providing guidelines for waste prevention, minimization, recycling, recovery, treatment, and disposal, as well as strategies for institutional capacity-building and public participation [13]. Waste Classification and Management Regulations (GNR 634 of 2018) [15] is another regulatory framework that provides guidance on how manufactures can resolve the issue of waste management. This regulation provides the criteria and procedures for the classification, management, and disposal of waste. They classify waste into various categories and prescribe standards and requirements for the handling, storage, transportation, treatment, and disposal of different types of waste [15].

In addition to these legal frameworks, regulatory authorities such as the Department of Environment, Forestry, and Fisheries and provincial environmental departments enforce waste management regulations and oversee compliance by manufacturing companies. They aim to ensure that waste is managed in a manner that protects human health and the environment, promotes resource recovery and recycling, and minimise the generation of waste and pollution in South Africa. Compliance with these regulations is essential for businesses, industries, municipalities, and other stakeholders involved in waste management activities.

The waste management industry is faced by various technological challenges that hinder the adoption of advanced technological methods. Yadav, Soni and Kumar [16] have identified significant barriers that prevent the adoption of technological methods in waste management strategies that encourage environmental sustainability. This includes barriers such as lack of strict government regulatory policies, poor financial planning, and lack of benchmarking processes. Other barriers that hinder the transition to technology and the integration of renewable solutions in manufacturing include high initial cost, technological limitations and unskilled workers [17].

3. Research Design and Methodology

This research employed a quantitative research method by utilizing a survey questionnaire as the research instrument to collect data from all 10 districts in KZN, including its metropolitan area, a province in South Africa known for its diverse communities and economic sectors. Non-probability sampling technique was employed which better fits the purpose of the research. The target population for this research are industrial manufacturing companies in KZN such as textile, chemical, steel, plastic and paper industry among others that are processing raw materials into finished products. Companies and representatives were chosen based on their operational sectors, industry experience, use and knowledge of waste management practices.

This research is conducted objectively and ethically to ensure that it is not harmful, biased, unfair, or discriminatory to any party. Closed-ended questions were used to collect the data as they are useful for quantifiable and standardised responses, and open-ended questions were used to collect deeper qualitative data as this allow respondents to provide detailed responses [18, 19]. Statistical Packages for the Social Science (SPSS) and Excel were utilised in this research to modify, process, manipulate, test and interpret data.

4. Results analysis

This section presents the interpretation of results. The analysis of results, firstly, outlines the summary of demographics. Furthermore, this section delves more into analysis the responses related in assessing waste management practices employed by manufacturing companies in KZN.

4.1. Characteristics of respondents

4.1.1. Respondents' distribution by district municipality

Figure 1 shows that most respondents are from eThekwini Metropolitan, which accounts for 26%, reflecting its role as a major industrial hub in KwaZulu-Natal. uMgungundlovu and Harry Gwala Districts follow with 14% and 12% respectively, while King Cetshwayo, Ugu, and uMkhanyakude each contribute 8%. uMzinyathi and Amajuba each represent 6%, with smaller contributions from Zululand at 4% and uThukela at 3%. This distribution highlights the concentration of manufacturing activities in more urbanised areas, with less representation from rural districts.

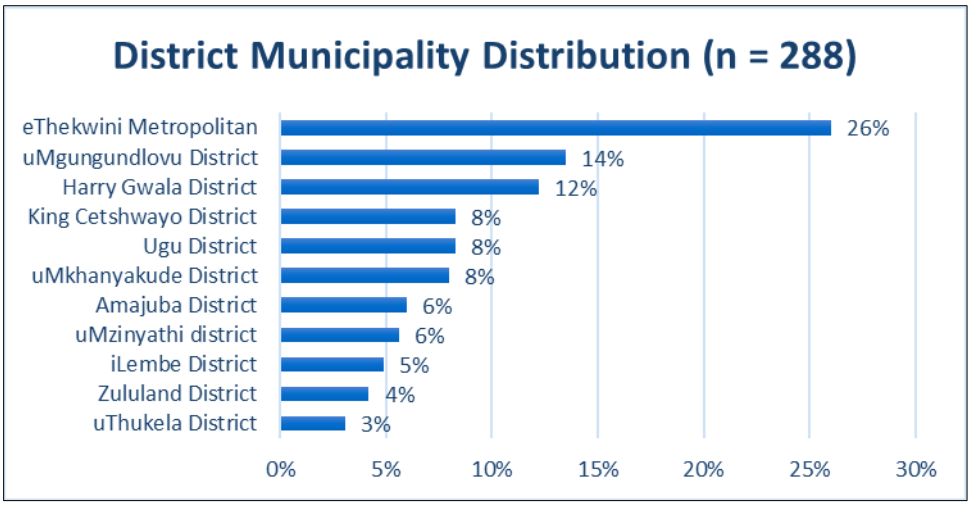

Figure 1 District Municipality Distribution

4.1.2. Manufacturing sector distribution

Figure 2 reveals that the metals and engineering sector leads the manufacturing industry, accounting for 29% of the companies. The textile, clothing, and footwear manufacturing sector follows closely at 16%, and furniture-related products manufacturing accounts for 15%. Other notable sectors include plastic and rubber manufacturing at 8% and building materials at 7%. There is a relatively small contribution from sectors like chemical manufacturing (6%), paper and pulp manufacturing (4%). Sectors such as metals and engineering, and automotive manufacturing make up a very small portion, in which each sector contributes less than a percentage of the total respondents.

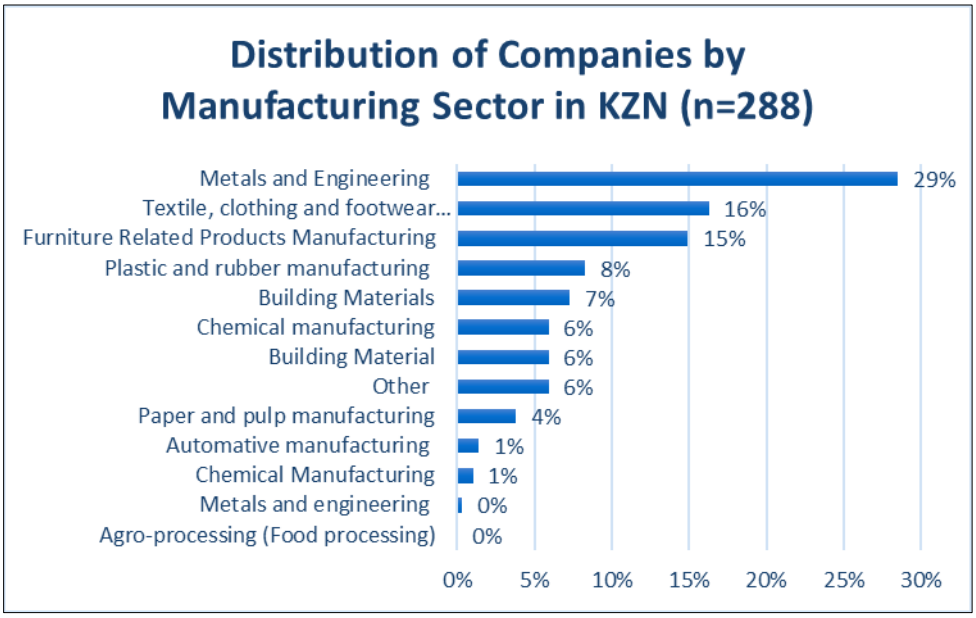

Figure 2 Distribution of Companies by manufacturing sector

4.1.3. Company existing years

The data on company existence shows that 40% of the approached companies have been operating for 20 years or more, representing the largest share with 114 companies (Figure 3). This indicates a strong presence of long-established businesses. Companies in operation for 0-5 years make up 22%, while those in 6-10 years account for 21%. Companies that have been active for 11-20 years represent 17% of the total. This distribution highlights that the study includes both well-established companies and a notable portion of newer ones.

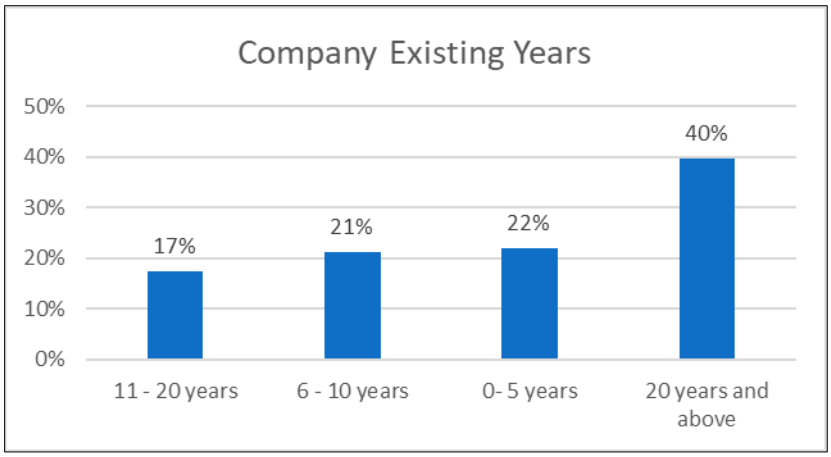

Figure 3 Company existing years

4.2. Existing Waste Management Practices

4.2.1. Types of Waste Generated from Manufacturing Companies

Figure 4 below shows the type of waste generated by manufacturing companies in their production processes; industrial waste is the most produced waste (66.7%). The municipal solid waste follows at approximately (34.7%), while construction and demolition waste constitute (11.8%) of the waste generated from manufacturing activities. The least common type of waste generated from manufacturing activities is fabric and textile waste (5.2%). The most notable figure is for industrial waste (66.7%), which suggests that traditional manufacturing processes typically involving cutting, machining, or drilling take place and generate a considerable amount of scrap and excess material. Thus, addressing these issues through better design, technology, and waste management practices can help manufacturing companies reduce their industrial waste significantly.

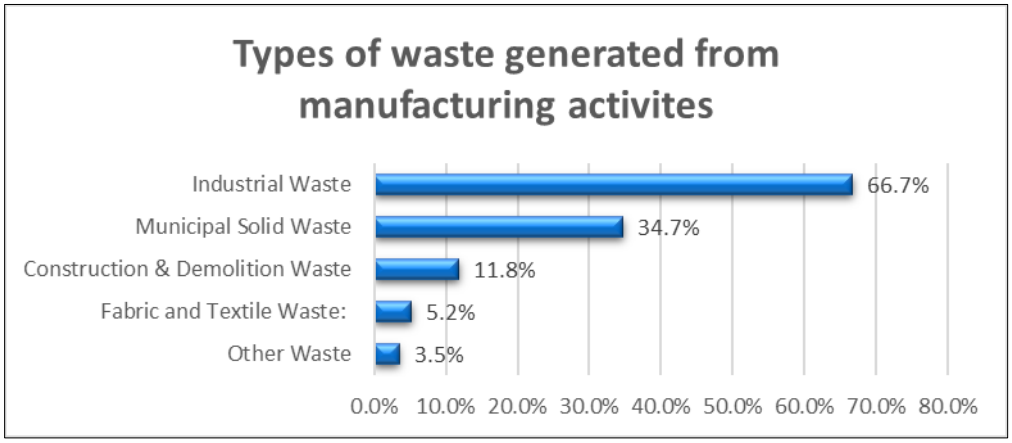

Figure 4 Type of generated waste

4.2.2. Waste Management Practices Among Manufacturing Companies

Figure 5 presents responses from manufacturing companies regarding their waste management practices. It shows that 35% of companies primarily dispose of waste, while 30.9% recycle it. Reuse is practiced by 24.7% of companies, and 8.2% recover waste. Other methods such as selling offcuts, outsourcing, and landfilling amounted to 1.2%. This suggests that most companies prioritise disposal, with recycling and reuse also playing significant roles. However, innovative, or alternative methods like recovery or selling offcuts are much less common, indicating room for growth in more sustainable waste management practices.

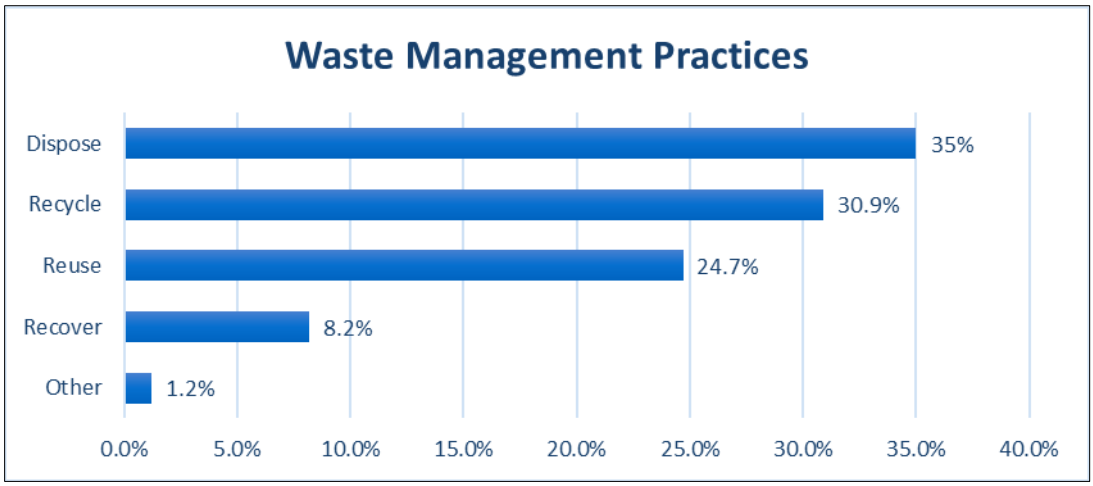

Figure 5 Waste Management Practices

4.2.3. Waste segregation and sorting

Figure 6 illustrates the various methods used by manufacturing companies to segregate and sort waste. The majority (41.3%) of companies use bins for different types of waste, indicating a common practice of separating waste at the source. Following this, 27.3% of companies mix all types of waste into a single bin, reflecting a lack of formal waste segregation protocols. A significant 16.8% of respondents reported that waste segregation is not applicable to their operations, suggesting that either waste management is outsourced, or the nature of the business does not necessitate waste sorting. Additionally, 9.2% of companies use color-coded containers to aid in the segregation process, offering a slightly more structured approach to waste sorting. Other methods, comprising 5.4%, include practices outside of the main categories, though specific details about these practices were not captured in the survey. This data suggests that while many companies engage in basic waste segregation techniques, a portion still relies on mixed waste disposal, and more advanced or specialized methods remain relatively uncommon.

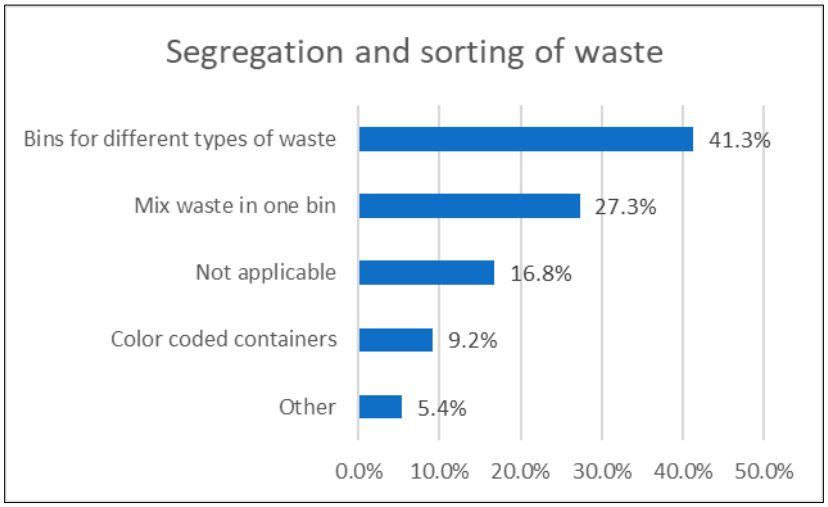

Figure 6 Waste segregation and sorting

4.3. Challenges and barriers faced by manufacturing companies in implementing innovative waste management solutions

4.3.1. Challenges faced by manufacturing companies to improve and implement waste management solutions

The survey results indicate that while most manufacturing companies in KwaZulu-Natal (88%) did not report significant challenges, a small but notable portion of companies are struggling with key barriers to improving their waste management practices (Figure 7). The most reported issues are financial constraints (2%) and limited knowledge (2%), with some companies also facing challenges related to inadequate infrastructure (1%) and limited space (1%). These

findings suggest that while most companies do not face major obstacles, targeted interventions addressing funding, knowledge-sharing, and infrastructure improvements could support the companies that are experiencing difficulties. These challenges are similar to the results reported by Polasi, Matinise and Oelofse [20].

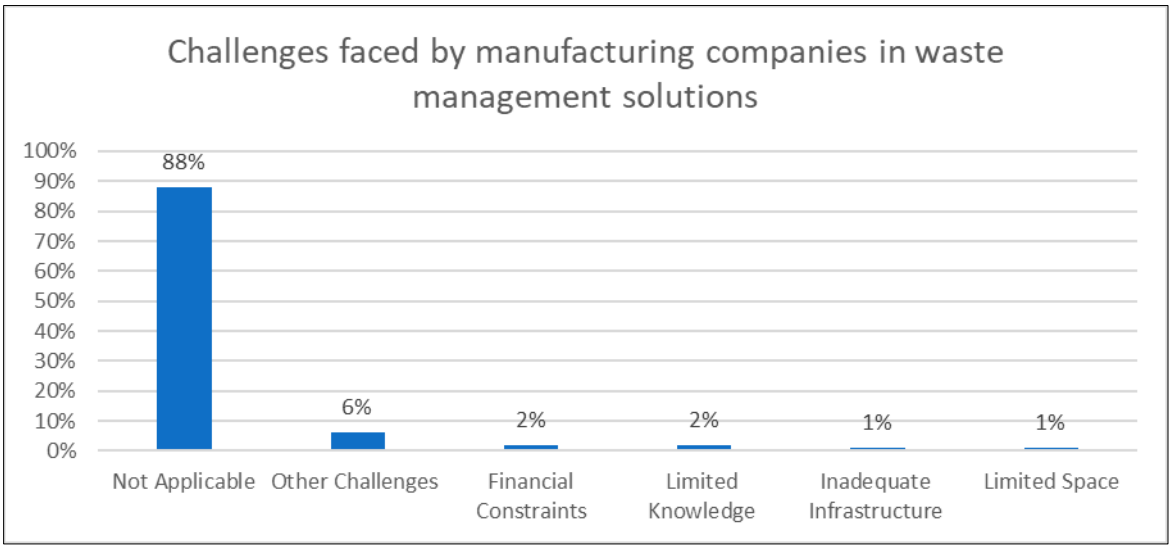

Figure 7 Implementation of Waste Management Solutions

5. Conclusion

This research assessed waste management practices among manufacturing companies in KZN provincial economy using quantitative research methods. Firstly, in assessing the current state of waste management practices in manufacturing companies, the results revealed that the most common type of waste that is generated from manufacturing process activities is industrial waste 66.7%%, followed by municipal waste 34.7%, construction and demolition waste 11.8%, fabric and textile waste 5.2%. Any other waste that is created during manufacturing activities was grouped in one "other" waste category that includes waste such as saw dust, oil and gas production waste, concrete waste among others that amounted to 3.5% of generated waste.

These results reveal that as manufacturing companies conduct their day-to-day business operations, they are likely to produce a substantial ton of industrial waste. With all the created waste, 35% of the surveyed companies are disposing their waste while only 30.9% are recycling their waste. Companies that are re-using their waste amounted to 24.7%, with only 8.2% of the companies that are recovering their generated waste from business activities. This significantly states that most manufacturing companies choose to dispose their waste. This is inconsistent with the Department of Environmental Affairs' [13] waste hierarchy that the disposal of waste should be the last resort.

Furthermore, 88% of companies surveyed revealed that they are not facing any barriers in implementing and improving waste management. With 12% of those companies indicated that they are facing challenges such as financial constraints, limited knowledge, inadequate infrastructure, limited space, and lack of return in investment in implementing those new solutions. These results further reveal that most manufacturing companies are not working on improving their waste management, that is the reason they have not encountered any challenges in improving their waste management.

Several recommendations can be deducted from this research. Manufacturing companies need to foster the culture of sustainability by engaging employees at all levels in waste management education and awareness programs. By doing so, companies can significantly reduce waste and contribute positively to the environment. As Mavitenga [6] and Bagherian [7] indicated that the lack of knowledge is also contributing to inappropriate handling of waste among manufacturing companies. The companies are also encouraged to invest in today's technology such as 3D to reduce material waste especially in industries such as fabric, textile and footwear, furniture related sectors, plastic and paper sectors that mostly create the waste from product measurements. As Narkhede, Chinchanikar, Narkhede and Chaudhari [21] argued integrating both traditional methods and advanced technology is considered important for growth of manufacturing sector, this approach was also recommended by Nwokediegwu, Ugwuanyi, Dada, Majemite and Obaigbena [22].

On the other hand, regulatory compliance is essential for ensuring that manufacturing companies manage waste responsibly and avoid penalties. By aligning compliance with incentives, companies can achieve significant environmental and economic benefits. It has been reported that despite waste management in South Africa being governed by key legislations such as The South African Constitution (Act 108 of 1996) [23], The National Environmental Management Act (Act 107 of 1998) [14]; National Environmental Management: Waste Act, 2008 (Act 59of 2008) [15], and National Waste Management Strategy among other pieces of legislation there is little or no enforcement for all these legislations in practice.

This research focused on assessing waste management practices within manufacturing companies. Other studies can extend this research by looking at other sectors on how they integrate innovation and advanced technologies to manage their waste. Other factors such as regulations, infrastructure, education and awareness that are main contributors in environmental sustainability can be looked at for future studies.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

References

[1] Mnguni P, Simbanegavu W. South African Manufacturing Sector: Situational Analysis. South African Reserve Bank Occasional Bulletin of Economic Notes OBEN 20/02; 2020.

[2] Vats R, Clonia R. Transforming Waste Management practices through Blockchain Innovations. In: Blockchain Transformations. 2024; p. 221–228.

[3] Ishola B. Handling waste in manufacturing: Encouraging re-manufacturing, recycling and re-using in the United States of America. Procedia Manufacturing. 2019;39.

[4] World Economic Forum. Reducing the carbon footprint of the manufacturing industry through data sharing. [Internet]. 2023. Available from: www.weforum.org/impact/carbon-footprint-manufacturing-industry

[5] Economic Development, Tourism, and Environmental Affairs. The KwaZulu-Natal Quarterly Economic and Statistical Overview. 2024.

[6] Mativenga PT, Ogwa-Ejon J, Mboha C, Sultan AAM, Shuaib NA. Circular economy ownership models: A view from South African Industry. 14th Global Conference on Sustainable Manufacturing. Stellenbosch, South Africa, 3-5 October 2017. Procedia Manufacturing. 2017;8:284–291.

[7] Bagherian A, Srivas A, Mukherjee S. Exploring barriers and strategic approaches in smart factory adoption: a real-world case study in a German manufacturing company. Sept 2024;134:5191-5224.

[8] Infrastructure News. State of South African Waste Industry. 3SMedia. 2022.

[9] Nkosi N, Muzenda E, Zwimba J, Pilusa J. The Current Waste Generation and Management Trends in South Africa: A Review. International Conference on Integrated Waste Management and Green Energy Engineering [Preprint]. 2013;4.

[10] Schenck CJ, Nell CM, Grobler L, Blaauw PF. Clean cities and towns: Understanding societal behaviour in order to reduce and divert waste going to landfills. Research Chair in Waste and Society. 2022.

[11] Mashudi S, Sulistiowati R, Handoyo S, Mulyandari E, Hamzah N. Innovative strategies and technologies in waste management in the modern era integration of sustainable principles, resource efficiency, and environmental impact. Int J Sci Soc. 2023;5(4).

[12] Department of Environmental Affairs. South Africa State of Waste Report. Pretoria, South Africa: Department of Environmental Affairs; 2018.

[13] Department of Environmental, Forestry and Fisheries. National Waste Management Strategy. Republic of South Africa; 2020.

[14] South Africa (SA). National Environmental Management: Waste Act; Act No. 59 of 2008. South African Government Gazette: Pretoria, South Africa; 2008.

[15] Department of Environmental Affairs. National Environmental Management: Waste Act, 2008 (Act No. 59 of 2008): Waste Classification and Management Regulation. Government Gazette, No. 36784; 2013.

[16] Yadav H, Soni U, Kumar G. Analysing challenges to smart waste management for a sustainable circular economy in developing countries: a fuzzy DEMATEL study. Smart and Sustainable Built Environment. 2023;12(2):361-384.

[17] Usman FO, Ani EC, Ebirim W, Montero DJP, Olu-lawal KA, Ninduwezuor-Ehiobu N. Integrating renewable energy solutions in the manufacturing industry: Challenges and opportunities: A Review. Eng Sci Technol J. 2024;5(3):674–703.

[18] Mishi S, Maredza A. Research methods for economics. 1st ed. Pretoria: Van Schaik Publishers; 2023.

[19] Saunders M, Lewis P, Thornhill A. Research Methods for Business Students. 5th ed. Harlow: Pearson Education; 2012.

[20] Polasi T, Matinise S, Oelofse S. South African Municipal Waste Management Systems: Challenges and solutions. 2020.

[21] Narkhede G, Chinchanikar S, Narkhede R, Chaudhari T. Role of Industry 5.0 for driving sustainability in the manufacturing sector: An emerging research agenda. J Strategy Manage. 2024; Emerald Publishing Limited.

[22] Nwankwo CO, Ninduwezuor-Ehiobu N, Ani EC, Olu-lawal KA, Ugwuanyi ED. Implementing circular economy principles to enhance safety and environmental sustainability in manufacturing. Int J Adv Multidiscip Res Stud. 2024;4(2):22–29.

[23] Republic of South Africa. Constitution of the Republic of South Africa, 1996. Pretoria: Government Printer; 1996.