DEVELOPING BUSINESS OPPORTUNITIES THROUGH WASTE MANAGEMENT IN THE DEMOCRATIC REPUBLIC OF CONGO

Kalengay Mbela[1*], Paulus Anna Kaarina[1], Boniface Kerima[2],

and Banze Alex Mutombo[3]

[1]Department of Education, Faculty of Education and Humanities, University of Namibia.

[2]Department of Accounting, Faculty of Economics, University of Namibia.

[3]Department of Mechanics, Institut Supérieur Pédagogique et Technique de Kinshasa.

[*]Corresponding Author's Email: mkalengay@unam.na

ABSTRACT: *In the Democratic Republic of the Congo (DRC), insalubrity is a serious problem that exacerbates dangers to public health and degrades the environment. In addition to causing urban pollution, poor waste management techniques also offer significant commercial opportunities that can spur economic expansion. This study looks into how effective waste management can turn problems with sanitation into profitable opportunities. To assess the existing status of waste management and its possible economic benefits, a mixed-methods approach was used to gather data from local companies, legislators, and waste management entrepreneurs. The results show that specific investments in waste-to-energy, composting, and recycling programs can improve public health, generate jobs, and promote sustainable urban growth. This study emphasizes how waste management and economic opportunity are intertwined, underscoring the significance of creating creative business models that use waste as a resource to improve the environment and the standard of living for urban dwellers in the Democratic Republic of the Congo.*

KEYWORDS: Waste Management, Democratic Republic of the Congo (DRC), Urbanization, Public Health, Environmental Degradation.

INTRODUCTION

Rapid urbanization is occurring in the Democratic Republic of the Congo (DRC), with major population growth occurring in cities like Kinshasa, Lubumbashi, Goma, and Mbuji-Mayi as a result of both natural population increases and rural-to-urban migration. The increase in population has put tremendous strain on municipal services, particularly waste management systems, which are frequently out-of-date, inadequately funded, or nonexistent in informal settlements. The outcome is an increasing insalubrity crisis, with residential areas seeing open dumping, overflowing drains, and uncollected solid waste. Serious problems with public health are exacerbated by these unhygienic conditions, which also contribute to environmental degradation. In many areas, particularly during the rainy season, waterborne and vector-borne illnesses like cholera, malaria, dysentery, and typhoid fever have become commonplace (Okin, 2024; Mukendi & Kabeza, 2023). Notwithstanding these difficulties, there is an unrealized potential associated with the waste problem. Urban garbage, especially organic, plastic, electronic, and industrial waste, is not only a potential source of economic resources that may be used to support company development, but it also symbolizes a larger systemic failure. Construction materials, recyclable metals and plastics, agricultural compost, and even energy sources like fuel briquettes and biogas can all be produced from waste (Kabwama et al., 2022; Musiana, 2024). Some African nations, such as South Africa and Rwanda, have already seen entrepreneurs, community cooperatives, and private investors show how successful waste valorization models can both solve environmental problems and generate employment.

Strategic waste management investments could spur inclusive economic development in the Democratic Republic of Congo, where informal businesses predominate and unemployment is still significant. It presents the possibility of innovation in green technology, urban agriculture, and renewable energy in addition to the creation of jobs, especially for women and young people. Furthermore, better waste management directly affects urban resilience and public health outcomes, particularly in light of climate change and growing urban vulnerability.

The purpose of this paper is to examine waste's dual character as a problem and an opportunity. It looks at the situation of waste management systems in major Congolese cities today and explores the ways in which local businesspeople, legislators, and members of civil society are embracing the idea of garbage as a resource. The study used a mixed-methods approach to examine the socio-economic and environmental potential of creating sustainable waste management business models. Additionally, the report highlights the necessity of community-driven, integrated strategies, encouraging policy frameworks, and collaborations between the public and private sectors. Showing how converting waste into opportunity may lead to a DRC that is cleaner, healthier, and more economically robust is the ultimate objective.

LITERATURE REVIEW

Rapid urbanization, poor infrastructure, and lax regulatory frameworks have made waste management in sub-Saharan Africa a critical issue (Kaza et al., 2018). The buildup of uncollected solid garbage in metropolitan areas has resulted in serious health hazards for the population, environmental damage, and a decline in quality of life in nations such as the Democratic Republic of the Congo (DRC). Despite these obstacles, the economic potential of garbage is becoming more widely acknowledged, particularly in areas with high rates of

informal entrepreneurship and low levels of formal employment (Wilson et al., 2012; UNEP, 2021). Waste can be converted into useful inputs for various industries, including construction, electricity, and agriculture, according to a number of studies (Pariatamby & Tanaka, 2013). For example, plastic, metal, and electronic garbage can be recycled or reused into commercially viable goods, while organic waste can be utilized to create compost, biogas, or organic fertilizers (Scheinberg et al., 2010). The circular economy, which stresses the continuous use of resources to reduce waste and environmental effect, is in line with these practices (Geissdoerfer et al., 2020). Additionally, waste entrepreneurship—the practice of people and small businesses collecting, sorting, recycling, and upcycling waste—has been the subject of recent scholarship (Gutberlet, 2008; Medina, 2010). These programs frequently provide livelihoods for vulnerable individuals, particularly women and youth, and close important gaps in municipal garbage services. Nonetheless, there are a number of obstacles, such as limited financial resources, insufficient policy backing, and poor public awareness. Research from South Africa, Ghana, and Rwanda demonstrates that waste-based businesses can make a substantial contribution to job creation and urban cleanliness when given the right kind of support, including incentives, training, and legal recognition (Asase et al., 2009; Samson, 2010; Akinbami et al., 2021). These results are pertinent to the Democratic Republic of the Congo, where waste management issues are extremely severe and the urban informal sector is heavily represented. Despite these advancements, the DRC has not gotten much scholarly attention when it comes to waste valuation and how it relates to economic growth. There is still a lack of knowledge about how waste may be reframed as a business opportunity, what sorts of laws might facilitate this change, and how various stakeholders—including the public sector, commercial sector, and civil society can work together to address sanitation while making money.

Conceptual and Theoretical Framework

The Resource-Based View (RBV) of the firm and the Circular Economy Theory are two interconnected frameworks that are used to direct this investigation.

Circular Economy Theory

The framework of the Circular Economy (CE) offers a paradigm for sustainable economic systems that maximize the use of available resources and reduce waste. CE prioritizes recycling, regeneration, and resource efficiency in contrast to the linear "take-make-dispose" model (Korhonen et al., 2018). When it comes to the DRC, CE offers a useful foundation for comprehending how e-waste recovery, composting, biogas production, and plastic recycling may all help reintegrate organic and inorganic waste into local economies. When implemented through community-led or small business initiatives, CE principles not only support environmental sustainability but also innovation and employment creation.

Resource-Based View (RBV) Theory

According to the strategic management theory known as the Resource-Based View (RBV), businesses can obtain a competitive edge by creating and employing resources that are rare, precious, unique, and non-replaceable (Barney, 1991). In trash management, this could entail creating in-house recycling technologies or learning how to handle waste products effectively and affordably. Even in turbulent macroeconomic circumstances, small businesses in the DRC that innovate in recycling and trash reuse could develop niche markets and reliable revenue

streams. When combined, these frameworks offer a perspective that views trash as a strategic resource that can be used to promote equitable economic growth and environmental restoration rather than as an issue that needs to be solved.

Research Questions

Based on the literature and theoretical foundation, the study is guided by the following questions:

1.   What are the main operational and structural obstacles to garbage management in DRC cities?

2.   How can waste management be developed into a thriving industry that encourages development and entrepreneurship?

3.   How may the circular economy influence the DRC's urban waste management plans?

4.   What legislative or institutional actions are required to help the DRC's waste-management sustainable businesses?

5.   How can actors involved in informal waste be incorporated into official processes to guarantee economic inclusion and environmental sustainability?

METHODOLOGY

This study examines the opportunity and difficulty of waste management in the Democratic Republic of the Congo's (DRC) metropolitan areas using a mixed-methods research approach. Through a combination of qualitative and quantitative methods, the study depicts the socio-economic dynamics and complexity of waste management systems. In relation to the waste-based company development, the methodology is set up to investigate stakeholder experiences, economic opportunities, and policy consequences.

Population

The general population under study comprises urban residents and key stakeholders involved in formal and informal waste management in the DRC. The geographical focus is on Kinshasa and Lubumbashi, the two largest urban areas in the country, which collectively represent a significant proportion of the national population and waste generation.

●   Kinshasa, the capital city, houses over 14 million people and faces severe sanitation and solid waste disposal challenges due to limited infrastructure and rapid urban expansion.

●   Lubumbashi, with a population of around 1.5 million, reflects similar waste-related concerns, although on a smaller scale.

Many members of this general community participate in informal waste management activities, such as open dumping, street pickup, and household-level sorting. Despite being an essential component of the urban sanitation system, these behaviors are frequently motivated by poverty and a lack of alternatives. Many people in this demographic group make their living by

gathering trash and recycling it informally, frequently without access to safety or market integration (Mihajlov et al., 2021). A wide range of stakeholders are taken into account in this study, including small business owners, community leaders, environmental NGOs, sanitation firms, municipal officials, and informal actors. Understanding the current waste management system as well as the obstacles and facilitators of waste-to-business transformation is based on their combined experiences.

Sample selection

To guarantee that the sample represents the variety of entities in the DRC's waste management ecosystem, a stratified random sampling technique was used. Formal versus informal actors, geographic location (Kinshasa versus Lubumbashi), and area of activity (collecting, processing, policymaking, entrepreneurship) were the basis for stratification.

Two hundred participants in all were chosen:

● 60 participants, including managers and staff from businesses engaged in recycling, composting, landfill operations, and regulated waste collection.

● 40 participants represented the government and policy, including environmental regulators, urban planners, and representatives of municipal governments.

● Participants in the informal: 100 people who sort or transform waste items, such as rubbish pickers, street recyclers, and small-scale informal business owners.

This sample allows for triangulation between perspectives from different sectors, facilitating a deeper understanding of the socio-economic and environmental landscape (Ruba et al., 2023).

Data collection

The study gathered data through a combination of primary and secondary sources:

Primary data

Structured surveys were distributed to all 200 participants to assess their perceptions of:

o   Current waste management practices

o   Opportunities for entrepreneurship

o   Challenges such as infrastructure gaps, health risks, or lack of support

o   The potential of waste-to-resource initiatives

Semi-structured interviews were conducted with a sub-sample of 30 individuals across all stakeholder groups. These interviews aimed to explore:

o   Personal experiences in waste collection or processing

o   Views on regulatory frameworks and institutional support

o   Suggestions for improving integration between formal and informal actors

    o   Aspirations regarding sustainable business models

Each interview lasted between 30 and 45 minutes and was recorded (with consent) for later transcription and coding. This approach allowed for rich qualitative data collection (Musiana, 2024; Kubanza & Simatele, 2019).

Secondary Data

Secondary sources included:

- Government reports on waste volumes, municipal budgets, and sanitation programs

- Academic studies on waste governance and circular economy practices

- Reports from international organizations such as UN-Habitat and the World Bank

- Community-based case studies of grassroots waste initiatives

These sources provided contextual background and comparative benchmarks (Zhang et al., 2022; Banda et al., 2023).

Data analysis

In accordance with the mixed-methods approach, the study used both quantitative and qualitative analysis techniques.

Analysis of quantitative data

The survey data was submitted to the following tests using SPSS software:

Correlation analysis to investigate connections between demographic factors (e.g., age, education, employment) and perceptions of waste-related opportunities; descriptive statistics (means, percentages, frequencies) to summarise participants' opinions. Regression analysis to identify the variables that predict a person's propensity to find or support waste-based enterprises, such as past experience, financial availability, or exposure to training.

Analysis of qualitative data

The interview data were transcribed and subjected to a thematic analysis approach. In accordance with Braun and Clarke's (2006) six-phase model, the researchers:

1. Acquainted with the data

2. The first codes were generated

3. Looked for recurrent themes (such as "entrepreneurial resilience," "innovation from necessity", and "lack of infrastructure").

4. Examined and improved themes

5. Identified and designated themes

6. Generated narrative insights are included in the conclusion

This procedure offered sophisticated insights into the institutional, social, and human aspects of waste management, especially in demonstrating the connection between lived experiences and more general development objectives (Seadon, 2010).

FINDINGS AND DISCUSSION

The results obtained from the quantitative and qualitative information gathered from Kinshasa and Lubumbashi stakeholders are shown in this section. The findings are examined in light of the study topics and the previously presented theoretical frameworks, specifically the Resource-Based View (RBV) and the Circular Economy Theory. Triangulation for better-founded suggestions is made possible by the inclusion of two data kinds, which also strengthens the analysis's robustness.
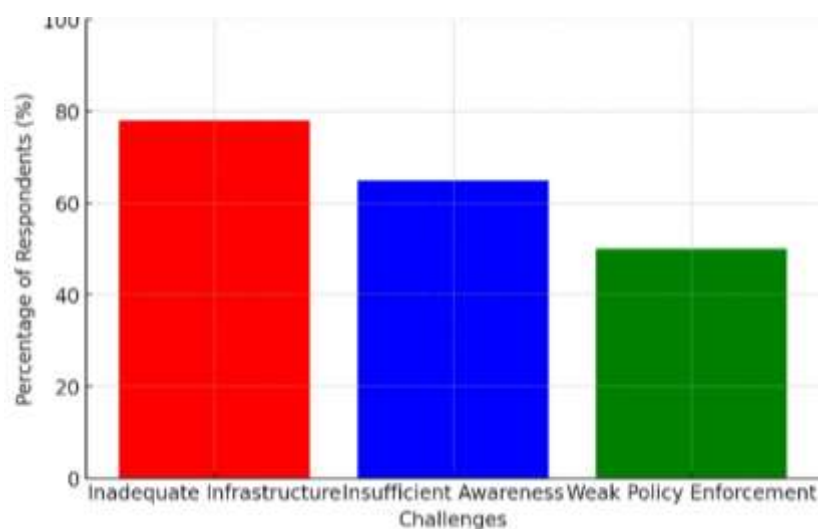
Findings from Quantitative Data

The structured survey responses from 200 stakeholders, including formal waste management enterprises, actors in the informal sector, government representatives, and policymakers, form the basis of the quantitative data analysis. Three main topics were covered in the responses: the difficulties in managing garbage, the financial prospects for companies that deal with waste, and the function of legislation in promoting sustainable waste management programs.

Primary Challenges of Waste Management:

Inadequate infrastructure was cited by a significant majority of respondents (78%) as the main barrier to efficient waste management in the DRC (see Figure 1). This problem is most noticeable in peri-urban and informal communities, where garbage collection services are frequently lacking or inadequately equipped. These results are consistent with earlier studies, such as Kabwama et al. (2022), which emphasize that inadequate infrastructure is a major contributing factor to sanitation problems in metropolitan Africa.

Figure 1: Primary challenges of waste management in the DRC

The lack of public education and understanding about waste segregation and recycling techniques was cited by 65% of respondents as another important obstacle. Attempts to create sustainable waste systems continue to be dispersed and ineffectual in the absence of focused education campaigns and community engagement. This supports the claims made by Banga (2011), who emphasized that altering family behavior is essential to reaching more general waste management objectives.

Additionally, 58% of participants pointed to a lack of accountability at the municipal level and inconsistent execution of current regulations as reasons for the restriction of inadequate regulatory enforcement. Additionally, Banda et al. (2023) stress that consistent monitoring and enforcement procedures are just as important to the success of waste policies as their design.

Economic Opportunities:

Significant optimism over waste management's economic potential was found in the poll. For instance, 72% of respondents thought that there were good and profitable business prospects in the waste sector, especially in sectors like recycling and waste-to-energy. Those with higher levels of formal education and younger individuals showed greater optimism. Perceived profitability and investment in recycling infrastructure were shown to be statistically significantly correlated ($r = 0.65$, $p < 0.01$), indicating that stakeholders consider physical infrastructure to be a fundamental component of economic viability. Additionally, the results of multiple regression analysis showed that availability to capital ($\beta = 0.45$, $p < 0.01$) and knowledge of recycling procedures ($\beta = 0.39$, $p < 0.05$) were significant predictors of entrepreneurial interest in waste-based enterprises. Furthermore, 60% of respondents said that increasing the effectiveness of collection and processing required the use of both digital and mechanical technologies, such as trash data dashboards, automated sorting equipment, and GPS-enabled garbage tracking devices. This supports results from other settings showing that digital innovations can draw in private sector investment and upgrade urban trash systems. Eighty percent of respondents supported the adoption of laws and incentives that would encourage environmentally friendly waste management techniques. Effective policy frameworks can improve the operational effectiveness of waste management systems, according to the data analysis, which showed that locations with existing waste segregation and recycling rules reported better levels of community participation and compliance (Zhang et al., 2022). Additionally, 67% of respondents supported tax breaks and subsidies for companies that participate in sustainable waste management, underscoring the necessity of government-led programs to assist SMEs in recycling their garbage (Kubanza & Simatele, 2019). Descriptive information detailing the respondents' age, gender, and educational background was also included in the analysis. Understanding the viewpoints of various stakeholder groups and adjusting treatments appropriately requires this information. Indicating a generational shift in attitudes toward sustainability, younger respondents (ages 18 to 30) were more inclined than older respondents (ages 51 and above) to embrace innovative waste management strategies. To investigate the connections between different elements influencing waste management procedures, a correlation analysis was carried out.

The findings showed that the efficacy of waste management policies and community engagement programs was strongly positively correlated ($r = 0.65$, $p < 0.01$). This implies that more community participation in waste management initiatives results in better overall results and increased compliance. The promise of digital innovations in the s0.65ector was further

supported by the discovery of a moderate correlation ($r = 0.48$, $p < 0.05$) between investment in technology-driven waste solutions and overall waste management efficiency.

Integration of Findings with Theoretical Frameworks

A thorough grasp of the difficulties and possibilities in waste management in the DRC is made possible by the combination of quantitative data with the theoretical frameworks of Resource-Based View (RBV) and Circular Economy Theory. According to research based on the Circular Economy Theory, considering waste as a resource rather than a liability can inspire creative solutions that not only lessen negative effects on the environment but also open up new business prospects. The possibility of a closed-loop system where trash is continuously repurposed, hence limiting environmental deterioration, is highlighted by the strong link found between perceived profitability and investment in recycling infrastructure (Korhonen et al., 2018).

The strong support for policy initiatives shows that stakeholders understand how crucial regulatory frameworks are to making this shift easier. Additionally, the recognition of digital technology as a major facilitator of waste management effectiveness is consistent with contemporary circular economy methodologies that prioritize technological innovation (Banda et al., 2023). Based on the Resource-Based View (RBV), the study shows that companies can obtain a competitive edge by using waste as a resource efficiently. The regression analysis's finding that financial resources and recycling practices awareness are important determinants of profitability is consistent with the RBV's focus on utilizing special resources to improve business performance (Hart & Dowell, 2011). The correlation analysis further supports the RBV framework by emphasizing the value of community engagement as a resource that can improve the efficacy of waste management programs. The results also show how resource-based skills may be used for sustainability, highlighting the significance of private sector involvement and government incentives in generating financial gains in waste management (Kubanza & Simatele, 2019).

Findings from Qualitative Data

Deep insights into the lived experiences, attitudes, and strategic viewpoints on waste management in the Democratic Republic of Congo were obtained through semi-structured interviews with 30 stakeholders, including trash entrepreneurs, local policymakers, environmental officers, and actors from the informal sector. Four major themes emerged from the thematic analysis, each with significant theoretical and practical ramifications.

Theme 1: Cultural Barriers and Public Perception

The unfavorable public opinion of trash, which is frequently based on socioeconomic and cultural beliefs, was one of the most prevalent topics. Many interviewees emphasized how trash is still viewed as a problem rather than an opportunity, especially by local government officials and urban dwellers. According to a Kinshasa waste sorting cooperative leader, "people in our communities still see waste as filth, something to be dumped, not something that can be transformed."

Theme 2: Informal Sector Innovation and Resilience

Despite operating outside the formal policy frameworks, several interviewees from the **informal sector** demonstrated **remarkable innovation and adaptability**. Waste pickers and community recyclers spoke of self-organized networks, locally developed sorting methods, and micro-enterprises based on plastic reuse, compost production, or metal recovery. "We may not have machines, but we know how to separate and sell plastics. We even make fuel briquettes from organic waste," shared a women-led cooperative in Lubumbashi. This finding is in line with research by Banga (2011) and Kabera and Wilson (2020), who point out that perception and public knowledge are important factors that influence citizen involvement in sustainable waste management programs. These cultural hurdles decrease public willingness to participate in waste-to-value initiatives and impede trash segregation at the source. This subject emphasizes the necessity of changing public perceptions to acknowledge trash as a resource in closed-loop systems from the standpoint of the circular economy. According to Kirchherr et al. (2018), consumer involvement and mentality changes are critical to the success of circular models, especially in low- and middle-income nations. This result is consistent with Wilson et al. (2012) and Chikodzi (2021), who support the official acknowledgement of the unorganized sector as a significant contributor to urban sanitation systems. In African cities, informal actors are frequently the operational backbone of garbage recovery, filling institutional gaps. In this case, the Resource-Based View (RBV) hypothesis is very pertinent. Actors in the informal sector have ingrained social networks, adaptive behaviors, and tacit knowledge—all intangible assets that can be used to gain an edge over competitors and promote inclusive economic growth (Hart & Dowell, 2011).

Theme 3: Missed Opportunities and Policy Disconnect

The gap between local realities and policy formulation was a recurring theme in all of the interviews. Numerous parties voiced their dissatisfaction with government agency coordination issues, lack of incentives, and bureaucratic inefficiencies. According to a number of business owners, the waste regulations in place were out-of-date, unenforced, or hindered small innovators.
"Investing in recycling is not incentivized. An environmental entrepreneur in Kinshasa stated, "You deal with too many ministries, and the tax system is not supportive." This bolsters the conclusions of Kubanza and Simatele (2019), who contend that institutional silos and inconsistent policies are enduring barriers to waste reform in sub-Saharan Africa. Furthermore, Zhang et al. (2022) stress that the private sector is still underutilized in the shift to sustainable waste management in the absence of robust regulation and focused incentives.

According to the theory of the Circular Economy, successful transformation necessitates both technological advancements and innovative regulations. In order to encourage and foster circular entrepreneurship, policymakers must create conducive environments.

Theme 4: Demand for Education and Training

Lack of technical training was cited by a number of respondents as a hindrance to expanding their businesses, particularly those from the youth and unorganized sectors. Although they pointed out the lack of easily accessible training programs, they indicated interest in learning more about contemporary waste management methods, financial literacy, and digital tools. A youth group leader from a recycling hub in Lubumbashi said, "We want to do more, but we

need skills—how to make compost better, how to package plastics for export, how to run a small business." The findings of Seadon (2010) and Musonda et al. (2021), who contend that skill development is a crucial pillar of waste sector reform, are consistent with this discovery. Even promising grassroots projects may not expand or be able to compete with outside service providers if proper training is not provided. Discussion: This is in line with the RBV and Circular Economy models, which both stress how critical it is to develop local communities' human capital and absorptive ability. Education broadens the community's pool of resources in addition to increasing individual output. With a more sophisticated understanding of the social, institutional, and behavioral aspects of waste management in the DRC, the qualitative data gives the quantitative results crucial context.

- The informal sector as a hidden but potent engine of innovation;

- Policy gaps and institutional disconnection are major obstacles;

- The urgent need for training, especially for youth and women in waste enterprises;

- Low public awareness is a barrier to participation and segregation.

Together, these revelations highlight the current waste management system's structural flaws as well as its unrealized economic potential. They support the study's theoretical claim that garbage can be transformed from an environmental annoyance to a catalyst for innovation, urban growth, and job creation when used wisely.

CONCLUSION

The prospects and problems related to waste management in the Democratic Republic of the Congo (DRC) have been thoroughly examined in this study, with particular emphasis on important urban areas like Kinshasa and Lubumbashi. The DRC has significant structural and cultural obstacles to efficient waste management, but it also has unrealized potential for innovation, job creation, and environmental sustainability, as shown by the used mixed-methods approach that combines statistical analysis and qualitative interviews. According to the survey results, the main barriers to efficient waste systems include poor infrastructure (78% of respondents), low public awareness (65%), and lax enforcement of legislation (58%). Nonetheless, 72% of stakeholders express increasing optimism that waste management can develop into a lucrative industry, especially with investments in waste-to-energy, recycling, and composting projects. Strong connections between profitability and recycling infrastructure investment ($r = 0.65$, $p < 0.01$), as well as qualitative evidence of community-driven solutions and informal sector innovation, support these findings. Waste is no longer seen as a liability when viewed through the prism of the circular economy theory; rather, it is a resource that can be recycled back into the production cycle, minimizing environmental damage while producing value. Similar to this, the Resource-Based View (RBV) concept shows how social networks, human capital, and tacit knowledge, particularly in the informal sector, can be significant assets for sustainable development and waste-based entrepreneurship. Interviews with stakeholders also emphasized the value of education, community involvement, policy coherence, and mentoring in overcoming obstacles and seizing possibilities. Any waste management program's capacity to connect policy and practice, match financial incentives with environmental objectives, and enable local actors, particularly women

and youth, to take the initiative in creating circular economies from the ground up will ultimately determine its success. Resolving the waste situation in the DRC presents a significant economic opportunity in addition to enhancing sanitation and lowering health concerns. The nation can move from unsustainable waste disposal methods to a flourishing circular economy that creates jobs, conserves resources, and safeguards public health with the correct combination of political will, financial commitment, community involvement, and educational initiatives. This study shows that trash can actually turn into wealth if it is managed well.

IMPLICATIONS TO RESEARCH AND PRACTICE

This study offers strong proof that waste management in the DRC is a business and economic growth hotspot in addition to being an environmental and public health issue. The findings highlight how urgent it is for practitioners, especially municipal governments, non-governmental organizations, and corporate innovators, to embrace a circular economy approach, in which trash is viewed as a resource rather than a liability. These insights can be used by policymakers to create incentives that are specifically targeted, assist small-scale garbage entrepreneurs, and incorporate people from the informal sector into formal waste systems. The study highlights the necessity of multidisciplinary research methodologies that connect public policy, economics, and environmental science. Also, it provides a reproducible mixed-methods framework that can be used in other African metropolitan contexts with comparable waste-related issues.

FUTURE RESEARCH DIRECTIONS

While this study offers foundational insights, several avenues remain for future exploration:

1. Longitudinal studies are needed to assess the long-term economic and health impacts of community-based recycling and composting initiatives in the DRC.

2. Further research could investigate the role of emerging technologies such as digital waste tracking, mobile platforms for waste trading, or AI in waste sorting—in enhancing operational efficiency.

3. Future research should explore public attitudes and behavioral drivers related to waste segregation and recycling, particularly in informal urban settlements.

4. Comparative studies examining waste management regulations across African cities could reveal best practices and inform better policy harmonization.

There is a need for gender-sensitive research to understand how waste entrepreneurship impacts women and marginalized groups differently, and how inclusive strategies can be designed.

REFERENCES

1. Awodele, O., Odukoya, O., & Odukoya, A. (2016). Assessment of medical waste management in seven hospitals in Lagos, Nigeria. *BMC Public Health*, 16(1), 1-10. https://doi.org/10.1186/s12889-016-2916-1

2. Banda, A., et al. (2023). Circular economy: An antidote to municipal solid waste challenges in Zambia. *IntechOpen*. https://doi.org/10.5772/intechopen.109689

3. Biola, A., et al. (2022). Epidemiological assessment of cassava mosaic disease in a savanna region of the Democratic Republic of Congo. *International Journal of Sustainable Agricultural Research, 9(4), 1-10*. https://doi.org/10.18488/ijsar.v9i4.3220

4. Chérubin, M. (2024). The role of ventriculocisternostomy in the management of hydrocephalus in Mali and the Democratic Republic of the Congo. *Cureus, 16(1)*, e59189.

5. Ddiba, D., et al. (2020). Governing the circular economy: Assessing the capacity to implement resource-oriented sanitation and waste management systems in low-and middle income countries. Earth System Governance, 3, 100063. https://doi.org/10.1016/j.esg.2020.10

6. E., M. (2023). Management of biomedical waste in the south of the Democratic Republic of Congo: Current situation. *Asian Journal of Environment & Ecology, 22(3), 1-10.* https://doi.org/10.9734/ajee/2023/v22i3491

7. Ellen Mac Arthur Foundation. (2021). Completing the picture: How the circular economy tackles climate change.

https://www.ellenmacarthurfoundation.org/assets/downloads/Completing-the -Picture-How-the-Cicular-Economy-tackles-Climate-Change-Report.pdf

8 Guman, W., & Wegner-Kozlova, M. (2020). Waste management based on circular economy principles. E3S Web of Conferences, 177. 04014. https://doi.org/10.1051/e3sconf/2020177040

9 Hart, S. L., & Dowell, G. (2011). A natural-resource-based view of the firm: Fifteen years after. *Journal of Management, 37(5), 1464-1479*. https://doi.org/10.1177/0149206311410601

10. Huo, Y., et al. (2022). Influence of maternal exposure to mass media on growth stunting among children under five: Mediation analysis through the water, sanitation, and hygiene program. *JMIR Public Health and Surveillance, 8(5), e33394.* https://doi.org/10.2196/33394

11. Inogwabini, B. I. (2020). The changing water cycle: Freshwater in the Congo. *Wiley Interdisciplinary Reviews: Water, 7(1), e1410*. https://doi.org/10.1002/wat2.1410

12. Kang, Y., et al. (2023). Environmental and economic performances of municipal solid waste management strategies based on LCA method: A case study of Kinshasa. *Heliyon, 9(3), e14372*. https://doi.org/10.1016/j.heliyon.2023.e14372

13. Keyzer, M., et al. (2020). Local perceptions on the state of the pelagic fisheries and fisheries management in Uvira, Lake Tanganyika, DR Congo. *Journal of Great Lakes Research, 46(5), 1101-1110*. https://doi.org/10.1016/j.jglr.2020.09.003

14. Kirchherr, J., Reike, D., & Hekkert, M. (2017). Conceptualizing the circular economy: An exploration of the transition from the linear economy. *Resources, Conservation and Recycling, 135, 1-12*. https://doi.org/10.1016/j.resconrec.2017.08.020

15 Kubanza, N., & Simatele, M. (2019). Solid waste management and environmental injustice in poor communities in Kinshasa: A cultural theory and systems approach. Environmental Management and Sustainable Development, 8(1). 1-15.

16 . Lubaki, J., et al. (2022). Protocol: Developing a framework to improve glycaemic control among patients with type 2 diabetes mellitus in Kinshasa, Democratic Republic of the Congo. *PLOS ONE, 17(5)*, e0268177. https://doi.org/10.1371/journal.pone.0268177

17. Mesjasz-Lech, K. (2021). Municipal urban waste management—Challenges for Polish cities in an era of circular resource management. *Resources, 10(6), 55*. https://doi.org/10.3390/resources10060055

18. Mihajlov, K., Djuric, M., & Stojanovic, J. (2021). Country in transition (Serbia) case: Circular economy starts from waste management. *Environmental Research and Technology*, 6(1), 1-12. https://doi.org/10.35208/ert.853792

19. Muke, M. (2023). Child neurodevelopmental disorders in armed conflict country, case of DR Congo: Long-term trauma impact on brain development in childhood: Review. *International Journal of Surgery: Global Health*, 6(1), e181.

20. Mukuku, O., et al. (2020). Epidemiology of epilepsy in Lubumbashi, Democratic Republic of Congo. *Neurology Research International*, 2020, 5621461.

21. N'Sungu, M., et al. (2022). Mediastinal bronchogenic cyst resected in Kinshasa, Democratic Republic of Congo: A case report. *International Journal of Surgery Case Reports, 92, 107775*. https://doi.org/10.1016/j.ijscr.2022.107775

22. Okitawutshu, M., et al. (2022). Key factors predicting suspected severe malaria case management and health outcomes: An operational study in the Democratic Republic of the Congo. *Malaria Journal, 21(1), 1-12*. https://doi.org/10.1186/s12936-022-04296-2

23. Okin, A. (2024). Geospatial analysis of malaria and typhoid prevalence due to waste dumpsite exposure in Kinshasa districts with and without waste services: A case study of Bandalungwa and Bumbu, Democratic Republic of Congo. *International Journal of Environmental Research and Public Health*, 21(11), 1495.

24. Rackimuthu, S., et al. (2022). COVID-19, measles, and yellow fever: The need to reinforce vaccination in the Democratic Republic of Congo. *Clinical Epidemiology and Global Health, 12, 100956*. https://doi.org/10.1016/j.cegh.2021.100956

25. Sadiki, M., et al. (2020). Obstacles and performance of agribusiness enterprises: Evidence from South-Kivu Eastern Democratic Republic of Congo. *Asian Social Science, 16(11), 7-15*. https://doi.org/10.5539/ass.v16n11p7

26. Seadon, J. K. (2010). Sustainable waste management: An integrated approach. *Waste Management, 30(1), 1-10*. https://doi.org/10.1016/j.wasman.2009.06.012

27. Singh, A., et al. (2021). Open dumping site and health risks to proximate communities in Mumbai, India: A cross-sectional case-comparison study. *Clinical Epidemiology and Global Health, 11, 100956*. https://doi.org/10.1016/j.cegh.2020.06.008

28. Vercus, A., et al. (2021). Determination of the toxicological risk of urban waste from the city of Uvira dumped into the north-western coast in Lake Tanganyika (Democratic Republic of Congo). *Journal of Environmental Protection, 12(1), 41-54*. https://doi.org/10.4236/jep.2021.1210041

29. Vinti, G., et al. (2021). Municipal solid waste management and adverse health outcomes: A systematic review. *International Journal of Environmental Research and Public Health, 18(8), 4331*. https://doi.org/10.3390/ijerph18084331

30. Xu, Y. (2024). Research on innovative models of waste recycling in urban infrastructure. *Academic Journal of Science and Technology, 4(1), 1-10*. https://doi.org/10.54097/4b1cqh43

31. Zhang, Y., et al. (2022). Introductory chapter: The overview of recent advances of sustainable waste management. *IntechOpen*. https://doi.org/10.5772/intechopen.105574