**Analysis of the socioeconomic and environmental impacts of waste scavenging industry**

Okwuchi Smith Onyekwere a,\*  , Amani David Haruna b  , Adinife Patrick Azodo c 

abc Department of Chemical Engineering, Federal University Wukari, Nigeria

\*Corresponding author

ABSTRACT

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Waste scavenging can be referred to as part of primary industrial sector that extracts raw materials for secondary industrial sectors that refines and manufacture products using the materials. This analysis examined the socioeconomic and environmental impacts of waste scavenging; a critical but often overlooked aspect of global waste management. This analysis focused on developing countries, exploring how solid waste scavenging diverts valuable resources out of landfills, reduces environmental impact, and supports informal recycling within a circular economy. However, it also emphasized the notable challenges waste pickers encounter, including hazardous working conditions and health risks from exposure to dangerous materials. By reviewing current research, this study’s objective is to fill gaps in knowledge and offer valuable insights for policymakers, waste management experts, and non-governmental organizations. It highlighted the need for a multifaceted strategy that recognizes the contribution of waste pickers while advocating for improved working conditions, social inclusion, and possible pathways to formalization within the waste management framework.

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#### **1. Introduction**

Waste management is a critical but often neglected aspect of global environmental efforts. Kumari and Raghubanshi [1] predict global municipal solid waste production to reach a staggering 3.4 billion metric tons annually by 2050, with developing countries at the forefront of this challenge. Rapid urbanization and increased consumption patterns are the main drivers. A study in China, the world's fastest-urbanizing nation, reported a 60% surge in municipal solid waste generation per capita between 1995 and 2015 [2]. This trend highlights the challenges developing countries face in managing waste, resulting in overflowing landfills. These overflowing landfills create significant environmental and public health risks [3]. Methane, a potent greenhouse gas, leaks from these landfills, significantly contributing to climate change [4, 5]. Decomposing organic matter in landfills creates toxic liquids that seep into the soil and groundwater, polluting important water sources [6, 7]. Overflowing landfills also become breeding grounds for disease-carrying insects and rodents, presenting health risks to the public [8].

In many developing nations, waste scavenging has emerged as a crucial informal practice. Waste pickers, sometimes referred to as waste collectors or scavengers, recover valuable resources like metals, plastics, and paper from discarded materials. This diverts waste from landfills, promotes informal recycling and contributes to a more circular economy [9-12]. Through their recovery efforts, waste pickers promote recycling, reduce demand for virgin resources, minimize waste generation, and benefit the environment by lowering carbon emissions and resource depletion. Waste scavenging offers a glimmer of hope for managing waste burdens, but it's a double-edged sword. Waste pickers often face hazardous working conditions, limited social inclusion, and health risks [13].

For instance, waste pickers known as Zabbaleen in Cairo, Egypt, collect over 80% of the city's recyclable waste without any formal support [14, 15]. Similarly, in Delhi, India, waste pickers recover and sell over 11,000 metric tons of plastic waste annually, demonstrating the significant contribution of the informal sector to resource recovery [16]. Just like the waste pickers in Egypt and India, Nigeria also has a large informal waste picking sector. These waste pickers, often referred to as "Baban Bolla" (local waste collectors), play a crucial role in the country's waste management system, despite encountering numerous challenges. Studies suggest that a significant portion, potentially over 60%, of Nigerian households rely on informal waste collectors rather than formal government services. This highlights the waste pickers' role in keeping cities clean and managing waste disposal. Organizations like the Waste Pickers Association are working to improve the working conditions and the lives of waste collectors in Nigeria [17].

These recovered materials are then sold to small recycling indusries, highlighting the role of waste pickers in creating informal recycling networks within a circular economy. Waste pickers often work in unsafe environments, exposed to various dangers. Physical injuries from broken glass and metal, musculoskeletal strain from carrying heavy loads, and traffic accidents are common incidents due to the lack of proper equipment and designated working areas [17]. The waste pickers also face exposure to toxins from hazardous materials like medical waste, chemicals, and decaying organic matter, which can lead to respiratory problems, skin infections, and even chronic illnesses [18,19]. The absence of toilets and basic hygiene facilities at waste dumpsites poses a significant public health risk.

This analysis examines the comparison between socioeconomic benefits, such as increased income opportunities for marginalized communities, and environmental impacts, like reduced landfill waste, of waste scavenging in developing countries. It aims to offer a clear understanding by looking at the advantages of waste scavenging for resource recovery, informal recycling, social inclusion, and environmental sustainability within a circular economy framework in developing countries.

#### **2. Socioeconomic and environmental impacts of waste scavenging**

Waste collection is a crucial aspect of our global ecosystem, yet it is often ignored. Waste scavenging involves much more than merely collecting and sorting recyclable materials from landfills and discarded items. This practice has far-reaching environmental and socioeconomic implications for society and the economy. It encompasses various activities that promote material recycling and create economic opportunities. Therefore, it is vital to comprehend the social and environmental impact of waste scavenging and its role in a sustainable economic framework – these are discussed in the subsection that follows.

***2.1.******Waste Scavenging's Impact on Landfills***

Informal recycling diverts valuable resources from landfills, aligning with principles of sustainable waste management and the circular economy [20, 21][12]. By extracting materials like metals, plastics, and glass from the waste stream, individuals collecting recyclable materials salvage resources that would otherwise contribute to landfill waste [22, 23]. This diversion not only alleviates pressure on limited landfill space but also mitigates environmental concerns such as methane emissions and groundwater contamination associated with landfills [24, 25]. Waste scavenging promotes a recycling loop by recovering valuable materials and redirecting them back into the production cycle [9][26]. Recovered materials can be recycled or repurposed, reducing the demand for new resources and lowering environmental impact [27]. Waste scavenging contributes to income-generating possibilities, particularly for marginalized communities, by generating income and fostering economic empowerment [28, 29].

Waste scavenging faces challenges such as hazardous working conditions and social marginalization of waste pickers [30]. Addressing these challenges through improved integration, training programs, and social support initiatives is crucial to enhancing the impact of informal recycling networks [31]. Waste scavenging plays a vital role in redirecting valuable resources from landfills, promoting resource recovery, and contributing to environmental sustainability and economic empowerment [9]. Efforts to formalize waste picking processes and improve working conditions can further increase the positive outcomes for both waste pickers and society as a whole [32,33].

***2.2.******Waste Scavenging's Environmental Impact Reduction***

Waste scavenging is a practice that has a hugely positive impact on our environment, and waste pickers deserve a special mention for the invaluable role they play in this regard. The activities of waste pickers not only helps to reduce the burden on existing landfills, but also helps to extend their lifespan and reduce the need for new ones, as pointed out by Ogbu *et al*.[29] and Krook *et al*. [34]. In addition to this, waste scavenging enables the recovery of reusable or recyclable materials from waste streams, which reduces the need for the extraction of new resources. This is particularly important given the negative impact that new resource extraction can have on the environment, including pollution. Studies by Papadaki *et al*, [27] and Krook *et al*. [34] highlighted the significance of waste pickers in this regard. Waste pickers also play a crucial role in reducing methane emissions by diverting organic waste from landfills. Organic waste is a significant source of this potent greenhouse gas, and waste scavenging helps to reduce this emission by keeping organic waste out of landfills. Furthermore, recovered materials such as recycled paper can help to reduce the demand for virgin wood, thereby promoting sustainable forest management and protecting forests. Finally, waste pickers who promote reuse and repurposing activities can significantly reduce the environmental impact of new product creation and resource extraction. This is highlighted by a study by Papadaki *et al* [27] who underscore the importance of waste scavenging in promoting sustainable resource management. Overall, the practice of waste scavenging is indeed a crucial component in reducing environmental impact and promoting sustainable resource management.

***2.3.******The role of waste scavenging in promoting informal recycling practices within a circular economy framework***

Waste scavenging is a key component of the circular economy, often overlooked in waste management strategies. Waste pickers play a crucial role in directing recyclable, reusable, or sellable items away from landfills, promoting environmental sustainability [35, 36, 37]. Waste scavenging serves as an economic lifeline for marginalized communities, offering avenues for income generation and economic empowerment [13][28]. Informal recycling networks help by collecting materials that are often missed by formal systems, leading to higher recycling rates. In essence, waste scavenging aligns perfectly with circular economy principles by promoting resource recovery, minimizing waste, and extending the lifespan of materials [12]. By harnessing the expertise and dedication of waste pickers, societies can optimize waste collection systems and achieve notable advancements in resource recovery, recycling efficiency, and overall waste management cost reduction [38, 39] Akin to the skilled artisans of waste management, waste pickers exhibit an unparalleled ability to identify and salvage valuable recyclables, thereby augmenting recycling rates and mitigating the environmental burden of waste disposal ([22][40][30]. Their contributions extend beyond mere economic gains, as evidenced by the pivotal role they play in curbing plastic pollution and fostering cleaner oceans [41, 42]. Through their efforts, waste pickers exemplify the essence of waste minimization and resource recovery, embodying the principles of the circular economy [43, 44]. Waste scavenging epitomizes the symbiotic relationship between environmental preservation and socio-economic development. Recognizing and enhancing the role of waste pickers in waste management systems can propel societies towards a more circular and sustainable future, promoting waste reduction, resource optimization, and community well-being.

#### **3. Challenges faced by waste pickers**

Waste pickers are critical players in managing waste in many communities worldwide. They work in the informal sector, where they help reduce environmental degradation, promote resource recovery, and support their families. Despite their valuable contributions, waste pickers face several challenges that prevent them from working safely, efficiently, and with respect. For example, they work in hazardous conditions and struggle with social marginalization and inadequate access to resources. To create a fair and sustainable waste management environment, we need to understand these challenges and find ways to address them. It is crucial to discuss the diverse challenges faced by waste pickers and potential solutions to improve their working conditions, protect their well-being, and advance their contributions to environmental and social sustainability.

***3.1.******Hazardous working conditions***

Waste pickers who work informally are exposed to various health and safety hazards that arise due to the nature of their work. These include exposure to harmful substances such as toxins, pollutants, and pathogens found in waste materials, which can cause respiratory issues, skin ailments, musculoskeletal disorders, and even cancer [45]. Unfortunately, there is often lack of personal protective equipment (PPE) like gloves, masks, and boots, among waste pickers which leaves them more vulnerable to injuries and illnesses [46]. Informal waste management practices can result in unsafe handling and sorting of hazardous waste, which not only poses a danger to pickers but also contaminates recyclables [47]. Furthermore, waste pickers usually work in hazardous environments that lack proper sanitation or ventilation, exposing them to additional health risks [48]. Sharp objects, fires, and collapsing structures pose a constant threat to their safety [18]. Finally, waste pickers informal status means that they are often excluded from social safety nets such as health insurance and workers' compensation, leaving them vulnerable in the event of accidents or illnesses [49]. Hazardous working conditions of waste pickers can pose significant risks, such as exposure to toxins, pollutants, and sharp objects, leading to respiratory problems, skin diseases, musculoskeletal disorders, and injuries ([32]. Improper handling of hazardous materials also poses environmental and health risks for waste pickers [50].

***3.2.******The implications of exposure to dangerous materials during scavenging activities***

The lack of access to formal protections and benefits leaves waste pickers at risk of exploitation by intermediaries, exacerbating their already challenging situation. Moreover, burning waste for heat or carrying out sorting operations in open dumpsites worsens air and water pollution, posing additional health risks for waste pickers [51, 52]. The hazardous conditions waste pickers face during scavenging activities highlights the importance of emergency protocols to protect their safety and health. Without adequate precautions and protective measures, waste pickers are susceptible to injuries, infections, and long-term health consequences from exposure to dangerous substances [32]. Scavenging activities pose significant risks to the health and well-being of waste pickers, making it essential to prioritize their safety and welfare.

#### **4. Research findings and insights**

#### The key findings are highlighted in this section and recommendations are made for improvement.

***4.1.******Overview of key findings from the analysis of current research on waste scavenging***

Waste pickers are key players in tackling both methane emissions and resource depletion by retrieving valuable materials from landfills [30]. Waste scavenging empowers marginalized communities by generating income through the sale of recovered materials, fostering entrepreneurship and local economic development [9]. Waste pickers also collect materials that are not picked up through formal recycling processes, improving the efficiency of recycling overall [22]. Despite their vital role, waste pickers face significant safety risks due to inadequate personal protective equipment (PPE), physically demanding tasks, and an unsafe work environment [22]. Additionally, they face social stigma and lack formal protections [33]. Moreover, informal systems can lead to low wages and potential exploitation within the waste-picking hierarchy. To address these challenges, several recommendations have been made. For example, integrating informal waste pickers into formal systems can significantly enhance efficiency, safety, and working conditions by setting up cooperative structures, obtaining licenses, and establishing buy-back centers [32].

 Additionally, policies promoting safety protocols such as regular safety training on handling hazardous materials, providing personal protective equipment, and access to healthcare are essential in ensuring the well-being of waste pickers [32]. Collaboration among waste pickers, local authorities, and waste management firms can also improve infrastructure, collection routes, and sorting practices. Finally, technological advancements such as sorting robots and mobile apps that optimize collection routes and track materials can significantly enhance the efficiency, accuracy, and safety of waste-picking operations. By diverting usable materials from landfills and feeding them back into the production cycle, waste scavenging plays a vital role in achieving sustainable waste management and promoting a circular economy [28]. By acknowledging its economic and environmental benefits and addressing the associated challenges, we can create a more sustainable and inclusive approach to waste management.

***4.2.******Implications for Policy and Practice***

Establishing a sustainable and equitable waste management system calls for a comprehensive and multifaceted strategy. This includes initiating various training programs, developing necessary infrastructure, extending government support, and fostering collaboration among stakeholders to formalize the waste-picking industry and enhance working conditions. Effective policy interventions and practical measures are crucial for attaining these goals while promoting environmental sustainability and social inclusion. Policymakers and practitioners can prioritize safety, empowerment, collaboration, and environmental stewardship in their efforts to build a more just and sustainable waste management system. By uniting efforts, future where waste pickers have secure livelihoods while safeguarding the planet can be created.

It is crucial to invest in training programs for waste pickers to improve their capacity to handle materials effectively and professionally. Policy initiatives should prioritize providing access to sorting facilities, collection bins, safety equipment, and training on waste segregation and safe handling practices to improve the efficiency and effectiveness of waste management processes [53, 54]. Proper training in e-waste identification and sorting techniques is crucial, as highlighted by Tanwani and Agarwal, (55], to minimize environmental hazards. Environmental awareness campaigns, as suggested by Akintunde and Akintunde, [56], can motivate safer practices. Ibelli-Bianco *et al* [57], have shown that comprehensive training programs on safe waste handling practices, hazardous material identification, and waste sorting techniques can empower waste pickers. Establishing Waste Picker Cooperatives, as advocated by Iglesias [58], can provide access to collective bargaining and training programs, which can enhance socio-economic stability. Establishing designated e-waste processing centers with proper ventilation and providing Personal Protective Equipment (PPE), can significantly improve safety.

Government support is vital, offering subsidies for PPE and providing training programs, as stated by Li *et al*. [59] and Jain *et al*. [60], respectively. Collaboration among stakeholders, including waste pickers, waste management companies, and governments, is essential for successful formalization efforts [61]. Policy initiatives should prioritize the safety and well-being of waste pickers by offering comprehensive training programs on waste segregation, safe handling practices, and customer service [32]. Policy and practice should foster collaboration to develop efficient waste management strategies, improve infrastructure, optimize collection routes, and enhance resource recovery [62]. Collaboration and knowledge exchange among stakeholders are crucial for creating safer work environments and empowerment opportunities [63].

According to Mlotshwa *et al*. [30] formalizing waste pickers through licensing and regulations within the waste management system acknowledges their vital role. Additionally, it offers financial protection and healthcare. Formalization offers various benefits, including improved working conditions, increased income, social security benefits, and empowerment through collective bargaining, as outlined by various studies [64]. The importance of integrating informal recycling networks with formal waste management systems is emphasized through enhanced integration and formalization.

Policy measures should focus on the formalization of waste-picking activities by establishing buy-back centers managed by cooperatives, licensing, and ensuring fair compensation for waste pickers. According to daSilva Guabiroba *et al*. [65], these measures are necessary for the effective management of waste and recycling [66, 67]. Supporting the formation of waste picker cooperatives emerges as a strategic approach to empowering waste pickers and improving their livelihoods. Cooperatives enable waste pickers to negotiate better terms, access resources, and advocate for safer working conditions. Policy interventions should encourage and facilitate the establishment of waste picker cooperatives to promote collective action and professional development [68]. Efforts to formalize environmental sustainability should focus on promoting a sustainable environment by reducing waste, extending the lifespan of landfills, and decreasing greenhouse gas emissions. Policy frameworks can encourage waste diversion from landfills and promote resource conservation by recognizing the valuable role played by waste pickers in waste management and sustainability [69]. (Nawaz *et al*., 2021).

#### **4. Conclusions**

This review investigated the potential benefits of integrating waste pickers into formal waste management systems. The research found that waste pickers can contribute to waste management by recovering resources, generating income, and promoting environmental protection. Formalizing waste picking as a legitimate profession can improve working conditions, economic stability, and social inclusion for waste pickers. To establish efficient and sustainable waste management systems, collaboration among stakeholders, including policymakers, NGOs, and waste management experts, is essential.

This review urges policymakers, waste management experts, and NGOs to take action in the following areas:

1. Formalization of waste picking involves recognizing it as a legitimate profession and establishing frameworks that ensure fair compensation, social security benefits, and improved working conditions for waste pickers.
2. Improvement of social inclusion and economic security to facilitate social integration and economic stability for waste pickers by granting them access to social protections like healthcare, pensions, and unemployment insurance.
3. Integrating waste pickers into formal waste management structures can enhance resource recovery, recycling rates, and overall waste management efficiency.
4. Collaboration among stakeholders, including waste pickers, governments, waste management companies, and NGOs, can establish knowledge sharing, resource allocation, and support systems for waste pickers.
5. Prioritizing the safety and well-being of waste pickers is crucial by providing essential resources like personal protective equipment (PPE) and training in safe waste handling practices.

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