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Assessing the Impact of Unresolved Waste Management on Human Capital Development in Indonesia: An Empirical Analysis

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ABSTRACT

Indonesia is confronting a severe waste management crisis that increasingly threatens not only environmental sustainability but also human capital development. Rapid population growth and inadequate waste infrastructure have resulted in widespread open dumping and burning, while government spending and strategic planning remain limited. This study seeks to shed light on the future implications for Indonesian human capital based on data gathered from recent empirical studies. Using a Systematic Literature Review combined with bibliometric analysis through the Biblioshiny tool in R, the study compares the impacts in urban and rural settings. It examines how ineffective waste management degrades environmental quality, harms public health, and undermines the nation's human capital, with broader implications for economic development. The findings highlight the urgent need to integrate waste management into national development strategies, emphasizing that improving collection systems, recycling initiatives, and sanitary disposal practices can enhance public health, promote green employment opportunities, and strengthen the human capital essential for sustainable economic development.

KEYWORDS waste management; environmental degradation; human capital; public health; economic development

INTRODUCTION

Effective waste management is critical to sustainable development; however, many developing countries still struggle with this issue (Guerrero et al., 2013). In Indonesia, rapid population growth and rising consumption have outpaced the development of adequate waste infrastructure. It is predicted that by 2045, annual waste generation could reach 82 million tons, overwhelming existing landfills (Salma, 2025). However, according to Salma (2025), most Indonesian local governments still allocate less than 1% of their budgets to waste services. Empirical studies have revealed weaknesses in waste management planning, with only about 40% of cities having up-to-date waste management plans, many of which have never been successfully implemented. As a result, a significant proportion of waste is simply collected and dumped or openly burned without proper separation (UNEP, 2021; Salma, 2025).

This unresolved waste management crisis has serious consequences for human development (Hossain et al., 2022; Rodić & Wilson, 2017). The quality of human resources, or human capital, typically refers to the health, skills, and productivity of the population (Asian Development Bank, 2019). When the population's health is compromised—due to malnutrition, disease, or inadequate living conditions—economic growth and development are among the first areas to suffer (Banks et al., 2011). Waste mismanagement contributes to environmental problems, such as air and water pollution. This suggests a direct pathway

through which current waste issues affect Indonesia's human resources (Barbier, 2016). Environmental degradation caused by improper waste handling directly affects public health and, consequently, human capital development (Browning & Cardenas, 2019). Air pollution in Jakarta alone causes thousands of deaths annually and imposes nearly USD 3 billion in health costs (Syuhada et al., 2023). By causing premature illness and death, air pollution indirectly reduces the country's gross domestic product (GDP), making Indonesian cities less productive and competitive due to a lower quality of life (Central Bureau of Statistics, 2023; Syuhada et al., 2023).

The research gap is significant because the pathways through which waste affects human capital—air pollution from open burning in urban areas versus water contamination from dumping in rural areas—are fundamentally different and require distinct policy responses. The urgency of this research is therefore substantial. Without a nuanced and comparative understanding, national development strategies risk implementing uniform solutions that fail to address context-specific challenges, thereby perpetuating health inequities and hindering optimal human capital formation across the nation (Ferronato & Torretta, 2019). Indonesia's demographic dividend, projected to peak in the coming decades, could be severely undermined if a significant portion of its future workforce is affected by preventable, waste-induced health problems.

The novelty of this study lies in its explicit comparative and integrative approach. Unlike prior research that tends to focus on urban air pollution or rural sanitation in isolation, this study employs a Systematic Literature Review (SLR) combined with bibliometric analysis to systematically map and synthesize evidence from both contexts. By analyzing publication trends and thematic clusters through the Biblioshiny tool, this research aims to uncover the intellectual structure of the field and identify how discourse on waste management's impact on human capital has evolved in Indonesia. This methodological approach enables a holistic understanding that transcends disciplinary silos.

Based on empirical analysis, the current article explores how Indonesia's failure to manage its waste threatens the quality of human resources, with a focus on economic development outcomes in both urban and rural areas. The review begins by outlining the country's waste management crisis and then examines its health and economic impacts. Particular attention is given to differences between cities and villages. Finally, the study discusses how these factors intersect with national economic development goals and future opportunities.

METHOD

This study employs a Systematic Literature Review (SLR) combined with bibliometric analysis to examine the impacts of ineffective waste management on human capital development in Indonesia. The research methodology was structured as follows:

Systematic Literature Review

The SLR method was used to identify, evaluate, and synthesize relevant empirical studies from the past decade (2014-2025) on the topic of waste management and its socio-economic effects. The inclusion criteria were studies that focus on waste management challenges, environmental degradation, public health impacts, and human capital development, with a particular focus on Indonesia and comparable developing countries.

Studies published in high-quality journals and databases such as Scopus were prioritized to ensure the credibility and relevance of the findings.

Bibliometric Analysis

A bibliometric analysis was conducted using Biblioshiny, a tool integrated with R software, to analyze the publication trends, thematic evolution, and citation patterns across the selected studies. This tool enabled the mapping of key research topics, authorship networks, and geographical trends. The analysis provided insights into the intellectual structure of the literature, highlighting major themes such as agenda setting, legislative politics, and policy processes in the context of waste management and its implications for human capital development.

Data Sources

The primary data for this study were gathered from Scopus database, which contains a comprehensive collection of peer-reviewed literature. The search was limited to studies published between 2014 and 2025 to ensure the inclusion of the most recent findings in the field.

Data Analysis

The selected studies were analyzed using both qualitative and quantitative approaches. The SLR allowed for thematic analysis, identifying critical areas of focus in waste management and human capital development. Meanwhile, the bibliometric analysis conducted through Biblioshiny identified publication trends, author collaborations, and geographical patterns in the research on waste management.

RESULT AND DISCUSSION

Waste Management Challenges in Indonesia

Solid waste management in Indonesia remains highly inadequate. According to UNEP (2021), in 2017 Indonesians generated approximately 66 million tons of waste, of which around 7 million tons consisted of plastic. Most of this waste originates from households and urban areas. Indonesian cities alone now produce roughly 105,000 tons of waste per day, and this figure is expected to increase to 150,000 tons per day by 2031 (UNEP, 2021). However, only about 39% of urban waste is formally collected (UNEP, 2021). Approximately 40% of urban households receive no waste collection services at all (UNEP, 2021). Outside urban areas, rural communities often have even less waste management infrastructure. In the absence of organized collection and disposal systems, households across Indonesia commonly burn or dump solid waste in open areas (UNEP, 2021). Such practices pollute the air, soil, and water; therefore, this situation poses significant risks to public health and hygiene.

Salma (2025) identifies that government support has been limited. Many local budgets allocated to waste management are negligible (often under 1%), and the majority of local governments lack up-to-date waste management plans. Existing formal waste management systems tend to focus only on collection and dumping, with very limited source separation or recycling (Salma, 2025). As one Indonesian waste expert observed, in practice “everything is mixed, collected, transported, and dumped again,” resulting in overloaded landfills and continued open disposal practices (Salma, 2025). This contributes to severe environmental degradation. Large quantities of plastic and debris are washed into rivers and eventually into

the ocean. Mismanaged plastic waste in rivers is estimated at 0.3–0.7 million tons per year (UNICEF, 2021). In 2021, UNEP reported that marine debris costs Indonesia approximately USD 459 million annually in lost fisheries, shipping, and tourism revenues due to plastic waste issues. In short, unresolved waste management is polluting Indonesia's cities, countryside, and coastal areas.

Urban Settings: Impacts on Citizens and Economy

In Indonesian cities, the waste problem is particularly acute. The consequences of waste mismanagement for human resources are multifaceted. Densely populated areas generate massive volumes of garbage that urban services struggle to manage. Overflowing landfills and informal dumps lead to widespread air and water pollution. In particular, many urban residents burn household waste. Open burning releases toxic substances and particulate matter, increasing the incidence of non-communicable respiratory diseases. Studies have found that in regions of Indonesia with high levels of waste burning, children experience significantly more acute respiratory infections (Irianti & Puguh, 2019). Chronic exposure to polluted air increases rates of asthma, bronchitis, and other illnesses among the urban workforce. These health effects translate into lost working days, higher medical expenditures, and reduced labor productivity. Both globally and in Indonesia, air pollution has been shown to cause non-communicable diseases (NCDs), such as heart disease and lung cancer, contributing to labor losses, increased healthcare expenditures, and even reduced national GDP (Syuhada et al., 2023). In conclusion, urban pollution arising from waste diminishes the health of the working-age population.

Beyond health impacts, overflowing waste degrades urban environments that sustain livelihoods. Contaminated water and soil damage crops in peri-urban areas and increase groundwater pollution. Toxic runoff can even affect urban drinking water supplies when waste is dumped near rivers. Moreover, environmental degradation carries significant economic consequences. Waste-driven pollution directly undermines the tourism industry, which is a vital component of Indonesia's economy. Cities and towns that attract businesses and visitors suffer when beaches, forests, and cultural sites are littered with garbage. Poor waste management therefore erodes the broader economic base that supports urban employment and human capital.

On the other hand, some initiatives highlight emerging opportunities in urban areas. Programs such as the United States Agency for International Development (USAID) SELARAS initiative in 2022 noted that improved solid waste management can "enhance citizens' quality of life" and create "stable green jobs." By investing in recycling and waste-to-energy systems, cities could generate employment opportunities and facilitate skills development for collectors, sorters, and plant operators. Nevertheless, until such structural improvements are widely implemented, the overall impact in urban areas remains predominantly negative, as rapidly growing cities continue to bear substantial health and economic burdens from unresolved waste issues.

Rural Settings: Impacts on People and Livelihoods

Rural Indonesia faces related but distinct waste challenges. Most villages have almost no formal waste management services. Residents typically rely on burning, burying, or dumping waste in fields and forests (Jambeck et al., 2015; Miller & Urdinola, 2010; Prüss-Ustün et al., 2016; Spears et al., 2013). Although rural areas generate less total waste than

cities, the lack of safe disposal mechanisms means that local environments and water sources are easily contaminated. In many rural communities, open defecation remains common. UNICEF (2021) reports that in the poorest rural households, approximately 36–65% lack access to basic sanitation facilities. Consequently, fecal waste contaminates surface water and wells, leading to widespread water pollution.

The health impacts in rural areas are severe, as contaminated water is a primary source of disease. In Indonesia, roughly a quarter of all children under five suffer from diarrhea, which remains one of the leading causes of child mortality (UNICEF, 2021). Unsafe water and inadequate sanitation in villages contribute directly to these statistics. Studies show that when water sources are tested, approximately 85% are contaminated with fecal bacteria (UNEP, 2021). Such exposure causes acute illnesses such as diarrhea, cholera, and typhoid, and may also contribute to chronic conditions including malnutrition, stunting in children, organ damage, and even cancer (UNEP, 2021). By undermining child health and development, waste-induced water pollution erodes human capital. Children who suffer recurrent illness or malnutrition often fall behind academically and may drop out of school, thereby reducing future workforce capacity. Similarly, poor adult health resulting from frequent diarrhea or respiratory problems caused by biomass and waste smoke leads to increased absenteeism in agricultural and small-scale rural industries. Therefore, rural waste and sanitation deficiencies impose a heavy disease burden that directly lowers the quality of the rural workforce.

Economically, rural areas depend heavily on agriculture, fisheries, and local trade. Pollution from untreated waste undermines these livelihoods. Toxic runoff into irrigation systems or fishponds can reduce crop yields and contaminate food supplies. Additionally, the time and financial resources spent treating preventable illnesses divert household resources away from productive activities. Although per capita waste generation in rural areas is lower than in urban settings, the relative impact on isolated communities may be greater due to limited access to services. Ultimately, unresolved waste problems perpetuate poverty in many rural regions, limiting access to education and vocational training and constraining human capital formation.

Effects on Economic Development and Human Capital

The quality of human resources is a fundamental driver of economic growth. In Indonesia's case, the waste crisis represents a significant but often overlooked constraint on development. Poor health resulting from waste-related pollution reduces labor productivity and increases healthcare costs, thereby slowing GDP growth (Syuhada et al., 2023). Environmental hazards such as air and water pollution undermine economic performance by decreasing worker productivity and imposing fiscal burdens (UNEP, 2021; Syuhada et al., 2023). High rates of child stunting and recurrent illness further compromise future human capital, as affected populations may struggle to attend school consistently or acquire necessary skills.

Conversely, the waste crisis is increasingly recognized as an economic opportunity. Policymakers and development agencies now view improved waste management as a pathway to green economic growth (Elagroudy et al., 2016; Kumar et al., 2023; Yu et al., 2023). For example, the World Bank has launched major programs to strengthen waste infrastructure in Indonesian cities, with the explicit aim of creating stable green jobs and

advancing a circular economy. Similarly, environmental and public health experts emphasize that reducing waste, particularly plastic pollution, can improve productivity and stimulate new industries. In contrast, failure to address these challenges risks perpetuating a cycle of poverty in which unhealthy and undereducated populations are unable to support Indonesia's long-term economic aspirations.

Both urban and rural areas contribute significantly to national development. In cities, a healthier workforce and a cleaner environment would enhance competitiveness and attract investment. In rural areas, access to safe water and reduced pollution would improve agricultural productivity and free labor for education and entrepreneurial activities. Ultimately, resolving waste management challenges is not merely an environmental imperative but also a strategic investment in human capital. As USAID notes, improper waste management poses substantial health and environmental risks; however, effective waste management can improve citizens' quality of life and promote sustainable development.

CONCLUSION

In Indonesia, unresolved waste management is more than an environmental nuisance. It is a threat to human resource quality and economic development. Both urban and rural communities suffer when waste is dumped or burned in the open. In cities, rampant waste burning and overflowing landfills poison the air and water, increasing respiratory and chronic diseases among the workforce. In villages, lack of sanitation and open dumping pollute drinking water and farmland, causing diarrhoeal diseases, child stunting and other illnesses. These health impacts translate into lower productivity, higher health costs, and poorer educational outcomes – all of which undermine Indonesia's growth.

To improve the quality of human resources, Indonesia must integrate waste management into its development strategy. Lessons from around the world show that tackling waste can generate jobs, improve health, and support a green economy. In the Indonesian context, focusing on waste reduction, recycling and sanitary disposal, especially in underserved rural areas would enhance human capital by ensuring cleaner water, healthier children, and a more productive workforce. Without such efforts, unresolved waste problems will continue to erode the very human capabilities that the nation needs for sustained economic progress.

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