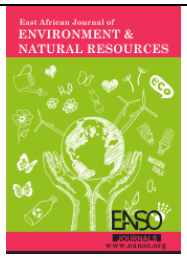

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Original Article

The Impacts of Waste Management Practices on Environmental and Social Well-being in Secondary Schools of Musanze District, Rwanda

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Waste Management, Environmental Impact, Social Well-Being, Secondary School.

ABSTRACT

This study explored the Impacts of Waste Management Practices on Environment and Social Well-being in Secondary Schools with a focus on selected schools in Musanze District. The study aimed to examine the types of waste generated in secondary schools, assess the methods used to manage this waste, analyze the environmental and social impacts resulting from these practices and identify the challenges faced by secondary schools in implementing effective waste management practices. A mixed-methods approach and tools were used, combining a survey with questionnaires, interviews, and focus group discussions with students, teachers, administrators and local authorities. The findings revealed that the most common types of waste generated include paper, plastic, food remains, and sanitary waste. Regarding management methods, the study found that most schools rely on basic practices such as open burning and dumping, with limited segregation, recycling, or proper disposal systems in place. On environmental impacts, it was observed that poor waste handling contributes to pollution, unpleasant odours, and blockage of drainage systems, negatively affecting the school environment and surrounding communities. In terms of social well-being, the study found that improper waste management exposes students and staff to health risks, reduces school cleanliness, and contributes to absenteeism, especially among female students due to poor sanitary disposal. The challenges to effective waste management practices include lack of awareness and education on waste management among students, inadequate waste disposal facilities and low involvement of stakeholders in waste management. The study concludes that waste management practices in secondary schools are inadequate and contribute significantly to environmental degradation and social challenges. It recommends increased awareness, training on proper waste handling, provision of bins, and stronger involvement of school administrators and local authorities to improve overall waste management and enhance both environmental and social well-being in schools.

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INTRODUCTION

Waste management is a crucial element in achieving sustainable development. In educational settings, the management of waste not only maintains a clean and healthy environment but also imparts critical environmental values to learners. In Musanze District, secondary schools are growing rapidly, which results in increased waste production. The mismanagement of this waste may lead to serious environmental degradation and negative health implications for students and surrounding communities (Adell, D., & Uwase, S.2016).

This paper seeks to understand the current practices in waste handling and their impact on school environments and the broader community. It explores both infrastructural and behavioural factors contributing to the challenges faced. The accumulation of waste in educational institutions has raised serious concerns about health and environmental risks. In Musanze District, secondary schools face challenges in managing waste. This study examines how current waste practices influence the environment and the well-being of individuals within school environments, aiming to identify sustainable strategies for waste reduction and environmental preservation.

Researchers have consistently found a strong correlation between the availability of waste disposal facilities and proper waste management behaviour among school populations. Social well-being is often tied to cleanliness and safety, which are compromised when waste is not effectively handled. Literature suggests that improving environmental awareness contributes to enhanced academic performance and student morale (Chantal, K., & Thierry, N.2019).

Objectives

General Objective

The general objective of the study is to analyse the environmental and social impacts of waste management practices in secondary schools of Musanze District.

Specific Objectives

The specific objectives of this study are the following:

- To analyze the current waste management practices in secondary schools
- To examine the environmental and social impacts of waste management practices in secondary schools
- To explore the challenges faced by secondary schools in implementing effective waste management practices

REVIEW OF THE LITERATURE

Current Waste Management Practices in Rwanda

Waste Collection and Segregation

In most Rwandan secondary schools, waste collection practices are basic and vary across

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schools, with urban schools generally having more structured systems compared to rural schools. Many secondary schools are working toward separating waste into different categories, such as recyclables, organic waste, and non-recyclable materials. In more urbanized areas like Kigali, schools have begun implementing simple waste segregation systems with separate bins for paper, plastics, and organic waste. However, in rural areas, segregation is less common, and waste is often collected in a single bin (Rwanda Environment Management Authority (REMA), 2016).

Recycling Practices

Recycling practices are gaining traction in some schools, but the extent of these efforts depends on the availability of infrastructure and community engagement (Graedel, T.E. and B.R. Allenby1995). Some schools in urban areas like Kigali have partnered with local recycling companies to collect recyclable waste, such as plastics, paper, and metals. These schools have introduced recycling bins and designated areas for collecting recyclables. However, even in these areas, the level of recycling is still low compared to other global standards (Rwanda Environment Management Authority (REMA), 2016). Organic waste, such as food scraps and plant material, is often composted in schools that have agricultural departments or large school gardens.

Waste Disposal

Waste disposal methods in Rwandan secondary schools primarily involve traditional approaches, with a heavy reliance on landfill disposal and incineration. Many schools dispose of their waste in open pits or local landfills. This practice is common in rural areas where waste collection services are not available or accessible. While some urban schools may have more formal waste disposal services, they still face challenges with ensuring the proper disposal of all types of waste (Clean and Green Rwanda, 2020).

Rwanda Secondary Schools and Environmental Management

Rwanda has made significant strides in environmental management, particularly through its policies and educational systems. Secondary schools play a crucial role in fostering environmental awareness and sustainability practices among students, who can later apply these principles in their communities and future careers. The integration of environmental management practices in Rwanda's secondary schools is driven by national policies, curriculum reforms, and initiatives aimed at enhancing sustainability at the grassroots level (Ministry of Education. (2015).

Environmental and Social Impacts and Health Concerns of Waste Management in Rwanda

Waste management in Rwanda, like in many other countries, has significant environmental, social, and health implications. The country's waste management practices have been evolving with an emphasis on sustainability, waste reduction, recycling, and pollution control. However, the growing population, urbanization, and industrialization have introduced new challenges related to waste management that affect the environment, communities, and public health. Below is an exploration of the environmental, social, and health impacts of waste management in Rwanda, highlighting the current situation and challenges.

Waste Management and Environmental Impact in Schools

Several studies highlight the negative environmental impact of poor waste management practices in schools. A study conducted on waste management practices in schools across Rwanda found that improper waste disposal, including unsegregated waste and the use of non-biodegradable materials, led to increased pollution, particularly plastic waste, which adversely affected the local environment. The accumulation of waste in and around school premises not only compromised air and soil quality but also contributed to the contamination

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of water sources due to improper disposal of hazardous waste. This study demonstrated the importance of adopting sustainable waste management systems to reduce environmental degradation in schools (Muhoza et al. 2021).

Social Impacts of Waste Management in Schools

Research on the social implications of waste management in schools has demonstrated that the quality of waste management directly affects students' health, behaviour, and learning outcomes. In a study conducted in secondary schools in Uganda, Nshuti and Uwizeye (2020) found that poor waste management practices were linked to a range of social problems, including increased absenteeism due to illness and diminished student concentration. The unsanitary conditions in schools discourage students from engaging fully in their studies, creating a barrier to effective learning. Moreover, the social stigma attached to dirty and unkempt environments negatively impacted students' perceptions of their educational institutions (Rwanda Development Board (RDB),2019).

Health Concerns Related to Waste Management in Rwanda

The burning of waste, especially plastics, is a serious health concern in Rwanda. The toxic fumes released during the burning process contain harmful substances, including dioxins, which can cause respiratory problems, asthma, and other chronic respiratory conditions. Prolonged exposure to these pollutants can also increase the risk of cardiovascular diseases (Ministry of Environment, 2020).

Inadequate waste disposal practices create breeding grounds for disease vectors, such as mosquitoes and rats. Stagnant water accumulated in improperly disposed waste can become a breeding ground for mosquitoes, leading to the spread of malaria. Furthermore, poorly managed solid waste can harbour bacteria, viruses, and pathogens that contribute to the spread of diseases such as cholera, diarrhoea, and dysentery (Global Environmental Facility (GEF),2016).

The Role of Environmental Education in Waste Management

Environmental education plays a crucial role in waste management practices in schools, promoting sustainability and responsible waste disposal behaviour among students. Incorporating environmental education into the school curriculum leads to a more environmentally aware student body, which is better equipped to adopt sustainable waste management practices (Kanyesigye, B.2019). In schools where environmental education was integrated into the curriculum, students not only learned about waste reduction techniques but also practised these behaviours both in school and at home (Nshimiyimana, 2018).

Waste Management Challenges and Solutions in Schools

In a study on waste management in schools, it is highlighted that secondary schools in rural areas of Rwanda, including Musanze District, face unique challenges in managing waste due to limited infrastructure and resources (Nkurunziza, A., &Umuraza, M., 2017). Schools often lack adequate waste management facilities, such as recycling bins, composting areas, and waste separation systems. Moreover, schools with fewer resources often face difficulty in obtaining proper training for staff and students on waste management practices. This results in improper disposal of waste and contributes to environmental pollution (World Bank, 2015).

MATERIALS AND METHODS

Description of the Geographical Area of Musanze District

Musanze is situated in the northwestern part of Rwanda, bordering Burera District to the north, Nyabihu District to the west, Gakenke District to the south, and Uganda to the northeast. It is home to the Virunga Massif, such as Mount Karisimbi, Mount Bisoke, Mount Muhabura, Mount Sabyinyo, and Mount Gahinga. Altitude in Musanze ranges from 1,800 meters to over 4,500 meters above sea level. Musanze has a temperate climate with an average temperature of about 15–

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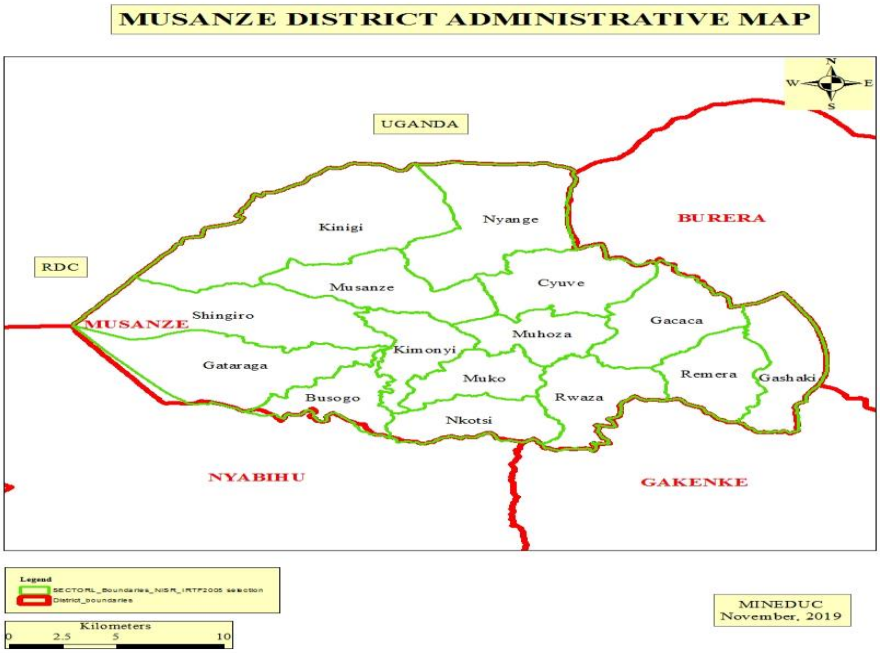
20°C. Musanze district has 74 accredited secondary schools, including public, government-aided, private secondary, technical secondary, day schools and boarding schools. All these schools have adopted a school feeding program with other school activities, which may be a source of waste from food left over.

Figure 1: Musanze District Administrative Map



Source*: Musanze District development strategy document*

Research Design and Sampling Techniques

This study in Musanze District, Rwanda, employed a mixed-methods approach to assess the impact of waste management practices on the environment and social well-being in secondary schools. The total target population for this study was 1480, which includes Students from secondary schools in Musanze District, selected Teachers working in the secondary schools, School Administrators (headteachers and waste collectors), and Local Authorities (Sector education officers, cell leaders, etc.). Musanze district consists of 74 accredited secondary schools according to the school data management system (SDMS). The population was found by considering the school headteacher from each of the 74 secondary schools, one Geography teacher from each school, one waste collector from each school, sixteen students from the environmental club in each school, fifteen sector education officers from fifteen Musanze district sectors and fifty-nine cells' leaders where schools are located.

Sample Size

To ensure the sample is statistically representative of the population, we calculated an appropriate sample size. This was done using a sample size formula for finite populations.

$$n = \frac{N * Z^2 * p\,(1-p)}{E^2\,(N-1) + (Z^2 * p\,(1-p)}$$

Where:

- n = sample size
- N = population size (1,480)
- Z = Z-value (e.g., for 95% confidence level, Z=1.96Z = 1.96Z=1.96)
- p = estimated proportion (since we don't know the exact proportion of certain behaviours, a conservative estimate of 0.5 is often used)

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- E = margin of error (commonly set to 0.05 or 5%)

The Calculation

Assume:

- N=1,480N = 1,480N=1,480 (total population)
- Z=1.96Z = 1.96Z=1.96 (for 95% confidence level)
- p=0.5p = 0.5p=0.5 (a conservative estimate for proportions)
- E=0.05E = 0.05E=0.05 (5% margin of error)

Substitute these values into the formula:

$$n = \frac{1480*1.96^2*0.5*0.5}{(0.05^2(1480-1)) + (1.96^2*0.5*0.5)}$$

n=339

Using a foundational statistical theory formula, a sample of three hundred thirty-nine (339) people was found. The three hundred and thirty-nine sampled population were found by randomly taking two schools from each of the fifteen sectors of Musanze District, being thirty schools representing the whole others, and we took eleven people from each of these thirty schools and nine local authorities representing the community.

RESULTS PRESENTATION AND DISCUSSION

Demographic Characteristics of the Respondent

The demographic characteristics of the respondents included gender, age, position within the school, and years of experience at the school.

Table 1. Demographic Characteristics of the Respondent

Category	Sub-Category	Count
Gender	Male	153
Gender	Female	177
Gender	Prefer not to say	9
Age	Below 18	27
Age	18 - 24	137
Age	25 - 34	96
Age	35 and above	79
Position	Student	222
Position	Teacher	74
Position	Administrator	15
Position	Support Staff	28
Years at School	Less than 1 year	55
Years at School	1 - 3 years	145
Years at School	4 - 6 years	80
Years at School	More than 6 years	59

Source: *Survey data, 2025*

The survey included 339 respondents: 45.1% male (153), 52.2% female (177), and 2.7% preferred not to say (9).
The majority of respondents were aged 18–24 (40.4%), reflecting a primarily young demographic typical of secondary schools. 42% of the respondents were in the range of 1 to 3 years working at school, 23.6% 4 to 6 years, 17% had more than 6 years at school, and 16% had less than one year at school. A good range of 4 to 3 years of respondents working at a school that has enough information on the history of waste management at school were well represented among the respondents, which reflects good and accurate data.

Waste Management Practices

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Table 2: Current Waste Management Practices in Secondary Schools with Frequencies of Respondents (Respondent Count)

Category (proposed questions)	Subcategory (Proposed responses)	Respondent Count
Waste Type	Organic waste	255
Waste Type	Plastic waste	64
Waste Type	Paper waste	280
Waste Type	Electronic waste	52
Waste Type	Other	42
Waste Collection	Centralized bins	120
Waste Collection	Separate bins	180
Waste Collection	Open dumping	30
Waste Collection	No specific system	9
Formal Waste Management System	Yes	200
Formal Waste Management System	No	159
Waste Management Responsibility	School administration	180
Waste Management Responsibility	Students	55
Waste Management Responsibility	External collectors	45
Waste Management Responsibility	Other	59
Waste Collection Frequency	Daily	140
Waste Collection Frequency	Weekly	100
Waste Collection Frequency	Monthly	50
Waste Collection Frequency	Irregularly	49
Waste Disposal Method	Burning	39
Waste Disposal Method	Open dumping	51
Waste Disposal Method	Recycling	11
Waste Disposal Method	Composting	229
Waste Disposal Method	Other	9

Source: *Survey data, 2025*

Types of Waste Generated

A survey done in Musanze District has shown that the most commonly generated waste in secondary schools is paper (280), followed by organic waste (255), plastic waste (64), and electronic waste (52). Other waste types account for 42 instances, indicating that paper waste is a significant contributor to the school's waste.

Waste Collection Methods

In the survey done in Musanze District, 180 respondents from different secondary schools reported using separate bins for different types of waste, followed by centralized bins in classrooms (120). Open dumping (30) and a lack of a specific system (9) were less common, showing that the school has at least some form of waste collection system in place.

Waste Management Responsibility

The school administration is responsible for waste management in most cases (180), with some involvement of students (55) and external waste collectors (45), as per a survey done, which indicates a mainly administrative responsibility for waste management.

Most respondents indicated that waste is collected daily (140), with some reporting weekly (100) and monthly (50) collections. This suggests that the frequency of waste collection is fairly regular.

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Environmental Impacts of Waste Management

Table 3: Environmental Impacts from Waste Management Practices with Frequency of Respondents (Respondent Count)

Category (proposed questions)	Subcategory (Proposed responses)	Respondent Count
Environmental Issues	Air pollution	115
Environmental Issues	Water pollution	44
Environmental Issues	Soil pollution	86
Environmental Issues	Pests/Diseases	135
Environmental Issues	No issues	67
Negative Impact Belief	Yes	273
Negative Impact Belief	No	30
Negative Impact Belief	Not sure	39
Environmental Measures	Awareness campaigns	107
Environmental Measures	Sorting/Recycling	213
Environmental Measures	Composting	179
Environmental Measures	Partnering with services	91
Environmental Measures	No measures	29

Source: *Survey data, 2025*

Observed Environmental Issues

Pests and diseases (135) were the most commonly observed environmental issues, followed by air pollution (115), soil pollution (86), and water pollution (44).

A significant portion (67) noted no environmental issues, indicating this portion had limited awareness of environmental issues; contrary environmental issues may vary across schools.

Perception of Negative Environmental Impacts

Most respondents (273) believe that improper waste management negatively affects the environment, suggesting strong awareness of the issue.

Measures to Minimize Environmental Impacts

The most common measures include waste sorting and recycling (213) and composting organic waste (179). Fewer respondents indicated that the school conducts awareness campaigns (107) or partners with waste collection services (91).

Social Impacts of Waste Management

Table 4: Social Impacts from Waste Management Practices in Secondary Schools with Frequency of Respondents (Respondent Count)

Category (proposed questions)	Subcategory (Proposed responses)	Respondent Count
Health & Hygiene Impact	Diseases	82
Health & Hygiene Impact	Unpleasant odour	148
Health & Hygiene Impact	Attracts pests	87
Health & Hygiene Impact	No impact	21
Involvement in Waste Management	Actively	80
Involvement in Waste Management	Occasionally	150
Involvement in Waste Management	Not involved	109
Belief in Proper Waste Management	Strongly agree	158
Belief in Proper Waste Management	Agree	120
Belief in Proper Waste Management	Neutral	42

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Category (proposed questions)	Subcategory (Proposed responses)	Respondent Count
Belief in Proper Waste Management	Disagree	15
Belief in Proper Waste Management	Strongly disagree	4
Waste Management Challenges	Lack of awareness	100
Waste Management Challenges	Inadequate facilities	90
Waste Management Challenges	Lack of funding	40
Waste Management Challenges	No external support	50
Waste Management Challenges	Other	59

Source: *Survey data, 2025*

Health & Hygiene Impacts

Unpleasant odours affecting school activities (148) and the attraction of pests (87) were the most commonly observed social impacts, followed by increased cases of diseases (82). A small number (21) indicated no noticeable impact, though this may vary by school.

Involvement in Waste Management

150 respondents indicated occasional involvement in waste management activities, while 80 are actively engaged. A substantial portion (109) is not involved in waste management activities, pointing to room for improvement in student and staff participation.

Belief in Proper Waste Management

A majority strongly agrees (150) or agrees (120) that proper waste management can contribute to a cleaner and healthier school environment, with only a small portion disagreeing (15) or strongly disagreeing (4).

Challenges in Waste Management

Common challenges include a lack of awareness and education among students and staff (100), inadequate waste disposal facilities (90), and a lack of funding for waste management programs (40). Fewer respondents cited no external support from government or NGOs (50) and other challenges (59). This indicates less involvement of stakeholders in waste management

CONCLUSION AND RECOMMENDATION

Conclusion

The survey findings reveal a comprehensive view of waste management practices and their environmental and social implications within secondary schools in Musanze District. With a balanced representation of respondents, primarily students, alongside teachers, support staff, and administrators, the data provides credible insights into the school community's experiences and perceptions.

The study indicates that while most schools have established formal waste management systems, there remains heavy reliance on traditional waste disposal methods such as composting, burning, and open dumping. Paper and organic waste dominate the waste stream, emphasizing the need for targeted recycling and composting strategies. Although some schools utilize separate waste bins and maintain regular waste collection routines, a significant portion still lack structured systems, pointing to infrastructural and organizational gaps.

Environmental consequences of current waste practices are evident, with common issues such as pests, air and soil pollution, and disease risks being reported. Despite these challenges, a large majority of respondents express awareness of the negative environmental impacts and show support for improved practices like waste sorting and composting.

Socially, poor waste handling has led to unpleasant odours, increased pests, and health concerns affecting the learning environment. Furthermore, although there is a positive attitude toward proper waste management, active involvement from students and staff is limited. Barriers such as lack of awareness, insufficient facilities, and limited funding were frequently

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cited, indicating that both behavioural and systemic improvements are necessary.

Overall, the findings suggest that while awareness is high and foundational structures exist in many schools, significant opportunities remain to enhance waste management through better infrastructure, education, community involvement, and external support. Strengthening these areas will not only mitigate environmental harm but also promote a healthier, more sustainable school environment.

Recommendations

Schools should develop and enforce clear waste management policies, with specific roles and responsibilities for students, teachers, and school management. These policies should include guidelines on waste segregation, recycling, and proper disposal methods. Local authorities should play a key role in ensuring these policies are effectively implemented and monitored.

Schools should implement regular educational campaigns to raise awareness about the importance of waste management. This can include workshops, seminars, and class projects aimed at teaching students and staff about waste segregation, recycling, and the environmental and health impacts of poor waste disposal. Environmental clubs and student-led initiatives can be encouraged to drive these campaigns.

Schools should be provided with sufficient waste management infrastructure, including separate bins for different types of waste (e.g., organic, recyclable, non-recyclable, hazardous). Schools should also establish designated areas for waste collection and disposal to minimize pollution. Local authorities and non-governmental organizations (NGOs) can be involved in supporting schools with waste management resources.

Schools should allocate a portion of their budget specifically for waste management purposes, covering costs for waste bins, cleaning supplies, and waste handling equipment. Additionally, partnerships with local businesses or international organizations can provide financial support for setting up and maintaining proper waste management systems.

Effective waste management requires the involvement of all stakeholders. Schools should collaborate with local authorities to ensure regular waste collection services are provided. Schools can also work with environmental NGOs, local businesses, and parents to create a more holistic approach to waste management.

Schools should introduce recycling programs and encourage waste minimization through initiatives like reducing single-use plastics, composting organic waste, and reusing materials for school projects. Establishing recycling clubs and organizing waste reduction challenges can motivate students to actively participate.

Schools should regularly monitor and evaluate their waste management practices to ensure their effectiveness. This could include periodic waste audits, feedback from students and staff, and adjustments to strategies as needed. Continuous improvement is key to making waste management practices sustainable.

Limitation/anticipated Problems

The study faced the following limitations:

Response Bias: some of the Participants provided socially desirable answers, especially when discussing environmentally responsible behaviours but it was overcome through the provision of a very comprehensive questionnaire.

Generalizability: The findings was about to be limited to the schools involved in the study and not representing all schools, but we ensured a very clear representation of schools in sampling.

Self-Report Data: The questionnaire tool normally relies on self-reported data, which may not always reflect actual behaviour, but we ensured the validation of the used questionnaire. Among other methodology constraints were about the distribution and collection of the questionnaires to and from the respondent but it was covered through the well-used sampling method of providing them into strata.

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