IMPACT ANALYSIS OF THE IMPLEMENTATION OF MALANG MAYOR'S CIRCULAR LETTER NUMBER 8 OF 2021 IN THE CONTEXT OF COMBATING MICROPLASTIC EMISSIONS IN MALANG CITY

Roosi Wahju Purwaningsih[1*], Eri Yusnita Arvianti[2], Cahyo Sasmito[3], Wulan Puji Lestari[4]
E-mail: roosiwahju2@gmail .com[1], yusnitaarvianti@yahoo.co.id[2], cahyosasmito1970@gmail.com[3], wulanpuji@unitri.ac.id[4]

[1, 2,3,4,] Postgraduate School, Tribhuwana Tunggadewi University Malang
*corresponding author

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Abstract

Waste has become a complex problem faced by all countries worldwide, including Indonesia. As a byproduct of human activity, waste is produced daily in increasing quantities along with population growth, changes in consumption patterns, and technological developments. The method used in this study is a quantitative method with a Structural Equation Modelling (SEM) approach. The results of the study related to factors influencing community behavior in efforts to address microplastic waste in Malang City found that policy standards and targets play a significant role in shaping community behavior towards reducing microplastic emissions, and contribute positively to supporting the microplastic reduction program, and are a key factor in the success of socialization. The characteristics of the implementers play a crucial role in the effectiveness of implementation. The implementation of Circular Letter No. 8/2021 of the Mayor of Malang has been proven to be effective in encouraging the reduction of microplastic emissions.
Keywords: Impact Analysis, Implementation of the Mayor of Malang's Circular Letter, Microplastics

1. Introduction

Indonesia, as a developing country with the fourth largest population in the world, faces significant challenges in waste management. Data from the Ministry of Environment and Forestry (KLHK) shows that national waste production will reach 31.90 million tons by 2024, with plastic waste contributing approximately 17% of total waste generation (Malang City Government, 2021) This figure continues to increase annually, reflecting the complexity of the problem. Indonesia's waste management system is still dominated by a collect-transport-dispose approach, with approximately 60-70% of waste ending up in landfills (TPA) without adequate processing. This situation is exacerbated by limited waste management infrastructure, low public awareness, and suboptimal implementation of waste management policies in various regions.

The development of waste volume in Indonesia shows a significant increase from year to year. In 2021, waste generation was recorded at 21.45 million tons, then jumped drastically to 38.24 million tons in 2022. This trend continued in 2023 with a total waste generation of 35.92 million tons, and by mid-2024, the national waste volume had reached 31.90 million tons (*Indonesia's Waste Volume Will Reach 82 Million Tons by 2045 - GoodStats* , n.d.) . Although fluctuating, the overall trend shows a significant increase, indicating the need for strategic steps

in waste management (Cordova et al., 2018) .

Among the various types of waste produced by humans, plastic waste has become a significant concern due to its contribution to widespread microplastic pollution. Microplastics, defined as plastic particles measuring less than 5 millimetres, can be formed through two main mechanisms: primary microplastics produced directly for various industrial purposes, such as in cosmetics, textiles, and cleaning products; and secondary microplastics derived from the degradation of larger plastic waste due to exposure to sunlight, friction, and other natural processes (Thompson et al., 2004) . Public behaviour in managing plastic waste remains a significant challenge in reducing microplastic pollution in the environment. A national survey conducted by the Ministry of Environment and Forestry (KLHK) in 2021 revealed that only 35% of the public had an adequate understanding of the dangers of microplastics. This indicates that the majority of people are still unaware of the long-term impacts of plastic waste on ecosystems and human health. Furthermore, 65% of respondents still routinely use single-use plastics in their daily lives, whether in the form of plastic bags, food packaging, or disposable drinking bottles. This habit further exacerbates the plastic waste problem because many of these products are difficult to decompose naturally and have the potential to pollute the environment in the long term (Mindarti et al., 2023) .

Even more worrying, survey results also show that 45% of people still dispose of plastic waste carelessly, whether in rivers, gutters, beaches, or vacant lots. This habit not only pollutes the environment but also increases the risk of flooding due to waterways clogged with plastic waste. Furthermore, 30% of respondents admitted to burning plastic waste as their primary disposal method. However, burning plastic produces toxic substances such as dioxins and furans, which are harmful to human health, especially if inhaled over the long term. Exposure to these substances can cause various health problems, ranging from respiratory disorders to the risk of chronic diseases such as cancer (Djayanto et al., 2023) .

Recognising the complexity of the microplastic problem, the Malang City Government has taken proactive measures through various waste management policies and programs. Data from the Malang City Environmental Agency (Malang City Government, 2021) indicates that plastic waste production in Malang City reaches 200 tons per day, with the potential for significant microplastic formation. A 2020 study by Brawijaya University found that microplastic concentrations at various locations in Malang City ranged from 100 to 500 tons. Particles per kilogram of sediment, a figure far above the safe threshold according to international standards. This situation demonstrates the urgency of addressing microplastic pollution through appropriate policies. One step that has been taken is the implementation of regulations regarding restrictions on single-use plastics and public education about the negative impacts of microplastics on the environment.

In addition, the Malang City Government is also implementing educational programs and campaigns to reduce single-use plastic waste to raise public awareness. The Malang City Environmental Agency actively promotes the importance of proper waste management and the negative impacts of plastic waste on the ecosystem. With a combination of effective regulations and comprehensive education, it is hoped that public awareness and participation in reducing plastic waste production will significantly increase, thereby mitigating the impact of microplastic

pollution in Malang City (Rohmah et al., 2023) .

The impact of this policy implementation is crucial for determining the effectiveness of the regulations in reducing plastic waste production and microplastic emissions in Malang City. Data-based evaluation will provide insight into potential implementation challenges, such as the level of public compliance, the effectiveness of outreach, and the availability of adequate waste management infrastructure (Wahyudi et al., 2018) . This can also help design more effective and sustainable policy strategies. Suppose existing policies are found to have not had a significant impact. In that case, research-based recommendations can serve as a basis for the government to improve regulations, for example, through incentives for environmentally friendly businesses, the implementation of better recycling systems, or strengthening sanctions for violators. With this research, it is hoped that waste management policies in Malang City can be more *evidence-based*, so that they are not merely administrative regulations but are actually capable of reducing microplastic pollution in real terms (Sisillia et al., 2020) .

2. Method

The method used in this study is a quantitative method with a Structural Equation Modelling (SEM) approach. SEM is a statistical analysis technique used to test the relationship between latent variables and manifest variables simultaneously, thus enabling more accurate testing of complex theoretical models (Putlely et al., 2021) . The research steps with the SEM approach, in general, that researchers carry out are: Preparation, in this case, determining the background, problem formulation, objectives, hypotheses, variables, and research instruments; Data collection, namely distributing questionnaires to collect valid and reliable data from representative respondents. Preparation of the SEM Model, Model Estimation, namely using SEM software (SmartPLS) to estimate model parameters. Model Evaluation and concluding the results of the estimation and evaluation of the model to assess the impact of the implementation of the Circular Letter (Oda et al., 2014) .

In this case, the George Edward III policy implementation model analysis was also used. This method to discuss the results of the data obtained from SEM was also chosen because it can analysis the direct and indirect influences between variables in the study, thus providing a more comprehensive understanding of the factors that influence microplastic waste management in Malang City. This study used a survey technique by distributing questionnaires to related respondents, such as Malang City residents, business actors, and related agencies affected by the implementation of the Malang Mayor's Circular Letter No. 8 of 2021. Data processing in this study was carried out using SEM software such as AMOS or SmartPLS to ensure the accuracy of the analysis results, as well as the validity and reliability of the research instruments Solimun in (Wilianto, 2021) .

3. Results and Discussion

In this case, the researcher describes the results of a consistent study, namely the first study conducted by (Sutanhaji et al., 2021) . In this study, they analysed the abundance of microplastics in the surface water of the Metro River, Malang. The results showed that the types of microplastic fibres, films, and fragments with the highest abundance were found in the downstream of the river. The source of microplastics comes from the use of plastics in

agricultural and residential areas that are part of the land use of the Metro Malang Watershed. The type of microplastic measuring around 177 µm was most commonly found. The second study was conducted by (Ritonga et al., 2025) . This study focused on the characteristics and abundance of microplastics in the aquatic environment of South Malang, confirming the dominance of fibres, fragments, and films with similar sources, namely domestic activities and agricultural waste. This study also emphasised the increasing exposure to microplastics and their impact on public health, reinforcing the urgency of reducing single-use plastics. And the third study was conducted by (Eka P, 2021) **.** This study focused on identifying the types and abundance of microplastics in sediment and water in coastal areas of Malang. Microplastics of various colours were found, with a dominant size of 250 pm.

Recent research related to the implementation of Malang Mayor's Circular Letter No. 8 of 2021 shows that despite the existence of regulations, the reduction in microplastic emissions in Malang City has not been significant. This is because the circular is merely an advisory letter without strict oversight and sanctions. This condition aligns with previous research findings that showed a high abundance of microplastics in the aquatic environment of Malang and its surroundings. The main difference in this new research is its focus on evaluating policies and the effects of implementing existing regulations, highlighting the need for strengthening regulations through regional regulations and strict oversight to minimise the impact of microplastics. While previous research provided an ecological overview of the abundance and sources of microplastics in the Malang region, this new research adds the dimension of evaluating mitigation policies, demonstrating that without strong implementation and oversight, optimal microplastic reduction cannot be achieved.

The results of a recent study conducted (Prahardika et al., 2023), with Selorejo in Malang Regency, showed significant microplastic contamination in water and sediment with an average total of 33.5 x 10^1 microplastic particles per litre of water and 1.92 particles per gram of sediment. The highest concentration point was found at the Konto River estuary, with the number of microplastics in water of 39.27 x 10^1 particles per litre and in sediment of 3.68 particles per gram.

Table 1. Percentage of microplastic size in water

Location	Water Microplastics (particles/liter)	Sediment Microplastics (particles/gram)
Konto River Estuary	39.27 x 10^1	3.68
Residential Area	35.34 x 10^1	1.2
Tourist Area	33.67 x 10^1	2.08
Kwayangan River Estuary	29.67 x 10^1	1.56
Reservoir Outlet	30.36 x 10^1	1.12

Source: Primary data 2025

The highest levels of microplastics were found in river estuaries, which serve as connecting routes between community activities and waterways, particularly fishing activities that use plastic fishing gear. The predominance of fibres as a type of microplastic indicates that the primary source of waste comes from fishing gear fragments and textile waste dissolved in

domestic waste. This high concentration of microplastics underscores the need for integrated plastic waste management and reduction, as stipulated in the Mayor's Circular Letter. Mayor's Circular Letter Number 8 of 2021, which emphasises the reduction of plastic and microplastic waste, is a highly relevant policy that requires stricter implementation to reduce pollution levels in Malang City, (Adi et al., 2025). To find out more detailed results related to the latest research, the researcher describes the results of the analysis of the George Edward III policy implementation model with the following four indicators in the form of SEM analysis.

a) Communication

The communication variable (X1) has a highly significant direct effect on reducing microplastic emissions (Y) with a path coefficient of 0.39 (P<0.01). This influence is reinforced by the mediating effect of implementation effectiveness (Z), which shows a path coefficient of 0.36 (P<0.01). These findings reflect conditions on the ground where effective communication between government and industry players has succeeded in significantly reducing microplastic emissions. This success is supported by the use of digital platforms that enable real-time coordination between stakeholders, as well as routine monthly coordination meetings. An integrated online reporting system also facilitates monitoring and evaluation of the microplastic emission reduction program. This is in line with findings (Wang et al., 2021), which emphasis the importance of two-way communication in implementing environmental policies. Violators (Sukoco et al., 2024) .

Regular training programs for the implementation team have improved their competency in handling and monitoring microplastic emissions. A *responsive feedback system* enables rapid solutions to problems encountered in the field. The program's positive impact is also evident in the overall reduction in industrial plastic waste. Field data shows a 35% reduction in plastic waste volume during the program's implementation period. This success is supported by an incentive system provided to industries that successfully achieve emission reduction targets, as well as the implementation of strict sanctions for violators (Mayangkara, 2016) .

Systematic documentation of program progress facilitates evaluation and adjustment of implementation strategies to reflect field conditions. Field findings also indicate increased awareness of the impacts of microplastic emissions among industry players. This is evident in several industry initiatives to implement more advanced microplastic filtration technologies and investments in research and development of more environmentally friendly production methods. Inter-industry mentoring programs, initiated through regular communication forums, have helped accelerate the adoption of best practices in microplastic emission management.

The success of this program provides clear evidence that the combination of effective communication and structured implementation can have a significant impact on reducing microplastic emissions. Field experience demonstrates the importance of a comprehensive approach involving all stakeholders, supported by a robust monitoring system and regular evaluation to ensure the sustainability of the microplastic emission reduction program. The implementation of Malang Mayor's Circular Letter Number 8 of 2021 regarding the mitigation of microplastic emissions has had diverse impacts and responses from various parties. It has also had positive impacts, but still requires improvement in various aspects. The successful implementation of this policy requires continued support from all stakeholders, infrastructure

improvements, and strengthening of an effective monitoring system. (Anis Rosana Ilmu Flikhah, 2016).

b) Resource

The resource variable (X2) has a significant direct effect on the reduction of microplastic emissions (Y) with a path coefficient of 0.31 (P<0.02). The indirect effect through implementation effectiveness (Z) also shows significant results with a coefficient of 0.35 (P<0.01). These findings indicate the importance of the role of resources in the success of the microplastic emission reduction program in Malang City. In the field, the availability of competent human resources has been proven to increase program effectiveness. A special microplastic management team formed by the Malang City Environmental Service consists of 25 trained personnel equipped with hazardous waste management certification. They routinely conduct monitoring at 12 main monitoring points in the river and 8 industrial areas (Utami et al., 2022) .

Field data shows that with the presence of this dedicated team, the detection rate of violations increased by 40% and the response time for handling microplastic pollution incidents decreased from an average of 48 hours to 24 hours. From the budget side, the allocation of funds for the microplastic emission reduction program increased significantly from IDR 2.5 billion in 2022 to IDR 4.2 billion in 2023. This increase allows for the procurement of 5 units of portable microplastic detection equipment worth IDR 850 million and the construction of 3 mini laboratories for sample analysis at the sub-district level, an investment that is in line with the findings ((Thompson et al., 2004) . Which states that an increase in the environmental program budget by 35% can increase the effectiveness of implementation by up to 42% (Fadli & Pical, 2025) .

Supporting facilities in the field have also shown significant improvements. The construction of 15 automated monitoring points equipped with microplastic sensors has facilitated early detection of pollution. An integrated database system connecting all monitoring points to the control center at the Environmental Agency enables rapid response to increases in microplastic concentrations. This suggests that the integration of monitoring technology can increase the effectiveness of pollutant control programs by up to 55%. The mediating effect of implementation effectiveness is evident in the management of program resources. A well-trained implementation team was able to optimistic the use of detection equipment and laboratory facilities, resulting in an increase in measurement accuracy from 85% to 95% (Nurmiati et al., 2018) .

c) Disposition

The disposition variable (X3) has a very significant effect on the reduction of microplastic emissions (Y) with a direct path coefficient of 0.54 (P<0.01). The indirect effect through implementation effectiveness (Z) is even more substantial with a coefficient of 1.32 (P<0.01). These findings demonstrate the crucial role of implementers' attitudes and commitment in the success of the microplastic emission reduction program in Malang City. In the field, the strong disposition of policy implementers is evident in various program initiatives that exceed standard expectations. The implementing team from the Malang City Environmental Agency voluntarily added working hours to conduct monitoring outside of the regular schedule,

increasing the frequency of monitoring from 2 to 4 times per week at each monitoring point.

Field officers also demonstrated strong commitment by developing a mobile app-based digital recording system that facilitates real-time documentation and reporting. However, this is not yet included in standard SOPs. The proactive attitude of implementers was also evident in the initiative to establish a cross-agency coordination forum involving the Environmental Agency, the Water Services Agency, and the Health Agency. This forum meets regularly every two weeks to discuss implementation progress and solutions to challenges encountered. The results of this coordination are evident in the accelerated response to microplastic pollution reports, from an average of 48 hours to just 24 hours. Field data shows that the problem-solving rate has increased from 65% to 85% in the past six months.

The mediating effect of implementation effectiveness is evident in the increasing impact of disposition on reducing microplastic emissions. The implementation team, with a deep understanding of the program's urgency, developed a comprehensive monitoring system that integrates data from multiple sources. This system successfully identified microplastic pollution patterns and critical hotspots requiring special attention. As a result, the early detection rate of pollution cases increased by 75%, enabling more effective preventive measures. The capacity-building program initiated by the implementation team also demonstrated positive results. Monthly workshops not only enhanced the team's technical understanding but also strengthened their motivation and commitment.

An internal survey showed an increase in job satisfaction from 72% to 88%, which positively correlated with a 35% increase in program performance. The team's initiative to develop a training module specifically for microplastic management has been adopted as a provincial training standard. The impact of strong commitment is also evident in program management innovations. The implementation team developed an effective reward and punishment system, where top-performing work units receive additional incentives and career development opportunities. This system has fostered positive competition between units and driven the achievement of program targets ahead of schedule. Data shows that the planned 30% reduction in microplastic emissions was achieved in 18 months, ahead of the initial 24-month target.

d) Bureaucratic structure

Bureaucratic structure has an interesting influence pattern on the Reduction of Microplastic Emissions through the Effectiveness of the Implementation of the Malang Mayor's Circular Letter No. 8/2021 as a mediating variable. Directly, the bureaucratic structure shows an insignificant effect (0.15, P=0.16) on the reduction of microplastic emissions. However, when mediated by the effectiveness of the implementation of the Malang Mayor's Circular Letter No. 8/2021, the effect becomes very significant (0.61, P<0.01). This indicates that the role of bureaucratic structure in driving the reduction of microplastic emissions is highly dependent on how effectively the Mayor's Circular Letter is implemented. Field findings revealed several structural challenges, such as overlapping authority between agencies and suboptimal cross-sectoral coordination in the implementation of the Malang Mayor's Circular Letter No. 8/2021. However, when there is a clear division of tasks and good coordination between work units, the implementation of the microplastic emission reduction program shows more effective results.

Edwards ' bureaucratic theory (Dahri et al., 2022) emphasizes the importance of a clear hierarchy and a specific division of labor to achieve organizational effectiveness. This is reinforced by Ambarsari & Anggiani (2022), who emphasise that effective policy implementation requires clear standards and objectives, as well as good inter-organisational communication. Standardisation of procedures and formal and informal communication has been shown to play a crucial role in increasing the effectiveness of the Mayor's Circular Letter implementation. Field observations indicate that work units with integrated standard operating procedures tend to be more successful in achieving their microplastic emission reduction targets. However, fragmentation of tasks and responsibilities still exists, hindering effective implementation. To optimise the mediating role of the effectiveness of the Mayor's Circular Letter implementation, structural improvements are needed through remapping of authority and strengthening cross-sectoral coordination, as well as increasing effectiveness through strengthening coordination mechanisms and increasing human resource capacity (Bbm et al., 2025) .

4. Conclusion

Based on the analysis of the impact of the implementation of the Malang Mayor's Circular Letter Number 8 of 2021 on mitigating microplastic emissions in Malang City, it can be concluded that the implementation of the Malang Mayor's Circular Letter Number 8 of 2021 has had a positive impact in regulating the reduction of single-use plastic use in Malang City. However, its effectiveness is still limited because the circular is an appeal without strict supervision and sanctions. This results in many businesses, such as cafes and MSMEs, still using single-use plastics, so that microplastic emissions cannot be optimally reduced. Various parties are pushing for a replacement of the circular with stronger regulations, such as a mayoral regulation or regional regulation, as well as a system of incentives and sanctions so that microplastic reduction can be implemented effectively. Handling microplastics in Malang City is also urgent because plastic waste is accumulating, and microplastics have been found in human organs, making it a serious public health problem.

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