



# Plastic Waste Management Dynamics: A SWOT and PESTLE Analysis at Environmental and Forestry Services

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**Abstract.** Waste management has emerged as a global concern across several developing countries, including Indonesia. Makassar, one of the big cities in Indonesia, is encountering difficulties in controlling plastic waste. This study seeks to examine the dynamics of plastic waste management at the Environmental and Forestry Service in Makassar by combining SWOT and PESTLE analyses to comprehend the existing circumstances. This study is defined by a descriptive qualitative approach. Data collecting methodologies included document analysis, interviews, and literature reviews. The results of this study, gathered from interviews and literature reviews, indicate an improvement in plastic waste management in Makassar. This is strengthened by governmental rules prohibiting plastic usage, which raises awareness and encourages citizens to substitute plastic items with eco-friendly alternatives. Moreover, plastic waste management has significant opportunities if executed properly, particularly with the upcoming government program aimed at building an environmentally sustainable trash-to-energy system that incinerates waste responsibly. Nonetheless, challenges include population expansion, constrained human resources, unclear policies, and the absence of restrictions on plastics producers will diminish the efficacy of this initiative. Collaboration with the community and the business sector is essential to improve the efficacy of plastic waste management.

**Keywords:** Plastic Waste Management, Waste, SWOT, PESTLE, Environment.

## 1 Introduction

In developing nations, especially Indonesia, waste management has emerged as a critical concern. In 2024, Badan Pusat Statistik By the first semester of 2024, the entire population of Indonesia was 282.477.584, according to data from the Indonesian government, which is the Directorate General of Population and Civil Registration of the Ministry Home Affairs Indonesia[1]. The population was dispersed throughout several areas, including big cities like Makassar, Surabaya, and Jakarta. Population growth was associated with an increase in the amount of garbage produced.

One of Indonesia's biggest metropolitan towns, Makassar, is now having trouble managing waste due to its fast population expansion. By the end of 2023, Makassar's population was above 1.4 million, according to data from the National Statistics Agency

Waste output has increased as a result of the big population and high degree of urbanization[2].

**Table 1.** Waste volume in Makassar 2020-2023.

Year	Daily Waste Generation (ton)	Annual Waste Generation (ton)
2020	996.71 m <sup>3</sup>	363.800,57 m <sup>3</sup>
2021	1.023,71 m <sup>3</sup>	373.653,93 m <sup>3</sup>
2022	1.022,53 m <sup>3</sup>	365.924,29 m <sup>3</sup>
2023	1.032,08 m <sup>3</sup>	376.70,41 m <sup>3</sup>

According to data from the Ministry of Environment and Forestry the amount of waste produced each day has varied in the last four years. The daily production of garbage climbed in 2023, peaking at 1,032.08 tons per day, despite a decline in 2021 and 2022[3]. In a similar vein, the yearly waste volume exhibits a pattern that aligns with the daily trash generation. This suggests that the overall quantity of garbage produced keeps rising in spite of initiatives to control and minimize it. According to study, between 60% and 70% of the waste produced by human activity is from organic, with the remaining 30% to 40% being inorganic. At 14%, plastic garbage makes up the second-largest portion of inorganic waste[4].

Plastic waste is a type of waste that is difficult to decompose and break down (non-biodegradable) because it takes hundreds of years to be completely broken down by the earth[5]The longer plastic waste takes to decompose, the smaller and less visible it becomes (microplastics), which will negatively impact the health of organisms and ecosystems. [6]

In recent decades, plastic use has increased rapidly, causing the accumulation of plastic waste on land, in rivers, and becoming very abundant on coastlines and in the oceans[6]. The amount of plastic garbage in Makassar increased to 674.80 m<sup>3</sup> in 2022 from 393.93 m<sup>3</sup> in 2021[7]. This information suggests that the amount of plastic waste generated in Makassar increases significantly every year. Irwan Ridwan Rahim, a lecturer in Environmental Engineering at Hasanuddin University, notes in an article published by Berita Kota Makassar that Makassar is considered to be undergoing a plastic garbage emergency, which further supports this[8]. All waste in Makassar is dumped directly into the Tamangapa landfill, leading to overcapacity at the site [4]

Since plastic waste is classified as non-biodegradable waste, Makassar's waste management needs to be treated seriously [9]. The government-affiliated Makassar Environmental Agency is crucial to the development and execution of plastic waste management plans. Numerous initiatives have been undertaken, including the Environmental Awareness Campaign, the Single-Use Plastic Campaign, and the Waste Banking Program. However, because the amount of plastic garbage in Makassar keeps growing annually, the handling of this waste is deemed ineffective.

Hill and Jones emphasize the significance of performing both internal and external studies in order to accomplish the intended goals in SWOT analysis is a tool used to determine the strengths, weaknesses, opportunities, and threats of both external and internal elements [10]. PESTLE, on the other hand, gives experts information on outside influences on the company. Numerous researchers have employed this analysis

to pinpoint and resolve different development obstacles. Both frameworks can be used to investigate potential solutions to issues, choose the best course for efforts, identify potential change points, and help modify and improve plans as they go [11]. In contrast, the method derived from these frameworks gives decision-makers a better knowledge and comprehension of the potential changes and how they can affect their company [12].

A number of earlier studies have examined Makassar's plastic waste, including "The Impact of Plastic Waste on Marine Pollution in Makassar City" [13] and "Ecological Architecture Approach in Designing a Plastic Waste Recycling Center in Makassar City" [4]. However, there is no comprehensive study that has been carried out to pinpoint internal and external causes and integrate both assessments. It is anticipated that by combining SWOT and PESTLE, the Makassar City Environmental Agency's strengths and weaknesses as well as the opportunities and threats posed by political, economic, social, technological, legal, and environmental factors will offer a deeper understanding of the difficulties in managing plastic waste. It is expected that the government, in particular the Makassar Environmental Agency, will be able to develop focused plans and policies to reduce plastic waste volume and enhance quality by having a better understanding of the internal and external factors affecting plastic waste management in Makassar.

## 2 Literature Review

### 2.1 Strategic Management Theory

The term strategy originates from the Greek word "strategos," meaning generalship or the tactics employed by a military leader to formulate plans for achieving victory in a battle. A strategy is a long-term plan devised to achieve a specific target [14]. Setiadi asserts that a strategy involves the creation and identification of business challenges, the management of internal and external issues, and the execution of solutions to achieve certain objectives [10]. According to Thomas L. Wheelen and J. David Hunger, strategic management includes the managerial decisions and actions that influence a company's long-term performance. This involves considering the internal and external environment, developing plans (either long-term strategies or tactics), implementing them, and evaluating their efficacy [14]. Sutardji lists the characteristics of strategic management as follows [15]:

- A key element of strategic management is its strategic concept.

- It develops a relationship between the organization and its surroundings and formulates strategies to adapt accordingly.

- It involves strategic choices taken by senior management and implemented within the organization.

- It measures the strengths and weaknesses of the organization's internal environment while analyzing external environmental opportunities and threats.

- Acquiring and maintaining it confers a competitive advantage.

The implementation of strategic management offers multiple advantages [16]:

- Understanding the Organization's Vision and Mission: Implementing strategic management enhances the understanding of the organization's objectives.

**Boosting Functional Efficiency:** Human resources should recognize and accomplish their objectives, leading to increased efficacy.

**Identifying and Mitigating External Threats:** By acknowledging the organization's internal and external risks, it enhances awareness of unforeseen events.

**Increasing Company Revenue:** Staff members understand how to achieve goals that would augment the company's profits.

**Expanding Market Presence:** Market reach can be enhanced through meticulous planning of promotional efforts.

**Organizational Development:** An organization can achieve continuous expansion and provide job opportunities and branch expansions throughout various fields by successfully dealing with challenges and adapting to the environment.

According to experts in the book *Strategic Management*, including Pearce and Robinson, differences occur between micro and macro forces in strategic management. They classify these forces into two categories: operational (internal) and remote (external). The economic, social, political, technological, and ecological factors defining an organization's external context. On the contrary, the internal context or operational elements—such as suppliers, consumers, consumer demographics, competitive standings, and the labor market—constitute the organization's strengths. Hill and Jones [10] state that external analysis identifies strategic opportunities and threats within the external environment and their potential impact on organizational objectives, while internal analysis assesses the organization's strengths and shortcomings.

The predominant planning tool in contemporary times is SWOT analysis, which offers a framework for strategy development. SWOT analysis comprises two components: internal and external elements. Organizations have control over their internal variables, including their strengths and weaknesses. Opportunities and threats are external factors that organizations have less or no control over [17]

Aguilar originally created PESTLE analysis as ETPS (Economic, Technological, Political, Social). The Arnold Brown Institute of Life Insurance later implemented it as STEP to evaluate strategic trends. The incorporation of external factors or screening for environmental alterations—collectively termed STEPE—was further applied to adjust this model. In the 1980s, the legal component—known as PESTLE—was subsequently included in this method. Yüksel asserts that PESTLE analysis fulfills two functions for organizations: it identifies the environment in which the organization operates and utilizes data obtained from PESTLE research to predict possible future events[18].

SWOT analysis can be integrated with several management approaches, such the Analytic Hierarchy Process (AHP), the PESTLE framework (Political, Economic, Social, Technological, Legal, and Environmental), and the Five Forces Model. Combining SWOT with additional analytical techniques may result in deeper and beneficial outcomes for businesses and organizations [19] This research will integrate SWOT with PESTLE, incorporating external aspects from Political, Economic, Social, Technological, Legal, and Environmental domains into the Opportunities and Threats components of SWOT analysis.

## 2.2 Stakeholder Theory

In 1984, Freeman did a study on stakeholders, publishing his findings in the book titled "Management Strategic: A Stakeholder." A stakeholder is defined as an individual or group that exerts influence on the achievement of an organization's objectives. This theory states that an increase in stakeholders inside an organization relates to enhanced efforts to create and maintain positive connections with authorities (sustainability report) [20]. Latupapua identifies three categories of stakeholders [21]:

1. Primary stakeholders are an individual or a group of individuals who are directly affected by a plan or project and have a direct interest in the activity. According to this definition, the citizens of Makassar City are the main stakeholders since they are immediately impacted by the environment and have an influence on the management of plastic waste.
2. Key stakeholders are an individual or a group of individuals who have legal authority related to decision-making. In this instance, two important parties involved in the management of plastic trash are the Makassar city local government and the Environmental Agency, which is a division of the Makassar city government. According to the Minister of Environment and Forestry Regulation No. P.75/MENLHK/SETJEN/KUM.1/10/2019 of 2019 concerning the Roadmap for Waste Reduction by Producers, the Local Government may create policies that forbid the use of specific products, product packaging, and/or containers. This is explained in Makassar Mayor Regulation (Perwali) No.21 of 2023 concerning the Prohibition of Plastic Bag Use.
3. Supporting stakeholders, are an individual or a group of individuals who do not have a direct interest but have significant concern, thus can become a quite influential facilitator in decision-making. In this case, the media, academics or researchers, and non-governmental organizations can all be considered supporting stakeholders since they can facilitate the management of plastic waste and make significant contributions.

Stakeholder theory may provide a solution to the issues of corporate management in the 21st century. This theory expresses concepts regarding ethical dilemmas, accountability, and sustainability within the framework of capitalist economics. This theory can offer insights into what is required for managers and students on achieving success in today's business environment. Mahon and Murray assert that a management must invest substantial resources or engage in persuading external stakeholders. They contend that integrating economic, political, and social objectives enhances the likelihood for corporate strategy success. The stakeholder approach must be directly implemented in the goal-setting process. Pearce believes that a manager must recognize the rightful needs of both internal and external stakeholders. He suggested implementing a system to identify, prioritize, and integrate this request with the objectives to be accomplished [22]. Nugroho categorizes the roles of stakeholders into five distinct classifications as follows[23]:

1. Policy creator, which refers to actors who have the role of making and determining decisions in policies/programs. Considering the government, which includes the

Environmental Agency, is in charge of formulating and advancing policies pertaining to plastic garbage, they are considered policy creators in this instance.

2. Coordinator, which refers to actors who have the role of coordinating between one stakeholder and other actors involved in the policy/program process. Coordination of Makassar's plastic waste reduction initiatives is also a responsibility of government or non-governmental organizations.
3. Facilitator, which refers to stakeholder who plays a role in providing facilities and ensuring the sufficiency of the needs of the targeted group. In this instance, the Makassar Mayor Regulation No. 93 of 2016 about the Position, Organizational Structure, Duties and Functions, and Work Procedures of the Environmental Agency lists the Makassar City Environmental Agency employees who are facilitators.
4. Implementor, which refers to stakeholder who plays a role in implementing policies/programs that include the targeted group within them. The Makassar Mayor Regulation No. 93 of 2016 about the Position, Organizational Structure, Duties and Functions, and Work Procedures of the Environmental Agency lists the employees of the Makassar City Environmental Agency who serve as implementers in this instance.
5. Accelerator, which refers to stakeholders who play a role in accelerating and contributing so that a policy/program is implemented effectively and achieved more quickly. In this regard, the academic community and the private sector act as accelerators by bringing new ideas and research to help Makassar manage its waste of plastic.

### 2.3 Plastic Waste Management

Plastic usage has grown to be a significant aspect of society's daily existence. Construction, healthcare, electronics, agriculture, the automobile industry, and food packaging are just a few of the industries that use plastics [24]. The majority of plastics, ironically, are not biodegradable and can end up in the trash for a very long time, which could endanger both the environment and public health. Plastics can cause issues that affect waste management, including increased greenhouse gas emissions in the atmosphere and other environmental harm, even after they are burned [25] In actuality, non-organic trash like plastic is problematic because it does not break down; instead, it can break down into even smaller particles, known as microplastics, which makes environmental contamination very simple [26]

Landfilling is one strategy used to deal with plastic waste. Landfilling has been a common practice throughout history, and most plastic waste is dumped there [27]. Non-biodegradable plastic waste builds up over time, requiring more spaces to handle the growing amount of debris. On the other side, hazardous leachate can be produced when plastic garbage comes into contact with groundwater or dangerous substances from other waste, which might harm the nearby soil [28].

According to Nurasyid, landfilling is regarded as one of the worst waste management practices[4]. Consequently, a number of plastic waste management techniques are put into place in response to this strategy, including the 3Rs: reduce, reuse, and recycle. Any leftover garbage that cannot be treated can then be transported to the final disposal location by reorganizing the collecting, transportation, and disposal system to minimize waste as much as feasible. Reduced garbage entering landfills, longer landfill lifespans,

and the fact that recycled waste has market value when resold are some benefits of this 3R system [29]

Makassar's garbage originates from a variety of locations, including offices, schools, shopping malls, and residential areas [26]. In order to create an ecologically friendly Makassar, the Makassar City Government and the Makassar Environmental Agency are working together to undertake a strategic program for the full reorganization of the waste management system. This program's main features are as follows [30]:

1. Tamangapa landfill management, which is the primary goal of the government's program
2. Community education and socialization regarding the value of recycling and the proper way to separate organic and inorganic waste
3. Strengthening the Waste Bank program and other waste management infrastructure. The Makassar Environmental Agency created the Waste Bank scheme, which enables individuals to trade waste—including plastic waste—for a predetermined sum of money.
4. The establishment of an electric-based waste management center is being discussed.

The Tamangapa landfill's waste management operations include sorting and separating rubbish by classifying it according to its type and quantity. Following that, the waste is gathered and moved from its original location to either a 3R waste management facility or a temporary storage area. The waste will then be carried to the last location for disposal, which in this case is the Tamangapa Antang landfill. The waste material will next undergo processing to modify its volume, composition, and properties. In order to safely return the waste to the environmental medium, it will be processed in the end [26].

### 3 Methodology

This study employs a qualitative, descriptive research methodology. Combining SWOT and PESTLE analysis to classify internal strengths and weaknesses as well as external opportunities and threats in politics, economics, social, technology, legal, and environments that impact the efficacy of plastic waste management, the study focuses on the Environmental Agency of Makassar City's program of plastic waste management. It is anticipated that comprehending the external context from this analysis would offer more profound insights into how plastic waste management policies and programs may be modified to address persistent difficulties. Both primary and secondary sources of data were employed in this investigation. Direct interviews with an Environmental Agency employee—more especially, a young specialist in the functional area of environmental impact control—were used to gather the core data for this study. In the meantime, literature reviews and books provided the secondary data.

### 4 Result and Discussion

Based on the interviews and literature review conducted by the researchers, the following SWOT and PESTLE analysis were generated:

- **Strengths**
  - a. Program Initiatives: Implementation of national programs such as the Waste Bank, 3R Campaign, Adiwiyata Program, and educational initiatives related to single-use plastic and plastic waste reduction.
  - b. Government Policy: The issuance of a circular by the Mayor of Makassar emphasizing the prohibition of plastic bags.
  - c. Achievements: The city of Makassar received the Adipura certification for the 2023-2024 period.
- **Weaknesses**
  - a. Proliferation of Plastic Producers: The large number of plastic producers and the absence of strict prohibitions or sanctions from the Makassar City Government.
  - b. Challenges in Program Implementation: Difficulties in consistently applying programs and policies both in the field and within the Environmental and Forestry Service of Makassar City.
  - c. Infrastructure Limitations: Insufficient transportation facilities to support the programs of the Environmental and Forestry Service.
  - d. Limited Human Resources: Uneven skills and knowledge among personnel in the Environmental and Forestry Service, along with a lack of staff to educate the citizens of Makassar.
  - e. Limited Data: Currently, the Environmental and Forestry Service only conducts surveys but has not undertaken research regarding the impacts of waste or data on plastic waste generated in Makassar.
- **Opportunities**
  - Political
    - a. Stakeholder Participation: Involvement from the Makassar City Government, Non-Governmental Organizations, and the private sector in plastic waste management.
  - Economic
    - a. Business Potential: Opportunities for business development from the Waste Bank program and recycling initiatives that can enhance profitability and create jobs.
  - Social
    - a. Awareness and Behavior of the Community: A majority of the population in Makassar is becoming increasingly educated about the importance of plastic waste reduction and implementing this in daily life through the use of tumblers and eco-friendly shopping bags.
  - Technological
    - a. Information Systems: The use of social media has the potential to reach a wider audience.
    - b. Project on Waste-to-Electricity Processing (PSEL): Discussions are underway to establish PSEL using environmentally friendly technology.
  - Legal

- a. Government Regulations: Support from the Makassar City Government through Regional Regulation No. 21 of 2023 regarding the prohibition of plastic bags.
  - Environment
    - a. Environment friendly technology: If the PSEL initiative is successful, it will contribute to less waste going to landfills, which will lessen pollution of the surrounding soil and water.
- **Threats**
  - Social
    - a. Population Growth: Urbanization and increasing population will lead to a rise in plastic waste volume, which will be difficult to manage without adequate systems.
    - b. Limited Environmental Awareness: Some segments of the Makassar population are less aware of plastic waste management issues, which can hinder program effectiveness.
  - Legal
    - a. Ambiguous Regulations: There are no clear regulations regarding the prohibition of plastic bags in traditional markets.
    - b. No Ban on Plastic Production: There is no ban on the production of plastic, it is still being manufactured and sold.
  - Environmental
    - a. Accumulation of Plastic Waste: The lack of effective plastic waste management in Makassar has led to increased accumulation of plastic waste in landfills.
    - b. A threat posed by microplastics: Both land and water can be contaminated by microplastics
    - c. Climate Change: Climate change can be triggered by plastic waste that is absorbed into the land and sea.

The interviews and literature reviews indicate that the Makassar City Environment Agency is promoting three major programs: waste banks, 3R recycling, and educational campaigns aimed at reducing plastic waste. These initiatives are nationwide projects undertaken by the national government, specifically the Indonesian Ministry of Environment and Forestry. The involvement of the Makassar city administration, specifically the mayor, in mitigating plastic waste usage constitutes a significant asset in plastic waste management. The policy reform, which originally restricted the use of plastic garbage, was replaced in 2023 by a complete prohibition on its use. Nonetheless, this cannot proceed effectively without precise execution. Currently, there is no policy in Makassar to prohibit or restrict plastic manufacturers. Furthermore, the utilization of plastic bags is widespread in traditional marketplaces, and the government has not enforced stringent penalties to eliminate unscrupulous company operators who persist in using plastic. The constrained human resources and infrastructure within the

environmental agency impede its capacity to educate the community. During the interview, Mrs. Fifi, a functional staff member, indicated that they continue to utilize private or public transportation to access various locations in the performance of their tasks. She acknowledged that the government has not offered specialized training for personnel in the management of plastic waste, necessitating self-directed learning. Siagian elaborate that product knowledge involves a comprehensive understanding of the product or service being offered, including its functionality, application, installation, and related aspects. [31]. If the personnel at the environmental agency lack specialized training in plastic waste management, it creates unequal product knowledge, since each individual possesses their own distinctive interpretation, hence weakening the program's effectiveness.

Plastic waste management is a significant opportunity when executed with a precise focus. From a political perspective, stakeholders, particularly critical stakeholders, have unified objectives to mitigate and diminish plastic waste. This is articulated in the Makassar Mayor Regulation (Perwali) No. 21 of 2023 regarding the prohibition of plastic bag usage. From an economic point of view, the 3R recycling initiative and Waste Bank has the capacity to enhance revenues and generate employment if executed proficiently. The operational procedure of the waste bank involves community members visiting the waste bank, situated at several locations within the sub-districts of Makassar, to deposit plastic garbage in exchange for a specified cash sum. The 3R recycling program enables the conversion of plastic trash into practical everyday things[32]. An insightful approach to plastic waste management is to convert it into handicrafts, as this enhances both its market value and aesthetic appeal. Plastic garbage can be transformed into handicrafts, including shopping bags, baskets, ornaments, wallets, and decorative lamps [33]

Mrs. Fifi asserts that the citizens of Makassar city are increasingly conscious of the necessity to diminish waste made of plastic. In the work environment sector, employees typically utilize water bottles or tumblers rather than purchasing bottled water. In schools, the Makassar city administration said that 16 schools have been honored with the Adiwiyata Mandiri and Adiwiyata National honors [34]. The Adiwiyata program, established by the Ministry of Environment and Forestry, aims to promote environmental awareness and stewardship within the community surrounding the school, promoting a green, clean, and aesthetically pleasing environment [34]. The Adiwiyata program guidebook states that one initiative to enhance service quality in school canteens is the prohibition of food sold in plastic, styrofoam, and aluminum foil packaging. Furthermore, government support in executing the regulation prohibiting plastic bag usage requires that the public provide eco-friendly shopping bags for use in supermarkets and other shopping centers[35].

The Makassar City Environmental Agency uses social media platforms Instagram and Facebook to share information related to environmental awareness education and other activities associated with the Environmental Agency's program. A noticeable post on Instagram @dinaslingkunganhidup\_makassar refers to the educational initiative on the Waste Bank program. The city government collaborates with China and several corporate sectors to execute the waste to Electricity (PSEL) project, with China investing 200 million USD to tackle waste and greenhouse gas emissions. The waste to Electricity process involves burning waste to ultimately produce electrical energy. The waste incineration facility possesses a daily capacity of 1,300 tons, featuring two

incinerator lines and a single steam generation unit[36].The Makassar City Environmental Agency has done an analysis of the environmental impact associated with the PSEL project and asserts that this project would not cause environmental pollution. [36] This offers a great possibility for the future, since it is anticipated that this initiative will diminish waste production, particularly plastic waste, while avoiding environmental pollution in nearby areas of Makassar.

Besides opportunities in plastic waste management, multiple threats require the attention of various stakeholders. Population expansion is identified as a danger to plastic waste management in Makassar. In 2022, the population of Makassar City was 1,444.88, rising to 1,454.96 in 2023, and reaching 1,464.64 by July 2024. The statistics indicate that the population of Makassar City has grown by roughly 0.6% yearly [2] The population growth will result in increased human activities, leading to an increased volume of waste in the future[37]. In addition, certain community members are not properly informed on the reduction of plastic waste. In an interview with a functional manager, Mrs. Fifi indicated that most merchants in traditional markets persist to utilize plastic bags for shopping, despite the government's prohibition on their use. This results from the lack of specific pressure to forbid sellers in traditional markets from using plastic bags. In accordance with circular letter No. 660/361/Circular Letter/DLH/XI/23, which reaffirms the prohibition on plastic usage as issued by the Mayor of Makassar. Additionally, plastics producers are not banned from limiting their production, which might hinder the effectiveness of the programs developed by the Environmental Agency regarding plastic waste management and reduction.

The threat to the environment is that the accumulation of plastic waste could increase if the federal programs are not executed properly. The accumulation of plastic waste will gradually degrade into smaller fragments until they become unnoticeable and transform into microplastics. Micro plastics can be swallowed, integrated, and potentially accumulate within the body or other organisms. These micro plastics have been proven to harm the sustainability of soil ecosystems. Plastic waste, such water bottles, fishing nets, plastic bags, tea bags, and other plastic containers, is recognized for lingering in higher ecosystems, especially aquatic and marine ecosystems, where it contributes to environmental contamination[38] The most dire threat is climate change. The official website of the Indonesian Ministry of Environment and Forestry states that plastic waste in the ocean may affect the biological carbon balance. If the issue of degraded plastic waste transitioning into microplastics remains unsolved, the ocean's role as a natural carbon sink may be endangered. [39]

## 5 Conclusions

This research was conducted by combining SWOT and PESTLE analysis to identify the strengths and weaknesses from the internal side of the Makassar City Environmental Agency and what opportunities and threats can be obtained in the fields of politics, economy, social, technology, law, and environment. By understanding the strengths and weaknesses, as well as leveraging opportunities and addressing existing threats, it is hoped that plastic waste management can be effectively implemented in the future. In addition to the researchers' time constraints, this study includes a number of flaws. Initially, this study only included a literature review and one informant from the

Makassar City Environmental Agency, which may have influenced the results and prevented them from accurately reflecting the opinions of the employees. To capture different viewpoints on plastic waste management, it is planned that future research will involve more informants from a variety of stakeholders, including the Makassar community, the mayor's office, and the Makassar city sanitation department. Second, it is anticipated that future studies will be able to use the SWOT matrix to perform a more thorough study in order to identify and develop focused solutions for Makassar city's plastic waste management.

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