



The driver, pressure, state, impact, response (DPSIR) approach in analyzing the case of waste emergencies in Bandung City

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ABSTRACT

Background: As the center of development and education in West Java, Bandung has faced a waste problem that continues to increase along with population growth. Indeed, there were two tragedies. In 2005, the Leuwigajah landfill exploded, and in 2023, the Sarimukti landfill was burned. These tragedies became the climax of the Waste Emergency in the city of Bandung. **Methods:** Using the driver, pressure, state, impact, response (DPSIR) framework and the literature research, this study aimed to better understand the urban waste problem faced by each region, especially the city of Bandung. **Findings:** It was found that the government's Response only addresses pressure and state, while driving force and impact still need to be addressed. **Conclusion:** From these results, it is recommended that awareness be raised among residents of Bandung through real appeals and persuasions and that manufacturers be required to be responsible for distributing their products. **Novelty/Originality of this article:** The application of the DPSIR framework to analyze and address waste management emergencies in Bandung, Indonesia. While this method has been applied in various contexts, it has yet to be specifically tailored to the unique challenges of this region. This approach underscores the importance of addressing both immediate waste management issues and underlying consumer behaviors. It provides a comprehensive strategy that involves the engagement of the government, private sector, and community.

KEYWORDS: DPSIR; policy; waste.

1. Introduction

With a fast-growing population, Indonesia is facing significant challenges in waste management. During the last ten years, the population has impacted the rise of waste production. The present study reviews how the increase in the population in Indonesia within the last ten years has contributed to the rise of waste production and its environmental impacts. According to the most recent data from the Central Statistical Agency (BPS), there has been an upward trend in the population over the last decade. Population growth remains high although some efforts have been made to control population growth, such as birth control. This has become a demographic challenge for Indonesia. The Population Census (SP2020) in September 2020 recorded 270.20 million

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people during the last decade. The total population of Indonesia from the 2020 Population Census increased by 32.56 million people compared to the results of the 2010 Population Census. Furthermore, according to the BPS, the total population in 2023 is projected to increase by 1.1%, reaching 278.8 million people. Such a vast number has had significant consequences in various sectors, including waste management.

Rapid population growth has significant direct consequences on consumption and production. The population increase implies an increased need for goods and services, increasing waste production (Surakusumah, 2023). Rapid urbanization also contributes to the increase in waste production, especially in large cities that experience rapid economic growth and mass urbanization. In addition, changes in people's lifestyles and consumption patterns become important factors. Increasingly, urban and modern societies tend to produce more plastic waste and boost the use of single-use consumer goods (Septiani, 2018), which are difficult to decompose and contribute to the accumulation of garbage.

The increasing amount of waste has severe environmental impacts. Uncontrolled waste disposal can pollute water and soil, destroy natural ecosystems, and harm flora and fauna. Plastic waste, which tends to dominate the composition of waste, has particularly threatened environmental sustainability and human health. Furthermore, the increase in the amount of waste also contributes to the issues of final disposal. Limited waste disposal sites have led to excessive land use and brought the risk of environmental pollution. Therefore, effective and sustainable waste management is necessary to maintain ecological balance (Vardopoulos et al., 2021).

The Indonesian government has taken various steps to address the problem of increasing waste production. Some initiatives include recycling programs, anti-plastic waste campaigns, and developing community-based waste management systems. However, despite these efforts, waste management challenges still need to be solved, and further attention is required. It is important to increase public awareness about the importance of wise waste management. Public education campaigns can help change consumer behavior and encourage the use of eco-friendly products. In addition, support from the private sector and active participation of the community in waste management programs can be critical steps in reaching this objective.

To overcome this challenge, there needs to be a holistic approach involving government, the private sector, and the community (Ramdani et al., 2022). First, the urgent step is strengthening waste management infrastructure, including recycling facilities and effective waste management systems. Second, there is a need to expand environmental education and public awareness programs to help change consumption patterns and user behavior. According to the National Waste Management Information System managed by the Ministry of the Environment and Forestry of the Republic of Indonesia on sipsn.menlhk.go.id, waste generation in Indonesia has reached an alarming figure. The total national waste generation reached 36,839.84 tons per day, and data on waste generation in 2023 reached 13,443,255.64 tons. Plastic waste shares a significant percentage of this number, creating particular problems in waste management.

Rapid population growth, urbanization, and changes in consumption are among the factors that contribute to waste management challenges at the national level. Poor waste management infrastructure and a lack of public awareness about the importance of wise waste management have complicated the efforts to address this problem. Furthermore, West Java, Indonesia's most populous province, faces challenges in waste management. According to the National Waste Management Information System (SIPSN), waste generation in this province reached 621,370.39 tons in 2023, where the majority of the waste generation comes both from urban and rural settlements (Data on the Amount of Municipal Waste Piled by Regency/City in West Java, 2024). Factors such as rapid population growth in urban areas and industrial factories can increase waste in West Java. These factors provide additional burdens on the existing waste management systems. The efforts to reduce single-use plastics and increase community participation in recycling programs are key to overcoming this challenge.

Data on waste generation in the city of Bandung, a center of economic growth and education in West Java, has unique characteristics in terms of waste generation. Serious problems related to waste arise in the city of Bandung, where waste production increases from time to time. In 2022, data from the BPS of Bandung showed that daily waste production reached 1,594.18 tons. The most significant contributor to this waste category is food waste. The daily food waste production in Bandung reaches 709.73 tons, or 44.52% of the total daily waste production in Bandung City. The second largest contributor next to food waste is plastic waste, which reached 266.23 tons per day or 16.7%. Next, paper waste sits in third place, with 209.16 tons per day or 13.98% of the total daily waste production in Bandung. The amount of waste production in Bandung City in 2022 increased compared to the previous year, according to data released by West Java Open Data on 18 July 2023 (Data on waste accumulation per capita by district/city in West Java, 2024).

The City Government of Bandung has implemented some initiatives and waste management strategies to address the issues of waste generation, such as recycling programs, anti-plastic waste campaigns, and encouraging active involvement from the community. However, further efforts are needed to achieve significant changes. The challenge of waste generation at the national level, West Java, and the city of Bandung requires a holistic approach that brings together the government, the private sector, and the community. Improvement in waste management infrastructure, better environmental education, and incentives for recycling practices can be a collective solution to create a cleaner and more sustainable future. Data on waste generation at the national, provincial, and regional levels provides a better understanding of the problems encountered by each region. By understanding the data, it is expected that more effective and targeted solutions will emerge to manage waste generation, reduce environmental impacts, and create a more environmentally aware society.

In mid-2023, Bandung experienced the climax of the waste emergency with the burning of the Sarimukti landfill. This is not the first case. In 2005, Bandung experienced the explosion of the Leuwigajah landfill. This research aims to describe the waste emergency case in Bandung so this crisis does not happen again a third time in the future and to provide recommendations to related parties.

Driver, pressure, state, impact, response (DPSIR) brings a simple understanding of the cause between environmental and human systems and its impacts. DPSIR can be used on various systems ranging from simple to complex systems. Systems that have used DPSIR are water management, urban ecological vulnerability, rural sustainable development efficiency, and microplastic pollution (Brunhara et al., 2023). The use of DPSIR to analyze waste management has been carried out by Shadiya & Shareef (2020) in the Maldives, Zovko et al. (2021) in Adriatic Croatia, Misganaw & Teffera (2021) in Bahir Dar City, Ethiopia, Nyika & Onyari (2021) in Southern Africa. Moreover, the occurrence of a Waste Emergency in Bandung City for the second time shows that the DPSIR created in the Environmental Management Performance Information Document (DIKPLHD) Bandung is incomplete and clear enough (Regional Environmental Management Performance Information Document, 2018). The 2018 DIKPLHD Preparation Guidelines do not ask for the DPSIR model to be closed, so it is unclear which elements, driving force, pressure, state, or impact, have been responded to. These two things are the background for DPSIR, which is still being used in this research.

2. Methods

This method will be used to analyze waste emergencies in Bandung City in 2023. This study used a literature review method from secondary data, which was then analyzed using the DPSIR framework. The primary data sources involved information from the Regional Technical Implementation Unit/Unit Pelaksana Teknis Dinas (UPTD), provincial/city government decrees, mass media news, and statistical data provided by the

BPS. Any data obtained through these sources was then verified and analyzed based on the DPSIR framework to ensure the accuracy and precision of research results.

3. Results and Discussion

3.1 History of the city of Bandung

The history of Bandung began in the 18th century when Sundanese people inhabited this area. In 1488, Prince Citarum from the Pajajaran Kingdom mandated the construction of a small town in the area that today becomes the center of Bandung City. In 1810, the Dutch colonial government established a government in Bandung and began the construction of city infrastructure such as roads, government buildings, and train stations. Bandung subsequently became the center of trade and education in West Java.

When Japan occupied Indonesia during World War II, the city of Bandung experienced a series of significant social and political transformations. After Indonesia gained independence, Bandung emerged as one of the main focuses of the struggle for independence, rapidly growing and becoming one of the industrial and educational epicenters. Currently, Bandung is recognized as a sophisticated metropolitan city with various creative industries, technology, and diverse education sectors. Apart from that, Bandung has also received recognition for its amazing natural attractions and cultural and culinary diversities. While discussing the islands, special attention is given to the analysis of the social impacts arising from the development of the tourism sector to support the development of the area. Despite rapid growth in many sectors, Bandung is currently experiencing serious problems related to environmental management, especially waste management. The city of Bandung, known to the general public to have many positive images, must also admit that it still has long-standing negative images regarding waste. Institutionally, waste management in the city of Bandung has quite a long history. It started in the 1960s under the leadership of Mayor R. Priatna Kusumah, who at that time proposed the program, namely Bandung Resik.

In 1985, during Ateng Wahyudi's leadership, the Bandung City Regional Cleaning Company was established. The establishment of the Regional Cleaning Company was expected to provide more professional waste handling and follow developments in waste management technology. However, in 2021, the Bandung City Regional Cleaning Company (PD) was officially liquidated by the Bandung City Government, so all services regarding waste management were transferred to the Department of Environment and Hygiene (DLHK) of Bandung City. The liquidation process was marked by signing the record transfer minutes at the Bandung City Hall on Thursday, 14 October 2021. The Bandung City Government stated that at that time, the city of Bandung was the last city to have regional-owned enterprises in waste management. Meanwhile, other district cities in Indonesia have already liquidated Regional Companies. Hygiene and other services were transferred to the relevant department. The performance of the Regional Company does not cause this liquidation, but this is simply to comply with regulations.

3.2 Waste emergency status in Bandung City

As explained in the previous chapter, population growth will go hand in hand with challenges in managing environmental impacts, especially regarding waste management. Since 2005, the city of Bandung has experienced a waste-related emergency. The first waste emergency in Bandung was in 2005 when an explosion occurred at the Leuwigajah landfill, which caused fatalities.

The national news media, *Tempo*, even said that the worst landfill incident in Indonesia was the Leuwigajah landfill. This incident was seen as a deadly tragedy due to mismanagement of the landfill. This final waste disposal site in Cimahi, West Java, exploded and collapsed on 21 February 2005. The trash slide hit two villages in Cimahi, namely Cilimus and Pojok, and killed 157 people. Quoted from *Tempo*, the incident 18 years ago

occurred at 02.00 Western Indonesian time. At that time, the Leuwigajah landfills, which used an open dumping system, were hit by heavy rain. As a result, the concentration of methane gas in the pile of rubbish increased so that the mountain of trash 200 meters in length and 60 meters in height at the Leuwigajah landfill collapsed and was followed by a huge roar. It can even be heard up to 10 kilometers. Thousands of tons of rubbish fell freely and hit two residential areas located under the Leuwigajah landfills. Hundreds of residents of Cilimus Village and Pojok Village did not have time to save themselves and were buried with thousands of tons of rubbish. Itoc Tochija, in his book *Tragedi Leuwigajah*, said that during the 15-day evacuation period, only the bodies of 157 residents were found, and hundreds of others were missing. The Leuwigajah landfill incident became the second worst incident in the world after a similar incident at the Payatas Landfill, Quezon City, Philippines, on 10 July 2000, which killed more than 200 people.

A year later, the Leuwigajah landfill was closed and did not operate as a rubbish dump. This termination aims to heal trauma among residents who survived. However, shortly after the incident, the Bandung area began to be overwhelmed with waste. This is because waste can no longer be thrown into the Leuwigajah landfill. As a result, trash is strewn all over the streets and settlements until Bandung is nicknamed the Sea of Garbage.

The Leuwigajah landfill tragedy was the forerunner to the birth of National Waste Awareness Day (HPSN). 21 February was chosen based on ideas and pressure from several parties to commemorate the events at the Leuwigajah landfill, Cimahi, West Java, on 21 February 2005. One year after the Leuwigajah landfill exploded, the government officially closed the Leuwigajah landfill and, through the Forestry Department, issued permission for the use of the Sarimukti Compost Processing Site as a temporary landfill to accommodate waste from the area of the city of Bandung. Sarimukti temporary landfill, which initially only served as a temporary waste storage area, has continued through lobbying for agreement renewal between parties until 2023; it is still being used as a landfill facility using the Controlled Landfill method.

However, in August 2023, the Sarimukti temporary landfill suffered from a huge fire. According to information, the fire was caused by a suspicious person who threw cigarette butts carelessly, while the weather was in a long dry season at the moment. As a result of the burning of the Sarimukti landfill, the West Java Provincial Government finally declared Bandung a Waste Emergency status. The emergency status in the city of Bandung was determined following the fire that burned the Sarimukti landfill on 19 August 2023. The Province of West Java determined the first emergency status through the West Java Governor's Decree No. 658/Kep.579-DLH/2023, 2023, which was completed on 25 October, followed by the second emergency status through Bandung Mayor Decree Number 658.1/Kep.2529-DLH/2023 dated 27 October to 26 December 2023.

This waste emergency status occurred due to the accumulation of unmanaged waste in the city of Bandung after the fire at the Sarimukti landfill, which had implications for limiting the waste quota given by the management of the Sarimukti landfill (West Java Province) to the city of Bandung. From the original 1.200 tons/day, it was limited to 600 tons/day. Meanwhile, Bandung City's daily waste generation has not decreased significantly.

The decree of the Mayor of Bandung for the period 27 October to 26 December 2023 stipulates the mandate for the formation of a Waste Management Task Force in Bandung City Waste Emergency Situations consisting of a combination of multi-stakeholders, such as academics, professionals, related regional offices, military, NGOs, religious institutions, and involvement all regional apparatus up to the neighborhood/ward level.

3.3 DPSIR framework

A paper written by Kristensen (2004) from the National Environmental Research Institute, Denmark, explains the use of a framework that distinguishes driving forces, pressures, conditions, impacts, and responses. This became known as the DPSIR framework and has since been widely adopted by various parties. This framework is seen

as a structure that can provide the indicators needed to give feedback to policymakers regarding the quality of the environment and the impacts resulting from political decisions that have been made or to be made in the future.

According to the DPSIR framework, there is a causal chain relationship that starts from 'driving forces' (economic sectors, human activities) passing through 'pressures' (emissions, waste) to 'state' (physical, chemical, and biological) and 'impact' on ecosystems, health and human functioning, and ultimately leading to political 'responses' (priorities, target setting, indicators) (Hřebíček et al., 2016; Gari et al., 2015). Describing the causal chain from driving forces to impacts and responses is a complex task and should be divided into several subtasks. An illustration of the DPSIR framework for the waste emergency status of the city of Bandung is presented (Figure 1).

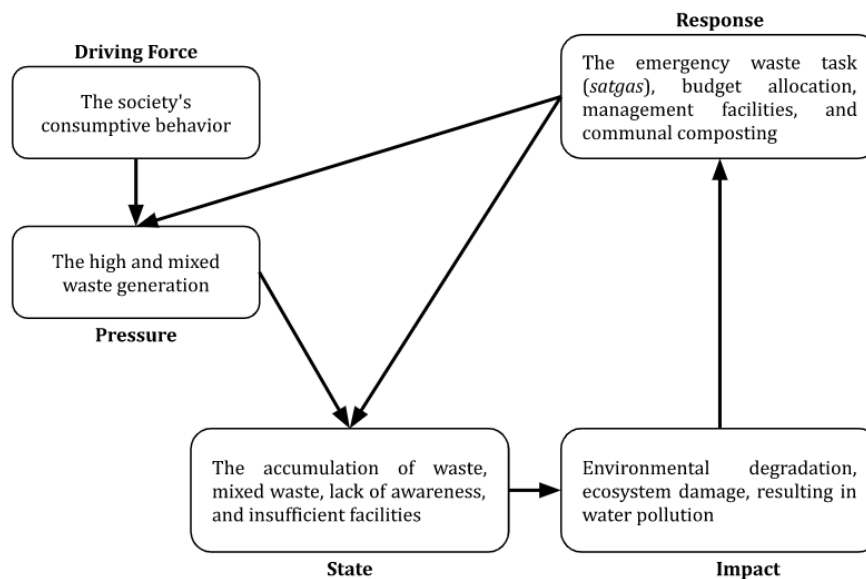


Fig. 1. DPSIR model of waste emergency in Bandung

Human activity (driving force) produces waste which is filling the Sarimukti landfill everyday. An everyday waste (pressure) puts pressure on the Sarimukti landfill and makes the Sarimukti landfill over-capacity (state). In conditions of over-capacity, an open dumping system used, and mixed waste, the Sarimukti landfill caught fire. Then the non-operation of the Sarimukti landfill causes waste generation in the city (state), causing environmental and aesthetic pollution (impact). The responses were establishing a task force, providing budget support, and establishing a communal compost (responses).

3.4.1 Driving force

Kristensen's paper (2004) states that the driving force is a need that underlies the emergence of the issues. In the context of the Bandung Waste Emergency, the most vital factor in the context of the driving force is the citizen consumer behavior, which is increasing daily. This can be seen from the amount of waste produced per capita, which increased by 0.01 kilograms from 0.65 kilograms per person per day in 2020 to 0.66 kilograms per person per day in 2021 (West Java Province Housing and Settlement Service in Open Data Jabar, 2022).

Indeed, the packaging of the product has become smaller, more used, and more complex types of materials. With the target market being the wider community, it makes sense that the higher the population, the higher the waste generation will be. According to data released by BPS in 2023, the population of Bandung reached 2,469,589 people. This number includes 1,226,915 females and 1,242,674 males. Thus, the difference in the number of males and females is 15,769 people, with the males outnumbering the females.

This number does not include residents around Bandung who work or study in Bandung, approximately eleven percent of the Bandung population (BPS, 2017), and non-permanent residents who came to Bandung, amounting to 68,823 people in 2022 (Somantri, 2023).

Tourists tend to produce more waste. A United Nations Environment Programme (UNEP) study found that tourists waste six times more on holiday (WWF-Indonesia, 2015). In 2023, 7.7 million tourists were visiting Bandung. This number increased by 17% compared to 2022 when it reached 6.6 million people (the Office of Culture and Tourism of Bandung City in Alhamidi, 2024). Moreover, Bandung has a lot of culinary tourism. From 2019 to 2022, there was an increase in the number of eateries/restaurants by 54.17%, from only 899 to 1,386 eateries/restaurants (BPS of Bandung, 2023). These eateries/restaurants and cafes will try to attract tourists and the people of Bandung to consume more.

In his book *Consumerism in World History, The Global Transformation of Desire*, Stearns (2001) suggested that we live in a world filled with consumerism, but rarely step back to examine what it means. Consumerism reflects a society in which many people set their life goals in some parts by acquiring unnecessary goods for subsistence or traditional display. They become entangled in the process of acquisition—shopping—and take part of their identity from the procession of new items they buy and show off. In this society, many parties have contributed to and served consumerism, from eager store owners who try to convince customers to buy more than they need to product designers hired to put a new spin on the existing models to advertisers seeking to promote new needs. The power of consumerism of the 2.4 million inhabitants of the city of Bandung is the driving force in the DPSIR framework for the Bandung Waste Emergency phenomenon in 2023.

3.4.2 Pressure

The term *driving force* entails human behavior, such as transportation or food production, that meets specific needs. This behavior provides 'pressure' on the environment due to the production or consumption process, which can be categorized into three primary forms: (1) overexploitation of environmental resources, (2) alterations in land utilization, as well as (3) emissions (chemicals, waste, radiation, noise) into the air, water, and land.

The wasteful nature of the driving force prevalent in the 2.4 million inhabitants of Bandung City leads to high levels of urban waste generation. In the records of the office of the Sarimukti landfill as the management under the West Java Provincial Government, the waste generated in Bandung City before the Bandung Emergency Waste incident was 1,100—1,300 tons/day. This is relatively high when compared to the waste generation of 3 other regions that also dispose of their waste at the Sarimukti landfill, namely the city of Cimahi, the regency of Bandung, and the regency of West Bandung, which produced waste generation of less than 250 tons/day.

The high waste generation from Bandung has made the space utilization at the Sarimukti landfill increasingly full/over-capacity. Even a local foundation (Non Government Organization/NGO) in Bandung issued a press release warning that Bandung would face a waste emergency situation long before the Sarimukti landfill fire occurred (Table 1).

Table 1. Bandung City daily waste generation 5 years before waste emergency in 2023

Year	2018	2019	2020	2021	2022
Weight (tons)	1,306	1,358	1,357	1,297	1,289

(Data on the amount of waste entering the Sarimukti Landfill in the Greater Bandung Area based on monthly periods in West Java, 2024)

The daily unsorted waste generation in Bandung reaches 1,300 tons/day and is a real pressure. If it is not managed well in the upstream and downstream, it will always fill up the landfill space no matter how large the landfill area can be provided. The landfill area will never be enough to accommodate the waste from the city of Bandung without good

waste management. The principle of collecting, transporting, and disposing of trash to the landfill without a good management concept will only accumulate problems in the future.

3.4.3 State

In the DPSIR framework analysis, the impact of pressure (pressure), has implications for the 'state' of the affected environment (states); that is, the quality of the various environmental compartments (air, water, soil, etc.) in relation to the functions performed by those compartments. Thus, 'environmental conditions' are a combination of physical, chemical, and biological conditions (Faseyi et al., 2023).

In the Bandung Waste Emergency context, States are reflected in several conditions. First, the waste has piled up in the Sarimukti landfill, and there is no space for more dumps, which has implications. Second, the waste from various garbage dumps in the city of Bandung cannot be transported to the Sarimukti landfill, resulting in waste generation, which has caused complaints from citizens and created environmental and visual pollution (the city's aesthetics are disturbed). Third, unsorted garbage piling up can cause rot, resulting in methane gas, triggering new fires, creating leachate pollution, and producing a pungent and unpleasant odor. Fourth, residents who are unaware continue to produce rubbish without realizing it because they still hand over their garbage to the rubbish men. Fifth, there is a lack of upstream waste management facilities and infrastructure within the city of Bandung that can intervene/reduce the amount of waste generated and sent to the Sarimukti landfill. This finding is the same as Le Thi Dao's (2023) result in Binh Hoa, Thuan An, Binh Duong Province.

3.4.4 Impact

Changes in the physical, chemical, or biological conditions of the environment determine the quality of the ecosystem and human welfare. In other words, changes in conditions (states) that occur in an area are likely to have an environmental or economic 'impact' on an ecosystem's function, as well as disrupt the ecosystem's ability to sustain life, and ultimately have implications for human health and the economic performance and social activities of the people.

In the Waste Emergency condition in Bandung, the impact is reflected in several conditions as follows. First, the accumulation of the Sarimukti landfill in an unsorted waste condition can create environmental pollution from leachate, which can flow and seep into the ground, polluting groundwater channels. The impact of leachate water pollution will be quite significant considering that the position of the Sarimukti landfill is in an elevated area below which there are water users in several villages, such as Sarimukti Village and Citatah Village. Second, due to the fire and the overcapacity of the Sarimukti landfill, the waste disposal will be limited where the quota for the city of Bandung decreased to 50% of the total quota allowed by the West Java Provincial Government as the management of the office of Sarimukti landfill. This limitation implies the need for a robust upstream waste management concept. Bandung's city government should think about managing the remaining 50% of its waste generation.

Waste not transported to the final disposal site due to the Sarimukti Landfill fire caused a buildup of garbage at the temporary disposal site (*Tempat Pembuangan Sampah/TPS*) that worsened the TPS's negative impact. Around Bandung City TPS, high organic and COD levels were found to exceed the specified quality standards, which is the impact of leachate on water pollution (Rahmawati, 2015). The waste in the open dumping landfill system is of various kinds and, in mixed conditions, produces leachate, a pollutant containing high levels of organic and non-organic compounds. Non-organic compounds in the form of heavy metals are often found in leachate (Langmore, 1998). Thus, groundwater contaminated with leachate will have increased its metal concentrations (Basberg et al., 1998). With local water company/*Perusahaan Daerah Air Minum* (PDAM) service coverage only reaching 66.60% in 2018 (BPPSPAM, 2019), 33.40% of Bandung City residents are at

risk of consuming water that has been contaminated with leachate produced by the garbage that has piled up in Bandung City.

3.4.5 Response

The ‘response’ provided by the public or policymakers results from unintended impacts and can influence any part of the chain between driving forces and impacts. An example of a response related to drivers is a policy of changing modes of transportation, for example, from private vehicles (cars) to public transportation (trains), while an example of a response related to pressure is regulations regarding permitted SO₂ levels in exhaust gas. In the Bandung Waste Emergency condition, the response made by the government was reflected in the establishment of the Waste Emergency Task Force, which, based on the decree of the establishment, involved various elements, including the regional government and non-governmental organizations such as community leaders who became members of the Task Force. However, the effectiveness of the Task Force is currently being questioned by various community organizations because the measures that the Task Force has taken are not yet effective for managing and handling waste generation in the city of Bandung.

Besides establishing the Task Force, the City Government of Bandung is also preparing Emergency Waste Budget Support. The one is preparing a budget for the composting program in residents’ homes. Lately, the Bandung City Government began distributing supporting infrastructure related to organic waste sorting through its newest innovation called composting bucket bags (Kang Empos). A total of 20% of the population in each sub-district will receive this composting bucket. If the program runs, it can reduce organic waste by 200 tons/day.

The city government of Bandung has also promoted the use of green open spaces or city parks as communal compost facilities. A large hole for accumulating compost or organic waste that residents have sorted has been prepared, and garbage officers are deployed to sort residents’ waste before transporting it to garbage trucks heading to the Sarimukti landfill. In terms of response, it seems that quite a lot of programs have been carried out to respond to the waste emergency conditions in the city of Bandung. However, has the response been right on target and provided a solution for handling waste in the city of Bandung? Thus, there can be synchronization between limiting waste generation upstream and targeted control downstream (Figure 2).

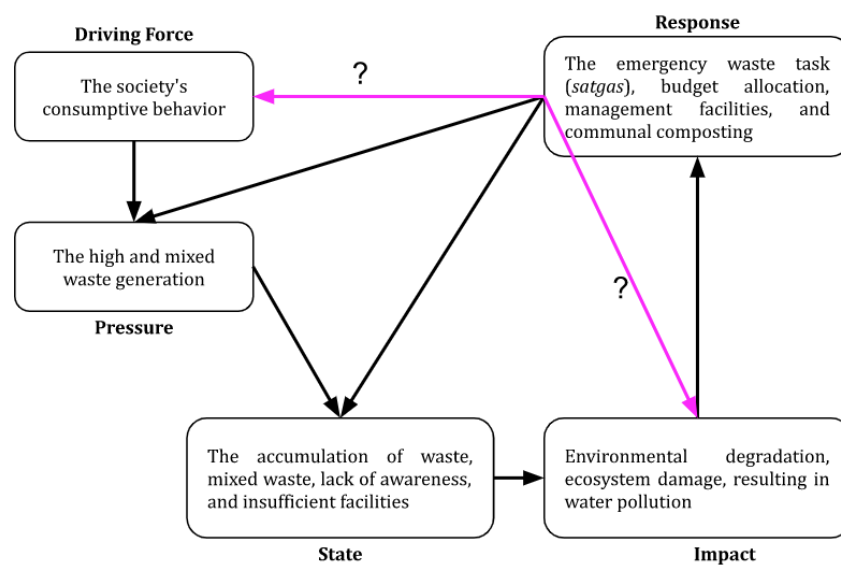


Fig. 2. Analysis of DPSIR model

In the DPSIR framework in Figure 1, the responses given by policymakers in the city of New Bandung target two aspects, namely pressure, and state (gray color arrows), but the

responses given cannot yet touch the driving force and impact as depicted in the framework image below (magenta arrow) (Figure 2). A response that reaches the driving force is important to resolve the root of the problem, which will have a chain effect on other aspects. Thus, the solution can significantly reduce the burden of snowballing problems that will persist over time.

Guerrero et al. (2013) found that stakeholders involved and having an interest in waste management are a large number. In the Bandung waste emergency, there were no stakeholders outside the government's response to the waste emergency. Waste management is seen as the responsibility of the local government only. To respond by preventing and mitigating the impact of waste, Prata (2024) suggests that the product entering the market should have a more sustainable design. Muresan et al. (2022) found that females and older people are more concerned about eco-friendly products so the program to empower them to be active in waste management.

4. Conclusions

This paper wants to describe the waste emergency case in Bandung using the DPSIR framework. From the analysis carried out, the problems of the city of Bandung are driven by people's consumptive behavior (driving force), which results in high and mixed waste generation (pressure). The increasing generation of waste led to the tragedy of the explosion of the Leuwigajah Landfill and the fire at the Sarimukti Landfill, which then caused rubbish to pile up at the landfill and in the city of Bandung (state). As a result, the environment and ecosystem around the landfill and in the city of Bandung were damaged, and the water was polluted (impact). The government responded by forming a task force, providing a budget for infrastructure for sorting organic waste, and encouraging the formation of communal compost (response). The Bandung City Government has responded to pressure and state, but not to driving force and impact.

Several recommendations can be provided for resolving the driving force aspect as follows. First, the entire community (Bandung city residents, without exception) should be aware that they are also responsible for waste generation in Bandung. Through appeals and persuasions, city residents should be actively involved in reducing city waste generation. Second, producers must also be responsible for production distribution throughout the sales area. Thus, it is not enough for the manufacturers to launch a CSR program at the central government level because the massive distribution of products, which creates waste, also spreads to the corners of the country. Therefore, the manufacturers need to participate in solving the problem of the generation of packaging waste in the regions.

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Author Contribution

S.R., J.R., and L.I.T. conceived and designed the study, performed the experiments, analyzed and interpreted the data, contributed reagents/materials/analysis tools, wrote the paper, prepared figures and/or tables, reviewed drafts of the paper and approved the final draft.

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Ethical Review Board Statement

Not applicable.

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