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EFFECTIVENESS OF PLASTIC WASTE MANAGEMENT PROGRAM INTO FUEL OIL IN TANJUNGPINANG CITY (CASE STUDY OF UPTD TPA GANET)

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Abstract

The plastic waste problem in Tanjungpinang City has increased along with the growth of community activities and the limitations of the existing waste management system. The local government, through the UPTD TPA Ganet, has implemented a program to convert plastic waste into fuel oil using pyrolysis technology as an effort to reduce waste volume. This study aims to analyze the effectiveness of the plastic waste into fuel oil management program in Tanjungpinang City. The research method used is a qualitative approach with a descriptive research type. Data collection was carried out through observation, interviews, and documentation with informants consisting of the Head of UPTD TPA Ganet, waste management officers, and the community. The analysis of program effectiveness refers to Subagyo's theory (2001) which includes program objectives, target accuracy, socialization, and program monitoring. The results of the study indicate that the program is ineffective. The objectives and target accuracy have been implemented well, but the program socialization has not been optimal due to limitations in legality and compliance with test result standards, as well as internal monitoring.

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INTRODUCTION

Indonesia ranks fourth as the most populous country in the world after India, China, and the United States. According to data from the Central Statistics Agency (BPS), Indonesia's population will increase from 278.6 million in 2023 to 281.6 million by mid-2024 (Saputri, 2024). This population growth has serious consequences for the increasing volume and diversity of waste produced. A World Bank report projects that the amount of global solid waste will increase drastically from 1.3 billion tons to 2.2

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billion tons per year by 2025, creating major challenges in environmental management and global waste management systems (Rahmawati & Yuni Wijayanti, 2024). The increasing volume of waste not only creates environmental problems but also impacts public health and the sustainability of natural resources, primarily due to the still low public awareness of the importance of good waste management and the limited infrastructure and efficient processing technology.

The waste management challenges in Tanjungpinang City reflect the challenges faced by many cities in Indonesia. The population is projected to increase from 234,840 in 2023 to 236,110 in 2024 (Irfan Fadhlurrahman, 2024), and waste production is also expected to increase. Based on the latest data, as shown in Table 1 below, the weight of waste transported to the Tanjungpinang City Landfill (TPA) Technical Implementation Unit (UPTD) increased from 31,569.48 tons in 2023 to 32,101.56 tons in 2024, while the volume of final waste processing increased from 126,277.92 m^3 to 128,406.25 m^3, representing a 1.72% increase. In the period from January to June 2025, there was a significant decrease with the weight of transported waste amounting to 18,006.80 tons and the volume of landfill amounting to 72,027.20 m^3, indicating an improvement in the waste management system through reduction and processing efforts.

Table 1. Waste data for Tanjungpinang City 2023-2025

Data description	2023	2024	2025
Weight of waste transported to the Tanjungpinang City TPA UPTD (tons)	31,569.48	32,101.56	18,006,80
Volume of waste generated that is finally processed at TPA/TPST/SPA (m^3)	126,277.92	128,406.25	72,027.20

Source: Opendata.tanjungpinangkota, (2025).

The Head of the Tanjungpinang City Environmental Agency revealed that the realization of waste volume levies collected to date is still far from the target. The total target of IDR 4 billion was planned to support the operational management of city cleanliness, but only around IDR 1.6 billion was successfully collected (Apriyani, 2025). This gap is a serious challenge for the Tanjungpinang City Government in realizing a clean, healthy, and well-organized city environment. The existing management system has not been fully able to keep up with the rate of increase in waste due to the low active participation of the community in the process of reducing, sorting, and processing waste from its source. Law of the Republic of Indonesia Number 18 of 2008 concerning Waste Management mandates that waste management must be carried out responsibly, sustainably, and equitably by emphasizing the importance of awareness, togetherness, and public participation.

Ideal waste management encompasses a series of structured processes, from waste reduction at source, sorting by type and nature, collection from the source to a temporary storage site, transportation to a final processing site, and processing the residue for safe return to the environment. However, in practice, this process has not been optimal in Tanjungpinang due to a lack of synergy between government policies and community behavior. The Tanjungpinang City Government has issued Mayoral Regulation No. 14 of 2022 concerning the reduction and use of plastic bags, but the successful implementation of this regulation depends heavily on the active involvement of all parties. Synergy between the government, the community, and the business world

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is essential to creating an integrated and sustainable waste management system, as a strategy focused solely on regulations and infrastructure will be insufficient without increased awareness and the active involvement of all elements of society.

One innovative and sustainable effort to address the problem of difficult-to-decompose plastic waste is through the use of pyrolysis technology. The Tanjungpinang City Environmental Agency has launched a program to convert plastic waste into fuel oil, aiming to reduce the volume of waste in landfills while providing added economic value to the community. Through the use of specific processing technologies, plastic waste can be converted into high-value products, namely alternative fuels such as gasoline, diesel, and kerosene. Pyrolysis technology processes plastic waste through an oxygen-free heating process to produce synthetic fuel oil, believed to be able to address two issues simultaneously: reducing the accumulation of plastic waste that burdens the environment and providing an alternative energy source that can be utilized by the community (Panama, 2022). This technology also has economic potential by opening business opportunities and creating jobs in the field of waste management.

Pyrolysis technology has been implemented in Tanjungpinang City since June 2023 by the Environmental Agency as a form of government commitment to improving the effectiveness of waste management. Originally invented by Muryani in Blitar in 2009, the pyrolysis machine is now used to recycle plastic waste into synthetic fuel. Although the relatively high investment cost of around IDR 60 million per unit poses a challenge in expanding the widespread application of this technology (Riono, 2022). This program not only aims to reduce waste volume but is also expected to encourage growing awareness and active community participation in independent waste sorting and processing, and is a strategic step in driving a circular economy based on sustainable waste management.

Program effectiveness is the key to success in achieving predetermined goals. According to Subagyo (2001) in (Handimsah & Rahman, 2025), effectiveness is the level of success of an organization or program in achieving planned goals, not only oriented towards the final result but also encompassing the process gone through and the achievement of outputs and outcomes in accordance with expectations. Program effectiveness can be measured through several variables, namely the determination of program targets, program socialization, program objectives, and program monitoring. The accuracy of program targets is a crucial factor because if the program is unable to reach the appropriate target, the use of resources will be suboptimal and the expected goals will be difficult to achieve. Program socialization is the most important element in policy implementation so that it can be accepted and understood by the community, so that program implementation will be more efficient and community participation will increase. Clear program objectives serve to direct the resources and efforts needed to achieve the desired results, while program monitoring is a systematic process to monitor, collect, and analyze information regarding the implementation of a program to ensure that the program is running according to plan.

Based on the phenomena that have been explained, the problem formulation in this study is whether the waste processing program into fuel oil by the Tanjungpinang City Environmental Agency has achieved the targets set such as the target volume of waste processed and the target fuel production. The purpose of the study is to analyze what factors support and hinder the effectiveness of the waste processing program into fuel oil by the Tanjungpinang City Environmental Agency, as well as to measure the

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extent to which this program is able to reduce the volume of waste in Tanjungpinang City. Theoretically, the study is expected to provide significant benefits and solutions in efforts to reduce the volume of waste through systematic steps such as prevention, reduction, reuse, recycling, and processing. The results of this study are expected to be a guideline for the government in formulating more effective and sustainable waste management policies, assisting the government in optimizing budgets, technology, and labor, as well as opening business opportunities and employment for the community in the collection, processing, and distribution of recycled fuel.

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The Concept of Effectiveness

Effectiveness is a concept that describes an organization's ability to achieve its goals and objectives optimally and on target. Overall, effectiveness refers to the organization's level of success in realizing desired results, taking into account the relevance and importance of the goals to be achieved. This concept emphasizes achieving results that are not only in line with targets but also aligned with established priorities (Aditya Wardhana, 2024). According to Edy Sutrisno (2007) in (Triani & Muslih Amberi, 2023), understanding of a program can be measured by the extent to which interest groups are able to understand and obtain information about the various activities within the program. Target accuracy can be evaluated based on the extent to which the program aligns with predetermined objectives. Programs implemented on time will be more effective in achieving goals and providing optimal benefits. Success in achieving goals can be evaluated based on the extent to which the objectives of the implemented activities are met, and tangible changes can be seen based on the extent to which the implementation of these activities has succeeded in providing positive impacts, sustainable benefits, and significant contributions to improving the welfare and quality of life of the community.

According to Campbell JP (1970:96), general effectiveness measurements include program success, target success, program satisfaction, input and output levels, and overall goal achievement. This theory assesses effectiveness based on several key aspects, namely program success, target achievement, program satisfaction, and the balance between output and input, including overall goal achievement (Anggara, 2022). According to Subagyo (2001) in (Handimsah & Rahman, 2025), effectiveness is the level of success of an organization or program in achieving its planned goals. Effectiveness is not only oriented towards the final result, but also includes the process undertaken and the achievement of outputs and outcomes that are in accordance with expectations. Program effectiveness is defined as the level of target realization, which indicates the extent to which the program's targets have been set with the variables of program target determination, program socialization, program objectives, and program monitoring. The accuracy of a program's targets is a crucial factor because if the program is unable to reach the appropriate target, resource use will be suboptimal. Program socialization is the most important element in policy implementation so that it can be accepted and understood by the community. Clear program objectives serve to direct the resources and efforts needed to achieve desired results. Program monitoring is a systematic process of monitoring, collecting, and analyzing information regarding a program's implementation to ensure that the program is proceeding according to established plans and achieving the desired results.

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Program Concept

According to John Backus, a program is a systematic and structured sequential description of the computational steps performed by a computer, with the ultimate goal of producing an accurate and efficient solution to a given problem. As programming technology advances, the role of programs has become increasingly crucial in various fields, from science and business to everyday life (Lesmono, 2024). According to Tayibnapis (1989) in Mesiono, n.d., a program encompasses all efforts undertaken by a person with the aim of achieving specific results or impacts that are expected to benefit individuals and groups. Programs are systematically designed to optimally achieve predetermined goals. A good program is expected to yield positive changes and significant contributions to various aspects of life, including education, social studies, and economics. Meanwhile, according to Joan L. Herman, a program is a series of efforts undertaken by a person with the aim of producing specific impacts or outcomes. To assess the success of the program, an evaluation is necessary by comparing the results with predetermined standards (Kawung et al., 2020).

Waste Management Concept

Waste management is a series of activities that include collection, transportation, processing, recycling, and disposal. Generally, this term refers to waste generated from human activities and is managed to minimize its impact on health, the environment, and aesthetics. The waste managed can be solid, liquid, gaseous, or radioactive, each of which requires specialized methods and expertise. Waste management methods vary depending on the conditions of each country, both developed and developing, and vary between urban and rural areas, as well as between residential and industrial areas (Fenny Febrya, 2022). According to Lisa Johnson in (RM Rachman et al., 2024), urban waste management encompasses not only the physical handling of waste but also the planning and implementation of policies and programs aimed at reducing the amount of waste, recycling, and reusing it. These efforts include the use of environmentally friendly technologies and increasing public awareness of the importance of sustainable waste management. According to Neolaka (2008:67), waste management is an effort to create a clean, healthy, and beautiful environment through planned and sustainable waste processing. This process is carried out harmoniously and in collaboration between the community, managers, and the government, with the aim of improving the quality of life and maintaining environmental sustainability (Nagong, 2021).

RESEARCH METHODS

The method used in this study is a qualitative approach with a descriptive qualitative research type. Referring to Kirk and Miller, qualitative research is defined as a tradition in the social sciences that fundamentally relies on human observations relating to individuals using language and their interactions (Muhajirin et al., 2024). According to Sugiyono (2015) in (Zuchri Abdussamad, 2021), qualitative research methods are approaches used to investigate objects in natural conditions, where the researcher acts as the primary instrument. Data collection techniques are carried out through triangulation, which combines various data sources to obtain more comprehensive information. Data analysis in qualitative research is inductive, meaning that researchers process data based on facts found during fieldwork. Research results emphasize meaning rather than generalizations, allowing researchers to understand the nuances of the phenomena being studied. Qualitative methods are research approaches

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that aim to understand and explain phenomena in depth. The advantage of qualitative methods lies in their ability to reveal the perceptions, meanings, and experiences of subjects in depth (A. Rachman et al., 2024).

This research was conducted at the UPTD TPA Ganet, Tanjungpinang City, Riau Islands Province, which has a major role in managing plastic waste into fuel oil. The research focused on the effectiveness of the plastic waste management program into fuel oil using pyrolysis technology. Data collection was conducted through observation, interviews, and documentation. The sampling technique used purposive sampling, where informants were selected based on their knowledge, experience, and direct involvement in program implementation. Data analysis used the Miles and Huberman model, which includes data reduction, data presentation, as well as drawing conclusions and verification. Informants in this study consisted of the Head of UPTD TPA Ganet, waste management officers, and the Tanjungpinang City community involved in program implementation.

Table 2. Research Informants

Informant	Amount
Head of UPTD TPA Ganet	1
Waste Management Officer	2
Public	3
Total	6

Source: Researcher Processed Data, 2025

RESULTS AND DISCUSSION

Overview of Research Location

Tanjungpinang City, the capital of the Riau Islands Province, is experiencing rapid development dynamics, both in terms of economy, population, and community activities. Population growth accompanied by changes in community consumption patterns accelerates the rate of daily waste generation, which is the responsibility of the local government. Plastic waste is one of the most serious problems because it is difficult to decompose naturally and has the potential to cause long-term pollution. Responding to this condition, the Tanjungpinang City Government, through the Environment Agency (DLH) and the UPTD TPA Ganet, initiated the Waste Management Program into Fuel Oil (BBM). This program aims to reduce dependence on the Final Disposal Site (TPA) whose capacity is increasingly limited, reduce the environmental impact of waste accumulation, and create added value in the form of alternative energy. The technology used is pyrolysis, which is a process of heating plastic waste at high temperatures without oxygen to produce liquid oil that can be used as a fuel alternative to diesel or kerosene. This program began in 2023 with the support of a 10-kilogram conversion machine and involving workers from the UPTD TPA.

Program Objective Indicators

The waste management program in Tanjungpinang City has clear and comprehensive objectives and has received a positive response from various parties. In general, this program aims to reduce waste volume, increase management effectiveness, and provide economic benefits for both managers and the community. The Head of the UPTD TPA Ganet explained that this program is not only designed to reduce waste volume, but also to increase economic value and support waste management operations

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if implemented according to plan. However, if the program is not implemented optimally, it will only function as an educational tool without providing a significant impact. The UPTD TPA Ganet also collaborates with waste banks in Tanjungpinang City to increase economic benefits for the community, encourage behavioral changes to avoid littering, and reduce the burden of waste sorting for the UPTD TPA because the process has been carried out from the beginning by the waste bank.

Public response demonstrated strong support for the program. They viewed the program as a positive and beneficial initiative, with the potential to significantly impact waste reduction in Tanjungpinang City. They also expressed their hope that the program would be implemented optimally and consistently to achieve its intended objectives. Overall, the program's objectives have been successfully implemented, supported by thorough planning and a positive response from various stakeholders.

Program Target Accuracy Indicator

Selecting the community as the primary target of the plastic waste conversion program is a sound step. Communities are seen as playing a strategic role because they have the greatest influence on the quantity and quality of waste produced. The Head of the Ganet Landfill Technical Implementation Unit (UPTD) emphasized that the program's success depends heavily on the level of community awareness and active involvement. Increasing community awareness and active involvement is crucial because communities act as both the primary actors and sources of waste production, and their behavior directly influences the effectiveness of waste reduction efforts. Selecting the community as the primary target is considered appropriate, given that the program requires their commitment and involvement to effectively achieve waste reduction goals.

Plastic waste management is carried out through structured stages, starting with the collection and sorting of waste directly at the source. Sorting is crucial because the waste discarded by the public is generally mixed with food scraps, metals, and other materials. Officers face challenges in the form of wet waste, which can hinder the incineration process. To overcome this, officers conduct initial collection and sorting, separating wet plastic waste for drying, while the dry waste is immediately processed. Overall, the program's success depends on identifying the community as the primary target, the importance of raising public awareness and participation, and the community involvement necessary to mitigate technical challenges in waste processing.

Program Socialization Indicators

The program's socialization has not been implemented optimally and faces several significant obstacles. The Head of the Ganet Landfill Technical Implementation Unit (UPTD) stated that public outreach regarding waste management into fuel oil has not been conducted because regulations related to the program's follow-up permit have not been issued. The program cannot be fully implemented because laboratory tests on the oil produced do not meet the feasibility standard, at only 91.5 percent, compared to the standard of 92 percent. Therefore, the follow-up permit process cannot be issued. This condition prevents the program from proceeding to the production stage or utilization of the processed products. The lack of legal and regulatory support prevents the UPTD TPA from conducting official outreach to the community, resulting in the community not receiving information about the program's objectives, mechanisms, and benefits.

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Although the program is not yet operational, the pyrolysis machine is still being used as an educational tool for those interested in learning about plastic waste processing. The community has shown interest and willingness to participate in outreach activities if they are conducted at a convenient time and do not conflict with work or household activities. Overall , it can be concluded that the program's outreach has not been successful due to obstacles such as the lack of further permits and substandard test results. This has prevented the program from being implemented optimally and the community from receiving adequate information about the program.

Program Monitoring Indicators

Monitoring of the plastic waste conversion program into fuel is carried out internally by the Head of the Landfill Technical Implementation Unit (UPTD TPA) without the involvement of external parties, such as supervisory agencies, local governments, or other relevant institutions. Monitoring is conducted once a month, so the program's oversight and supervision mechanisms are still limited and suboptimal. The plastic waste management process is running smoothly and stably. The pyrolysis machine is functioning according to operational standards, and the workforce is performing adequately. This confirms that, from a technical and human resource perspective, the program is being implemented effectively and in accordance with its stated objectives.

The challenges encountered were minor, primarily related to the quality of the raw materials, including plastic waste that was still wet or mixed with organic waste and other unprocessable materials. To address these issues, officers sorted the waste at the source, collected it, and dried the wet plastic waste before processing it. The dried plastic waste was then processed according to standards, ensuring smooth operations and the quality of the fuel produced. Overall, the plastic waste-to-fuel program was effective from a technical and human resource perspective, but there were limitations in external monitoring mechanisms and a reliance on the quality of the raw materials.

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CONCLUSION

Based on the research results and discussions presented, it can be concluded that the plastic waste management program into fuel oil in Tanjungpinang City is ineffective. Of the four indicators used, two indicators have been running well, namely program objectives and the accuracy of program targets, while the other two indicators have not been running optimally, namely program socialization and program monitoring. The program objectives have been implemented well, as evidenced by the program having clear and comprehensive objectives to reduce waste volume and increase management effectiveness, and received positive responses from various parties. The accuracy of the program's targets is also appropriate by establishing the community as the main target considering their strategic role as the most influential party on the amount and quality of waste produced. However, the program socialization has not been implemented because the results of laboratory tests on the oil produced have not met the feasibility standard, namely only 91.5 percent while the standard is 92 percent, so the further licensing process cannot be issued and causes the UPTD TPA to be unable to conduct official socialization to the community. Program monitoring is carried out internally by the Head of the UPTD TPA without the involvement of external parties and is only carried out once a month, so the program's monitoring and supervision mechanisms are still limited. Technical obstacles that arise in the form of

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plastic waste that is still wet or mixed with organic waste and other materials still frequently occur, even though they have been overcome through sorting and drying the waste before processing.

Based on the research conclusions, several recommendations are formulated to improve the effectiveness of the plastic waste management program in Tanjungpinang City. The UPTD TPA Ganet needs to improve the quality of the processing results to meet the established eligibility standards so that further permits can be issued and the program can be fully implemented. Although further permits have not been issued, outreach to the community is still necessary to increase public understanding of waste management and sorting from the source and foster environmentally responsible behavior. The program monitoring mechanism needs to be improved by involving external agencies such as supervisory agencies and local governments to obtain more objective and comprehensive evaluations, and the frequency of monitoring needs to be increased so that problems can be identified and addressed quickly. Strengthening waste sorting at the source and improving sorting and drying facilities are needed to reduce technical obstacles such as plastic waste that is still wet or mixed with other materials. The Tanjungpinang City Government also needs to provide support in the form of adequate budget allocation for program development, including the procurement of pyrolysis machines with larger capacity and the provision of supporting facilities that can increase the efficiency and effectiveness of the program as a whole.

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