Plastic Waste Paving Blocks as an Alternative for Non-Organic Waste Management in Lembang Gantarang Keke Village

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ABSTRACT

Improperly managed waste causes environmental problems, particularly plastic waste, a non-organic waste that decomposes with difficulty. In Kelurahan Lembang Gantarangkeke, Tompobulu District, Bantaeng Regency, no dedicated waste disposal site exists, so residents dispose of waste in rivers and behind their houses or burn it in gardens. This activity aimed to produce paving blocks from plastic waste as an alternative waste management approach for non-organic waste. University students in a community service program conducted the activity from 30 August to 15 September 2026 in ten stages, from problem identification to the utilization of paving blocks. Plastic waste was collected from the kelurahan environment and households with direct education, then sorted and prepared in a dry condition. Paving blocks were made by heating new oil in a wok until boiling, adding plastic waste piece by piece while stirring, gradually adding sand, and pouring the mixture into aluminum molds to cool and harden. The activity produced 25 rectangular paving blocks measuring 10 × 20 cm with a height of 6 cm. A simple test on about five paving blocks, after one night of setting, by dropping another paving block on each and

stepping on it, showed no visible cracks. The paving blocks were then used as borders of a flower garden at the kelurahan office. In conclusion, paving blocks have potential as one alternative for utilizing plastic waste, although laboratory testing and a broader waste management system are still needed.

1. Introduction

The increasing number of people and changing consumption habits make the volume, types and characteristics of waste increasingly complex, so waste has become a national problem that needs to be managed comprehensively from upstream to downstream (UU 18 Tahun 2008). On a global scale, the size of the population and the quality of the waste management system are key factors in determining how much plastic waste is left without management and could become an environmental contaminant (Jambeck et al., 2015).

One kind of waste that needs to be addressed is non-organic waste - materials which do not break down easily through natural processes. Plastic can be classified as a non-organic waste (Mustakim et al., 2024). It is estimated that by 2015 there were about 6,300 million metric tons of plastic waste produced around the world. Out of the total amount of plastic waste generated, roughly 9% of it was recycled, 12% of it was incinerated and 79% of it ended up in landfills or in the natural environment (Geyer et al., 2017). This means that the majority of all plastic waste generated has not been put to use in any way.

Plastic waste which is poorly managed results in long-lasting environmental damage due to the fact that plastics degrade extremely slowly. Poorly managed waste may be transported to the ocean through inland waterways, such as rivers (Jambeck et al., 2015). Globally, it has been estimated that approximately 1.15 to 2.41 million metric tons of plastic waste enters the ocean from rivers each year; the majority of the largest sources of riverine input are located in Asia (Lebreton et al., 2017). According to estimates provided by Jambeck et al. (2015), Indonesia is one of the countries contributing the most mismanaged plastic waste. In addition to being released into waterways, waste is also often burned openly. Open burning of waste, including waste generated at the household level, is a major cause of air pollution and can generate substantial emissions in many developing nations throughout Asia and Africa (Wiedinmyer et al., 2014). Research conducted in Semarang demonstrated that the combustion of plastic produced the highest proportion of emissions compared to other types of burned waste. Furthermore, research showed that the potential risk of developing non-cancerous illnesses associated with exposure to open waste burning exceeded acceptable safety thresholds (Ramadan et al., 2023).

The same issue exists in Lembang Gantarangkeke Village, Tompobulu District, Bantaeng Regency. The researchers spent a week observing the community and conducting interviews with community members and village officials. They discovered that there were no trash cans provided in Lembang Gantarangkeke Village. Community members were throwing away their trash in the river, in the yard of their homes, and occasionally burning trash in their yard. Of all the trash thrown into the environment, the team found that much of it consisted of plastic waste which had not been utilized. The team also noticed that if trash is burned in the yard during the dry season, it may result in a fire. Therefore, it is clear that we must find alternative

ways to dispose of or burn plastic waste indiscriminately. According to UU Nomor 18 Tahun 2008, waste reduction includes reducing waste generation, recycling waste, and reusing waste. Creating new uses for plastic waste through processing plastic waste into new products can help achieve this goal.

Several studies have examined the potential use of plastic waste as a building product. Kumi-Larbi et al. (2018) produced low-density polyethylene (LDPE) sand blocks by combining LDPE bags and water sachets, two products commonly found in developing nations with limited or non-existent waste collection and recycling infrastructure. The process used by Kumi-Larbi et al. was relatively simple. Kahfi et al. (2025) tested the feasibility of producing paving blocks from a combination of PET plastic waste, sand, and used motor oil in different proportions. Kahfi et al. then evaluated the properties of each block type including weight, water absorption, and compressive strength, in a laboratory environment. Mustakim et al. (2024) described a community-based educational program in the city of Parepare, South Sulawesi, where PET plastic waste was processed into cement-free paving blocks. The project involved young people who attended as participants.

Paving stones are an option to use plastic waste because of several factors. First, the product has a distinct shape and use as a ground cover, paving stones are widely used for paving and creating landscaping in garden areas, backyards and open spaces (Kahfi et al., 2025). Second, the process to create the product requires minimal equipment, which includes a large container, a mixing device, a heat source and molds. Third, the raw materials required to produce the paving stones may come from the local community. Fourth, once completed, the final product is instantly identifiable and available for immediate consumption.

As a result of this, students participating in the 79th Community Service Program (KKN) from State Islamic University (UIN) Alauddin Makassar - posted to Post 9 in Lembang Gantarangkeke Village - produced paving blocks using plastic waste during August 30 - September 15, 2026. This plastic waste was gathered from behind schools, along riverbanks, and in front of residents' homes; in addition, a portion of the plastic waste was given directly by the community. Additionally, the students visited around 100 households to educate them on the prohibition of dumping waste in rivers; the danger of burning trash during dry seasons; and the fact that plastic cannot decompose. After collecting the plastic waste, the students combined it with used motor oil and sand, created paving blocks, tested them lightly, and then placed them as borders for a flower garden at the village office.

This program was not developed to develop a new technology because the use of plastic in making paving blocks has been done before. The uniqueness of this program is that there are three things. One is that this program is being conducted in an administrative village (Kelurahan) where there is no waste disposal site. Another thing is that the plastic materials used for the paving blocks are from different kinds of waste collected by the local community members and residents of their homes, and they will be processed without washing or grinding. Finally, the paving blocks that will be produced will be immediately used to create borders for a flower garden per the request of the Head of Lembang Gantarangkeke Village so that both the process of creating the paving blocks and how they will be used can be documented together. This initiative has several goals: (1) To provide information about how to make paving blocks with plastic waste, used oil and sand; (2) To create paving blocks as

another way to utilize plastic waste; (3) To use the paving blocks to make borders for a flower garden at the village office; and (4) To document the results of simple tests so that they may be used as references for future similar projects.

2. Method

The activity took place in the village of Lembang Gantarangkeke in the subdistrict of Tompobulu in the regency of Bantaeng; it took place from August 30 to September 15, 2026. Students in the 79th batch of the Community Service Program (KKN) at the State Islamic University (UIN) Alauddin Makassar who were assigned to Post 9 in the village of Lembang Gantarangkeke provided assistance. Residents of the community and local authorities participated in the activity in several ways including providing feedback in informal discussions, giving plastic waste and sand to the students, and helping with basic testing of products. Students demonstrated to residents of the community how to make paving blocks out of plastic waste using a ten-stage process (Figure 1). Problems were discovered through a week-long observation of the community along with informal interviews of residents and local authorities.



Figure 1. Flowchart for Processing Plastic Waste into Paving Blocks

The materials used consist of newly purchased oil, sand provided by local residents, and various types of dry plastic waste. The composition of materials for a single paving block is presented in Table 1. The plastic waste is not measured in fixed quantities; rather, its amount is adjusted to ensure a dense mixture, with a preference for a higher proportion of plastic.

Table 1. Paving Block Composition Per Piece

Material	Dose	Information
Oil	700 ml	New Oil
Sand	300 ml	Added Slowly
Plastic Waste	Adjusted	Variate, Especially Dry

Sources: Prepare By The Author

The equipment used includes a large pan, a stirring implement, a gas stove as a heat source, an aluminium mold measuring 10 × 20 cm with a height of 6 cm, and a face mask as personal protective equipment.

The plastic waste that had accumulated behind the school, at the banks of the river, and in front of the homes of local residents, was picked up by the team. Some of the waste was turned over to us directly by the residents. We visited about 100 households and educated them about how to properly dispose of their waste on site. We informed them that dumping waste in rivers is illegal; that burning waste during the dry season could cause fires; and that since plastic does not decompose, it must be managed correctly. Our education program was solely for informational purposes and we did not formally evaluate our program. Before

processing the plastic waste, we sorted it, without washing it, and ensured it remained dry. We cut up large pieces of plastic, whereas we processed smaller pieces as they were. The production of paving blocks is carried out in an open are, away from residential settlements, trees, and any flammable materials. The steps are as follows:

1) Oil Heating. The oil is heated on a cauldron with a gas stove until it boils.
2) Melting Plastic. Add the plastic waste one by one while stirring continuously until it is combined.
3) Sand Mixing. Sand is added gradually, then the mixture is cooked while being stirred until thoroughly blended.
4) Molding. The batter is poured into aluminium molds measuring 10 × 20 cm with a height of 6 cm.
5) Cooling and Hardening. The mixture is left in the molds for approximately 30 minutes until it takes shape. The paving blocks to be tested are left to set overnight before testing.

The measurements in Table 1 apply to one paving block. The whole process produces 25 paving blocks. Safety at work. Heating oil and melting plastic over a fire pose a risk for burns, fire and being exposed to smoke and fumes. Melting plastic produces dangerous chemicals, so it is recommended to wear masks and heat-resistant gloves (Mustakim et al., 2024). Some types of plastics, including PVC and polystyrene, will produce toxic fumes when heated (Kahfi et al., 2025). This procedure includes many types of plastic, so the hazards associated with them need to be considered. To protect themselves, the team is wearing masks and performing the heating process outside in an open area, such as a garden, located far enough away from homes, trees, and other flammable substances.

The evaluation of these paving block products focused solely on the quality of each product, and did not measure how much knowledge or skill was developed by residents. One way that the quality of these products was evaluated was via a simple test performed on about five (5) out of twenty-five (25) paving blocks produced. After being allowed to cure for one night, each tested paving block had a second paving block dropped upon it. Once dropped, a person then stood upon the first block. This testing was completed in conjunction with local residents and sub-district officials. Results were visually observed, and recorded based upon whether cracks were visible. No measurements were taken, and no assessments were made of properties including compressive strength, water absorption, or weather resistance. Observations, informal interviews, and photos were used to gather data, which were then analyzed using a qualitative descriptive methodology. Upon request of the Head of Lembang Gantarangkeke Sub-district, the paving blocks that resulted from the project were installed as boundaries for a flower garden located at the sub-district office.

3. Results and Discussion

An first week observation and formal or informal interviews with residents and local sub-district officials showed that there was no designated waste disposal site in Lembang Gantarangkeke Sub-district. The residents would either dispose of their waste in the river or behind their house, or even burn it in their garden. Plastic waste (A Form of Non-Organic Waste) is located all over the area and is still being unused. Since the amount and types of

waste were not measured during the first phase of this study, the current state of affairs is described as a qualitative description.

Using waste management theories, the type of waste management system used will determine how much of the plastic waste generated will remain unmanaged (Jambeck et al., 2015). When there are no waste collection or recycling services available within a country's borders, such as those found in many developing nations, the LDPE-type plastics are generally viewed as having no value and therefore can be thrown away in an arbitrary manner (Kumi-Larbi et al., 2018). This same type of behavior has been observed in this sub-district. If waste is improperly managed it could ultimately enter the aquatic environment through river systems (Jambeck et al., 2015). Burning waste openly is a primary cause of air pollution (Wiedinmyer et al., 2014). For example, a survey conducted with households in Semarang found that burning plastic was the leading contributor to overall emissions from burning all types of waste (Ramadan et al., 2023). However, the specific effects on the local rivers and air quality have not been determined. Additionally, according to the team's observations, burning waste in gardens or open areas during periods of dryness poses a potential fire hazard.

Waste materials made from plastic were collected from the rear of the school, along the shores of the river, and on the properties of the local residents. Some of the residents were even able to give us their waste. (Figure 2). Our team visited about 100 households to educate them about the ban on dumping waste into rivers; the hazards of burning garbage during the dry season; and the fact that plastics do not break down naturally. We then sorted all of the collected plastic into categories based on the type of plastic. We kept the sorted plastic dry (no washing). We cut large pieces of plastic into smaller sizes. However, we did not change the size of the smaller pieces



Figure 2. Plastic Waste Collection in Lembang Gantarangkeke Village

The discovery of plastic waste on river banks and in front of schools confirms that plastic exists in the sub-district area, however, the amount of plastic was not quantified. As stated in UU Nomor 18 Tahun 2008, waste management involves the process of sorting and collecting, therefore, the actions taken in this initiative are relevant to both phases. This initiative included raising awareness among residents about waste issues, however, whether residents gained any knowledge or changed their behavior due to the initiative was not assessed and thus will not be included as an outcome. Previous research has demonstrated that before melting down the plastics, the plastics were cut/shredded into small pieces (Kahfi et al., 2025; Mustakim et al., 2024). On the other hand, the present initiative only cut up the larger pieces of plastic and did not wash them; there is no evidence indicating if the lack of washing influenced the overall results. Also, in contrast to previous research which focused on one type of plastic (i.e., PET/LDPE), this initiative used multiple types of plastics.

Oil that has been newly purchased will be heated in a large pot using a gas stove until it boils. Plastic waste will be added one at a time and mixed in as much as possible before introducing the sand slowly, and continuing to mix and heat the ingredients until they are completely combined. The entire procedure will take place outdoors, far away from any homes, and the people involved will wear protective masks (Figure 3). Each paving block produced will contain 700 mL of oil and 300 mL of sand, and the quantity of plastic will be altered to produce a firm consistency (Table 1).

This stage is consistent with what has been previously researched. Kahfi et al. (2025) boiled the oil, put in the plastic so that it would melt, and added sand. In their research, the oil was used as a way to melt the plastic and distribute the melted plastic within the sand. However, there is a distinction in the composition. Kahfi et al. (2025) used about 150-270 cm^3 of waste oil for each mold with a volume of 1,200 cm^3. For our project, we will use 700 ml of new oil for every paving block. We do not know how much plastic is being used. If we assume the same ratio applies to each paving block, we will need around 17.5 liters of new oil for 25 paving blocks. There has been no testing done on whether or not having a larger amount of oil affects the quality of the final product. Therefore, this composition may not be the best option.



Figure 3. The Mixing and Preparation Process for Paving Block Material

The mixture is poured into an aluminum mold that is 10 x 20 centimeters and has a height of six centimeters. It will be allowed to set for about 30 minutes before it is removed from the mold. After the paving blocks have set, they were allowed to sit overnight to complete their curing process. In addition, the molten plastic was used as a binder; therefore, no cement was required during the production of the paving blocks. Mustakim et al. (2024) called these types of paving blocks "cement-free." The size of the mold that was used in this research was also the same size as the mold that Kahfi et al. (2025) used in their study; i.e., 20 x 10 x 6 cm. Although the size of the molds was similar, it does not mean that the quality of the products is comparable due to differences in composition and processing techniques.

The experiment created 25 rectangular paving stones that measure 10 x 20 cm and are 6 cm thick (Figure 4). A basic experiment was conducted on five paving stones that had been left to dry for approximately one night. One of the paving stones is dropped onto another paving stone and someone steps onto it. The experiment was done in conjunction with the residents of the area and village officials (Table 2).



Figure 4. Finish Product, and The Use of Product

The tested paving blocks appeared to have no visible cracking which indicates that they initially had a level of resistance to the applied treatment. However, since the current test method did not produce quantitative data; it is impossible to compare these findings with the results from previous laboratory tests on the compressive strength and/or water absorption of similar paving block types. Kahfi et al. (2025) reported the weights, water absorption, and compressive strength of paving blocks at 14, 21, and 28 days. At day 28, the maximum compressive strength was found to be 12.25 MPa and therefore was considered Grade D and thus appropriate for use within parks. It remains unclear whether the paving blocks tested as part of this project are acceptable for use according to the pertinent standards until such time as additional testing of a similar nature is performed. Paving blocks were used as borders for flower beds at the sub-district office, at the request of the sub-district head (Figure 4). Due to time constraints, their use was limited to the arrangement of these flower beds.

Table 2. Paving Block Simple Test Recap

Aspect	Information
Produced Paving Block	25 Piece
Tested Paving Block	Around 5 Piece
Suppress	Around 30 Minute, Overnight Before Testing
Action	Drop Test and Pressure Test
Executor	KKN Team, Residents, Sub-District Staff

Sources: Prepared By The Author

UU Nomor 18 Tahun 2008 includes the limitation of waste generation, recycling, and reuse as forms of waste reduction. These three practices align with the 3R principle (reduce, reuse, recycle). Processing plastic into new products can be categorized as either recycling or reuse; however, such activities do not contribute to the limitation of waste generation (reduction). Within the waste management hierarchy, waste prevention is the preferred option, while disposal at a final processing site is the last resort (Johansson, 2023). Consequently, the production of paving blocks should be viewed as one potential utilization alternative, rather than a substitute for waste prevention or broader waste management systems.

Kumi-Larbi et al. (2018) highlight the potential for community-based waste management using simple technology to process plastic into sand-bound blocks. In this context, the production of paving blocks serves as a potential example of how plastic can be utilized, rather than being discarded into rivers or burned. This potential has not yet been tested. The distinction between the results, analysis, and potential is summarized in Table 3.

Table 3. Result, Analysis, and Future Potential

Aspect	Result	Analysis	Potential
Product	25 Paving Block (10x20x6) Cm	Plastic Can Be Processed Using Simple Tools into Solid Products	Has The Potential to Serve as An Example of Plastic Utilization
Resilience	Around 5 Paving Block Hold in Simple Test	Initial Resistance to Dropping and Trampling	Potentially Suitable for Light Decorative Use; Laboratory Testing Required
Utilization	Used As Park Border, and Around Sub-District Office	Used on The Location	Potentially An Example of Use Elsewhere
Waste Management	Processing Plastic from The Resident	Unmeasured Observed Plastic Waste	It Has The Potential to Complement Sorting and Collection; Its Impact on Disposal and Incineration Has Not Yet Been Measured

Sources: Prepared By The Authors

The primary problem with this method is that the heated mixture emits an unpleasant smell when heated. Therefore, if the heating can be done in an open space like a garden and away from people's homes then this issue will be lessened. Also, there are safety issues when heating plastic and oils on a open flame. These issues can be reduced by using personal protective equipment like masks and doing the heating in an area where there are no trees or flammable materials nearby. According to Mustakim et al. (2024), heating plastic produces dangerous waste products. Kahfi et al. (2025) have also said that the heating process will use more energy. Some of the other challenges that need to be addressed include the need for a lot of fresh oil to produce one paving block, and the limited amount of time available to put down paving blocks in a flower garden. Factors that supported this study were the amount of plastic waste being generated in the sub-district, direct contributions of waste from residents, contributions of sand from members of the community, residents and sub-district official's participation in informal interviews and simple testing, the availability of basic equipment (A Large Pan, Gas Stove, And Aluminum Mold), and a location where the cooking could take place in a garden setting. Additionally, there was a request made by the sub-district head to develop a flower garden which gave the resulting product a definite use. This activity has several limitations:

1) The testing was qualitative and performed on approximately five paving blocks. Stepping was carried out by only one person, and neither the load nor the drop height was measured.
2) Compressive strength, water absorption, and weather resistance were not tested, so long-term durability is unknown.
3) Heating emissions and residual oil are not measured.
4) Quantity and weight of plastic waste processed.

5) The types of plastic vary; they are neither washed nor measured by mass, and are only cut down if they are too large, making it difficult to replicate the exact composition.
6) Informal interviews are conducted without a written instrument, so the results are descriptive in nature.
7) The activity will take place from August 30 to September 15, 2026, with no follow-up monitoring.

Meanwhile the potential and the continuity of this program, especially in utilizing plastic waste can be said, however this is merely an advice not yet an achievement:

1) Laboratory testing (Compressive Strength and Water Absorption) is conducted before paving blocks are used more extensively, following the testing approach used in previous research.
2) The composition, including the weight of the plastic, is recorded so that the process can be replicated and compared. An analysis of the oil-to-plastic ratio is also necessary, as the amount of oil used in this activity is greater than that in previous studies.
3) Establishment of safety procedures (personal protective equipment, locations distant from residential areas and flammable objects) and assessment of heating-related emissions.
4) Monitoring the condition of paving blocks in the flower garden over time to provide preliminary information regarding their durability.
5) Development of a more comprehensive waste management system at the sub-district (Kelurahan) level, encompassing waste sorting, collection, and the provision of disposal facilities, is necessary, as paving blocks can only accommodate certain types of waste.
6) A separate evaluation of the educational impact, should a subsequent party wish to assess changes in the residents' behavior.

4. Conclusion

The purpose of this project was to: describe the method used to create paving blocks using plastic waste, oil, and sand; produce 25 paving blocks; use those 25 paving blocks as border material for a flower bed at the sub-district office. A limited evaluation of about five of the paving blocks showed no obvious signs of cracking. However, there was no testing of the paving blocks' compressive strength, water absorption capacity, or ability to withstand environmental conditions (Weathering). Therefore, although the results indicate that paving blocks created from plastic waste, oil and sand may provide a partial solution to managing plastic waste within Lembang Gantarangkeke, which currently has no designated waste disposal site, it is important to recognize that paving blocks created from plastic waste are only one component of a larger, more comprehensive waste management system.

For continued growth, the next stage of the project will involve laboratory testing; documenting raw materials, their relative proportions of oil, etc.; developing safety protocols; evaluating emissions resulting from heating operations; and designing a waste management system that includes sorting, collecting, and disposing of waste. Additionally, there is need for evaluation of the effects of educational campaigns on the behaviors of residents. The

methodology outlined here can be used as a reference by similar projects in different areas, with the understanding that the same limitations apply.

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