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Innovation of BATIK (Batako Plastik): Utilizing Plastic Waste as an Environmentally Friendly Business Opportunity

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ABSTRACT

The increasing problem of plastic waste has become a serious environmental challenge, particularly due to its non-biodegradable nature and its negative impact on ecosystems. On the other hand, the demand for construction materials such as paving blocks continues to grow along with infrastructure development. This study aims to examine the utilization of plastic waste as an alternative material in the production of environmentally friendly paving blocks with economic value for the community. The method used in this study is the Participatory Action Research (PAR) approach, which actively involves the community through stages of observation, planning, training implementation, evaluation, and reflection. The study was conducted in Rengas Village, Kedungwuni District, with waste collectors as the research subjects. Data were collected through observation, pre-test, post-test, and practical assessments to measure improvements in participants' knowledge and skills. The results show that the utilization of plastic waste in paving block production produces materials that are lighter in weight, have lower water absorption, and exhibit good wear resistance. In addition, there was an improvement in community knowledge and skills in plastic waste management. From an environmental perspective, this innovation contributes to reducing the volume of plastic waste, while economically it can reduce production costs by approximately 25% and create new business opportunities for the community. In conclusion, the use of plastic waste as a material for paving blocks has significant potential as an innovative solution for waste management while supporting sustainable development based on a circular economy.

1. Introduction

Plastic waste remains a global issue that has not yet been optimally resolved. The increasing consumption of plastic in daily life, such as the use of plastic bags, bottles, and single-use packaging, has led to a continuous rise in the volume of plastic waste each year (Rafi & Perkasa,

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2023). Plastic waste is difficult to decompose naturally and can take hundreds of years to break down, thus posing a serious threat of environmental pollution to soil, water, and ecosystems as a whole.

In addition, improper handling of plastic waste, such as open burning, can produce hazardous substances that negatively affect human health and the environment (Karuniastuti, 2016). If left unmanaged, plastic waste can degrade soil and water quality and contribute to the formation of microplastics that are harmful to living organisms (Arini et al., 2024). These conditions indicate the need for innovative solutions that not only reduce plastic waste but also provide added value to society.

One potential innovation is the utilization of plastic waste as a material in the production of paving blocks. This approach not only helps reduce the volume of plastic waste but also offers advantages such as lighter weight, lower water absorption, and better wear resistance compared to conventional paving blocks (Padang et al., 2024). In addition to environmental benefits, this innovation also has economic potential by reducing production costs and creating new business opportunities for the community (Fathonah et al., 2024).

The implementation of this innovation at the community level has shown positive results, both in increasing environmental awareness and creating new economic opportunities. Training and assistance programs in processing plastic waste into paving blocks have been proven to improve community knowledge and skills, as well as encourage active participation in environmentally based circular economy practices (Pradipta et al., 2024).

Based on the above explanation, research on the utilization of plastic waste as a material for paving block production is important to conduct. This study not only focuses on the technical aspects of the product but also examines its environmental, economic, and social impacts. Therefore, it is expected that the results of this research can contribute to sustainable development and serve as an innovative solution for plastic waste management.

2. Method

The community service activity conducted in Rengas Village, Kedungwuni District, employed a *Participatory Action Research* (PAR) approach, in which community members were actively involved in the entire process rather than merely acting as participants. The implementation was carried out in five stages: beginning with observation and focus group discussions (FGDs) with residents to identify plastic waste problems, followed by collaborative planning to develop training modules tailored to local conditions along with their success indicators. This was followed by the implementation of training on August 27, 2025, attended by waste collectors, which included circular economy concepts and hands-on practice in processing plastic into paving blocks through sorting, melting, molding, and cooling processes.

Subsequently, data were collected through pre-tests, post-tests, and practical assessments to measure changes in participants' knowledge and skills. The activity concluded with a joint reflection to evaluate the outcomes and formulate follow-up plans. The PAR approach was chosen because it has been proven to foster a strong sense of ownership and sustainable participation (Rahmawati et al., 2024), while also positioning the innovation of plastic-based paving blocks as a practical solution that not only addresses environmental issues but also creates economic opportunities for rural communities (Rahmat et al., 2024).

3. Results and Discussion

The implementation of the community service activities in Rengas Village was carried out through five interconnected stages, each producing concrete outcomes. In the first stage, the KKN team, in collaboration with the Rengas Village government, conducted direct field observations to examine the actual conditions of waste management in the area. The observations revealed that plastic waste was the most dominant type of waste accumulation and had not been properly managed, as it was mostly burned or left to accumulate in open areas, posing potential risks of soil, water, and air pollution in residential environments.

These findings were reinforced through Focus Group Discussions (FGDs) involving local residents, including waste collectors who had direct experience and understanding of the field conditions. During these discussions, participants were not only encouraged to express their concerns but were also guided to identify potential opportunities that could be developed from the existing problems. As a result, it was found that the availability of plastic waste as raw material in the village was abundant yet underutilized, while the enthusiasm of residents, particularly waste collectors, to engage in productive solutions was relatively high. The mapping of problems and potentials in this stage served as a crucial foundation for subsequent stages, ensuring that the program was designed based on actual community needs rather than external agendas (Rahmawati et al., 2024).

In the second stage (collaborative planning), all findings from the observation phase were used as the basis for designing a training program that was contextual and relevant to the conditions of the Rengas Village community. The KKN team, together with the village government and community representatives, collaboratively developed training modules for producing paving blocks from plastic waste, tailored to the participants' literacy levels, technical abilities, and the availability of local tools and materials. This module development was not conducted unilaterally but involved participatory discussions to ensure that the content truly reflected the needs and capacities of the participants (Rahmawati et al., 2024).

The module onsisted of two main components: conceptual understanding of the circular economy and plastic waste management, as well as practical guidelines for producing paving blocks, including sorting, melting, molding, and cooling processes that could be carried out using simple equipment available in the village. In addition, measurable success indicators were established at this stage as evaluation benchmarks, including participant attendance and engagement, the volume of plastic waste processed into products, and the level of improvement in participants' knowledge and skills as measured through pre-test and post-test instruments.

The establishment of clear indicators from the outset is an essential component of the PAR approach, as it enables all stakeholders, both the KKN team and the community, to jointly assess the extent to which the program meets its intended objectives (Rahmat et al., 2024). This well-structured and participatory planning phase played a significant role in ensuring the smooth implementation of the subsequent training activities, while also fostering a shared commitment that the program is not merely a one-time activity but an initial step toward sustainable environmental management in Rengas Village (Pradipta, 2024).

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Fig. 1. Product Demonstration

In the third stage (training implementation), which was conducted on August 27, 2025, in Rengas Village, Kedungwuni District, all plans developed in the previous stage were realized through a training program attended by waste collectors as the main participants. The training began with a conceptual session introducing participants to the concept of the circular economy, an approach that transforms the perception of waste from something to be discarded into a resource that can be processed into valuable products. This conceptual understanding was considered essential as a foundation before participants engaged in practical activities, ensuring that they were not only technically skilled but also understood the importance of the activity for environmental sustainability and the village economy (Pradipta, 2024).

Following the conceptual session, the training continued with demonstrations and hands-on practice of the paving block production process conducted in groups. The first step involved sorting plastic waste, where participants separated plastic based on type and removed other materials such as paper, metal, and organic waste to ensure the purity of the raw materials. The sorted plastic was then placed into a stainless steel container and heated to approximately 200°C using a wood-fueled stove until it melted completely, while being continuously stirred to ensure even melting and to prevent sticking to the container walls. This melting process was carried out in an open or well-ventilated area to minimize exposure to harmful gases generated during heating (Firman et al., 2025).

The melted plastic was then poured into paving block molds and compacted by pressing to eliminate air cavities within the product. The filled molds were allowed to cool naturally or with the assistance of water, and once hardened, the paving blocks were removed from the molds to produce final products ready for evaluation.The results of the practice showed that all participant groups successfully produced paving blocks that met the required mold shape standards. Technically, the products were consistent with findings from previous studies, which indicate that incorporating plastic into construction materials offers several advantages compared to conventional materials. In addition, the lightweight nature of plastic resulted in paving blocks that were lighter than those made from traditional cement and sand mixtures, making them easier to transport and install (Padang et al., 2024). The products also demonstrated good durability, making them suitable for use as paving materials in village-level road infrastructure.

However, one limitation that requires attention is fire resistance. As confirmed by Ambali et al. (2021), plastic-based materials are flammable, making them unsuitable for applications requiring high fire safety standards. This limitation was clearly communicated to participants as part of comprehensive and transparent education, ensuring that the products are used appropriately and responsibly.

Fig. 2. Activity Implementation

In the fourth stage (data collection), the KKN team systematically documented all aspects of the activity implementation as objective and measurable evaluation material. Data collection was conducted using two main instruments, namely pre-tests and post-tests to measure changes in knowledge, as well as direct practical assessments to evaluate improvements in participants' skills. The pre-test results, conducted before the training began, indicated that most participants lacked sufficient understanding of the circular economy concept, the potential use of plastic waste as a valuable raw material, and the technical stages of paving block production.

After the training, a post-test was administered using the same instrument, and the results showed a significant increase in knowledge among all participants, both in terms of conceptual understanding of sustainable plastic waste management and technical knowledge of the production process from sorting to final product. This improvement indicates that the training method, which combines theoretical instruction with hands-on group practice, is effective in accelerating knowledge transfer to participants (Rahmawati et al., 2024). In addition to knowledge gains, practical assessments also showed that all participant groups were able to independently produce paving blocks that met the required standards of shape and density, demonstrating that technical skills can be effectively acquired within a single intensive training session when the module is designed in a contextual and participatory manner (Rahmat et al., 2024).

From an environmental perspective, the data collected during the activity showed that a certain volume of previously unmanaged plastic waste was successfully processed into valuable paving block products. This directly reduced the accumulation of plastic waste that could potentially pollute soil and water in the Rengas Village environment, in line with findings by Firman et al. (2025), which confirm that plastic-based paving block production contributes significantly to reducing environmental plastic waste. In addition, the use of recycled plastic as the primary raw material reduces dependence on natural resources such as sand and cement, whose exploitation continues to increase along with infrastructure development, thereby indirectly supporting the conservation of local natural ecosystems (Karuniastuti, 2016).

From an economic perspective, the data indicate that this innovation has significant potential for cost efficiency in production. By utilizing plastic waste as a partial substitute for conventional raw materials, production costs of paving blocks can be reduced by up to 25% compared to those made entirely from cement and sand (Padang et al., 2024). This cost efficiency is not only relevant for individual-scale production but also opens opportunities for villages to develop financially viable and sustainable waste-based business units. Furthermore, activities such as the collection, sorting, and processing of plastic within the production chain have the potential to create new job opportunities for local residents, particularly waste collectors who previously had limited access to the added value of the materials they gather (Ansori, 2024). Overall, the data collected at this stage serve not only as evidence of the program's impact but also as a foundation for the reflection stage, where all stakeholders collaboratively discuss and formulate more strategic and structured follow-up actions.

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In the fifth stage (reflection and follow-up), all stakeholders evaluated the implementation of the program and agreed that the PAR approach was effective in fostering a strong sense of ownership, as the community was actively involved from beginning to end. In addition, plans were established to further develop the product by incorporating local organic materials to enhance the strength and flexibility of the paving blocks, as well as to explore village-scale commercialization opportunities as a sustainable source of additional income for the Rengas Village community (Pradipta, 2024).

Fig. 3. Paving block results from plastic waste

4. Conclusion

Based on the results of the community service activities conducted in Rengas Village, Kedungwuni District, it can be concluded that the utilization of plastic waste as a material for paving block production is an innovative solution that provides benefits from multiple aspects. Through the *Participatory Action Research* (PAR) approach, the community was actively involved in every stage of the activity, from problem identification to evaluation, thereby increasing a sense of ownership and ensuring program sustainability. Technically, the paving blocks produced from plastic waste exhibit good characteristics, such as lighter weight, low water absorption, and adequate wear resistance, although they still have limitations in terms of fire resistance. From a social perspective, this activity improves community knowledge and skills in managing plastic waste productively. Environmentally, the utilization of plastic waste has been proven to reduce the volume of waste that pollutes the surroundings. Meanwhile, from an economic perspective, this innovation has the potential to reduce production costs and create new business opportunities for the community. In conclusion, the use of plastic waste as a material for paving blocks has significant potential to be developed as an environmentally friendly construction alternative while supporting sustainable development based on a circular economy. However, further development is needed, particularly in improving product quality and scaling up production, so that it can be applied more widely.

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