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Training to create fiber-optic flower crafts from gallon waste

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ABSTRACT
The problem of plastic waste in Indonesia is increasing due to high consumption and low awareness of waste management, requiring creative efforts to support the 3R principle in line with government policy in Undang-Undang Nomor 18 Tahun 2008 tentang Pengelolaan Sampah and Peraturan Menteri Negara Lingkungan Hidup Nomor 13 Tahun 2012 tentang Pedoman Pelaksanaan Reduce, Reuse, dan Recycle Melalui Bank Sampah. This activity aims to increase public awareness of waste management and provide training on using mineral-water gallon waste to create economically valuable flower crafts, incorporating fiber-optic technology as an aesthetic innovation. The implementation methods included site surveys, waste management education, training in making flowers from gallon waste, fiber-optic installation, and LED electronic circuit assembly using resistors and batteries, based on basic DC circuit calculations. The training was conducted through demonstrations, hands-on practice, and mentoring in five activity sessions involving PKK women in Gandikan Hamlet, Gumpang Village. The activity results show that the community can create flower crafts from gallon waste and understand the basics of fiber-optic installation and simple electronic circuits. However, further guidance is still needed at the stage of installing electrical circuits. This program enhances the community's knowledge, skills, and environmental awareness, and opens opportunities for product development as a local UMKM with economic value.

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ABSTRAK
Permasalahan sampah plastik di Indonesia semakin meningkat akibat tingginya konsumsi masyarakat dan rendahnya kesadaran pengelolaan sampah, sehingga diperlukan upaya kreatif untuk mendukung prinsip 3R yang sejalan dengan kebijakan pemerintah dalam Undang-Undang Nomor 18 Tahun 2008 tentang Pengelolaan Sampah dan Peraturan Menteri Negara Lingkungan Hidup Nomor 13 Tahun 2012 tentang Pedoman Pelaksanaan Reduce, Reuse, dan Recycle Melalui Bank Sampah. Kegiatan ini bertujuan untuk meningkatkan pengetahuan masyarakat mengenai pengelolaan sampah serta memberikan pelatihan pemanfaatan limbah galon air mineral menjadi kerajinan bunga bernilai ekonomi dengan tambahan teknologi serat optik sebagai inovasi estetika. Metode pelaksanaan meliputi survei lokasi, edukasi pengelolaan sampah, pelatihan pembuatan bunga dari limbah galon, instalasi serat optik, serta perakitan rangkaian elektronik LED menggunakan resistor dan baterai berdasarkan perhitungan dasar rangkaian DC. Pelatihan dilakukan melalui demonstrasi, praktik langsung, serta pendampingan pada lima sesi kegiatan yang melibatkan ibu-ibu PKK di Dusun Gandikan, Desa Gumpang. Hasil kegiatan menunjukkan bahwa masyarakat mampu membuat kerajinan bunga berbasis limbah galon dan memahami dasar instalasi serat optik serta rangkaian elektronik sederhana, meskipun pendampingan lanjutan masih dibutuhkan pada tahap pemasangan rangkaian listrik. Program ini meningkatkan pengetahuan, keterampilan, dan kesadaran lingkungan masyarakat, serta membuka peluang pengembangan produk sebagai UMKM lokal bernilai ekonomi.
Kata Kunci: *fiber optik; kerajinan bunga; pelatihan; pemanfaatan sampah*

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INTRODUCTION

Waste is material discarded from human or natural activities that has no economic value (Irwan et al., 2020). Waste is a common issue and a universal phenomenon across countries (Masruroh, 2021). According to the latest report, Indonesia is the second largest contributor of plastic waste in the world after China, with around 7.8 million tons of plastic waste produced each year, and most of this waste is not managed correctly, with around 58% not being collected or managed (Zahrah et al., 2024). Population growth, urbanization, and mass consumption are driving the surge in waste generation. Waste has become a problem for the community due to improper management. There are three aspects to the waste problem: upstream, downstream, and process. Downstream refers to increased waste disposal. Process refers to the limited resources available to both the community and the government. Upstream refers to the suboptimal system implemented for final processing (Fadillah & Yuliarti, 2025).

The government has issued Undang-Undang Nomor 18 Tahun 2008 tentang Pengelolaan Sampah, which discusses the objectives of waste management to improve public health, environmental quality, and sustainable living standards. The government also encourages the involvement of all Indonesian citizens in 3R (Reuse, Reduce, Recycle) waste management through Peraturan Menteri Negara Lingkungan Hidup Nomor 13 Tahun 2012 tentang Pedoman Pelaksanaan Reduce, Reuse, dan Recycle Melalui Bank Sampah and Peraturan Presiden Nomor 97 Tahun 2017 tentang Kebijakan dan Strategi Nasional Pengelolaan Sampah Rumah Tangga dan Sampah Sejenis Sampah Rumah Tangga (Marlina, 2025). The 3R principle consists of reducing, reusing, and recycling. Reducing means minimizing the amount of goods used, reusing means utilizing goods repeatedly, and recycling means processing unused goods into new goods that have value. The 3R concept is also aligned with the circular economy approach, a material management model that seeks to reduce waste by maximizing recycling and extending the product life cycle (Sari et al., 2025). In addition, research shows that 3R education and active community involvement can increase the effectiveness of village-based waste management, especially in areas with TPS3R facilities. These findings reinforce the importance of the community's role in creating a more sustainable, long-term-oriented waste management system (Kristina et al., 2025).

Gumpang Village is a village in Kartasura District, Sukoharjo, Central Java, Indonesia. This village has the second-largest area in Kartasura District, after Pucangan Village. Gumpang Village has 16 Dusun, 7 Rukun Warga (RW), and 55 Rukun Tetangga (RT). The village is home to several industries, including the textile industry by PT. Tyfountex Indonesia and the printing industry by CV. Pulau Lampuan. Additionally, small and medium-sized enterprises (SMEs) support the local community's livelihoods. Gumpang Village has a Reuse, Reduce, Recycle Waste Management Site (TPS3R) that collects and manages community waste. Waste is sorted by type and reused through recycling, such as leaves used as compost. Waste at the TPS3R is divided into two types: organic and inorganic. Organic waste is usually collected and burned, while plastic waste is collected and later sold for 1500-2000/kg. Household waste (wet waste) is collected by DLH Sukoharjo trucks. However, the TPS3R in Gumpang Village is not yet functioning optimally because waste is not being reused and recycled.

Public awareness in Gumpang Village is still low. Some residents still litter and improperly dispose of waste, such as by burning it or dumping it in inappropriate places, including rivers, which can have negative impacts. Meanwhile, burning plastic can cause air pollution. Incomplete combustion of plastic at temperatures below 8000°C causes the formation of dioxin compounds. Dioxin compounds are compounds that can cause cancer, hepatitis, liver swelling, and nervous system disorders (Dewi, 2022). In addition, dumping waste into rivers can harm the community by obstructing water flow, causing overflow during the rainy season.

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Increasing public awareness of waste management can be achieved through an educational approach that emphasizes that waste is not only an environmental problem but also a resource that can be processed into useful, economically valuable products. One implementation uses mineral water bottles as the primary material for decorative flowers. The used gallons are processed through simple stages such as cleaning, cutting, and shaping, then combined with fiber optic technology connected to an LED light source to provide a more attractive visual effect. Optical fibers are used because a protective layer surrounds their core and usually other protective layers to maintain the physical integrity of the fibers, making them suitable for transmitting light efficiently with minimal loss (Gao et al., 2025). The working principle of fiber optics relies on light reflection and refraction, which guide light through the fiber (Irawan et al., 2024). The use of optical fibers is an aesthetic innovation that enhances product value without requiring complex technology. Through this activity, the community is introduced to creative recycling, which not only reduces plastic waste but also creates opportunities to develop commercially valuable products, thereby increasing environmental awareness and community economic empowerment.

Previous community service activities have shown that using plastic waste as a valuable product is an effective way to raise environmental awareness and empower communities. Research indicates that processing waste into handicrafts can improve community skills while creating environmentally based business opportunities (Ratnaningsih et al., 2021). Another study shows that recycling activities not only help reduce plastic waste but also instill economic values and savings habits from an early age (Hukubun et al., 2024). Additionally, research has shown that education and direct practice in school waste management can improve participants' knowledge, attitudes, and creativity in using inorganic waste to produce valuable products (Gunawan et al., 2025; Pratiwi et al., 2023; Sandiar et al., 2023). In general, these studies confirm that craft-based waste management is a relevant strategy to support environmental education, waste reduction, and community economic empowerment.

This training implements optical fiber in flowers made from used gallons. The addition of optical fibers in this activity is because the interference pattern of light waves within optical fibers is influenced by wavelength and the physical structure of the fiber. This makes optical fibers not only useful for telecommunications but also for aesthetic applications, creating visual variations in creative work (Aprilia & Arianty, 2025). The use of fiber to enhance the aesthetics of decoration from used gallons can transmit light through the mechanism of total internal reflection so that light can be directed to a specific point without much loss of intensity (Chamoin et al., 2022; Chen et al., 2020; King et al., 2022; Umar et al., 2025).

Therefore, the RG OLE Team, together with the KKN 139 group, held an ‘Information Session and Training on Making Flower Crafts from Mineral Water Gallon Waste Combined with Fiber Optic Technology’. The information session aimed to increase community understanding in Gumpang Village, Kartasura District, Sukoharjo Regency, of waste management and utilization. The training aimed to leverage waste to create high-value flower crafts and improve human resource quality. These flower crafts can be sold on marketplaces or used as home decorations.

Literatur Review

Inorganic Waste Management Based on the 3R Principle

Waste is the residue of human activities or production processes that no longer have direct value and can cause negative environmental impacts. Based on their nature and characteristics, waste is classified as organic or inorganic. Organic waste comes from biological materials and is relatively easy to decompose naturally. In contrast, inorganic waste, such as plastic, metal, and glass, is difficult to decompose, so it can

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persist in the environment for extended periods and become a source of pollution if not managed properly (Daeli et al., 2025; Ratnaningsih et al., 2021).

Waste management is widely implemented through the 3R principle (Reduce, Reuse, Recycle). The reduce principle aims to reduce waste generation at the source; reuse encourages the reuse of waste that is still usable; and recycle emphasizes the processing of waste into new products with value. The application of the 3R principle has proven effective in reducing landfill waste while increasing resource efficiency (Derawati, 2021).

Using inorganic waste as a valuable material is a concrete implementation of the principles of reuse and recycling. Various studies show that plastic waste can be processed into handicraft products that have aesthetic and economic value. Processing inorganic waste into creative products not only reduces waste volume but also shifts public perception from discarded material to a valuable alternative resource (Insusanty et al., 2024). This approach supports sustainable environmental management and creates opportunities for community-based creative economic development.

Community Empowerment through Training

Community empowerment is a planned process to improve the capacity of individuals or groups to identify, manage, and solve problems they face independently. Empowerment focuses not only on outcomes but also on the process of building the community's knowledge, skills, and confidence so they can play an active role in social and environmental development (Ratnaningsih et al., 2021).

Training is a key tool in community empowerment efforts, as it transfers applicable knowledge and skills. Through training and hands-on practice, the community not only understands concepts in theory but also applies them in their daily lives. Various community service activities indicate that training in waste management and waste-based crafts effectively increases participants' environmental awareness, technical skills, and creativity (Insusanty et al., 2024; Nuriramadhana, 2024).

The level of active community participation greatly influences the success of community empowerment through training. Active participation encourages a sense of ownership of the activities, increases motivation to learn, and strengthens the sustainability of program outcomes. Research shows that direct community involvement at every stage of activities, from planning through implementation, contributes significantly to attitude change, increased environmental awareness, and strengthened community socioeconomic capacity (Karmeli et al., 2020). Thus, participation-based training is a strategic approach to creating sustainable social impact.

Creative Economy and Product Innovation

The creative economy is an economic development concept that relies on creativity, ideas, and innovation as the main sources of added value. In the creative economy, a product's value is determined not only by its raw materials but also by its design, functionality, and uniqueness that distinguish it from similar products. This approach enables the use of simple resources, including waste, to be processed into products with economic value and competitive advantage (Karmeli et al., 2020; Putra et al., 2022).

Crafts are a form of creative economy product with high added value potential. Through creativity and processing, materials that were previously worthless, such as plastic waste, can be transformed into products with aesthetic and commercial value. Various community service studies show that waste-based crafts can increase the utility value of materials, expand business opportunities, and support community economic empowerment, especially at the household and local community levels (Rahmawati et al., 2022; Ratnaningsih et al., 2021).

https://doi.org/10.17509/dedicated.v3i2.92823

The added value of handicraft products can be enhanced through simple innovations, such as integrating optical fiber technology. Optical fibers transmit light efficiently via total internal reflection, enabling attractive visual effects without consuming significant energy. Research shows that optical fibers are not only relevant in telecommunications but also have potential for aesthetic applications in light-based creative products (Chamoin et al., 2022; Chen et al., 2020). The integration of simple innovations, such as optical fibers, into waste-based craft products adds value by enhancing visual appeal, product differentiation, and potential for higher selling prices, thereby strengthening these products' position within a sustainable creative economy (Bai & Tan, 2013).

METHODS

The methods applied in this activity were training and hands-on practice. The training included several activities, such as presenting materials and practicing making flowers from used gallon containers by the KKN team, who had previously conducted trial-and-error tests. In developing a process to make flowers from used gallon containers, the team reviewed several studies that used plastic waste instead of gallon waste (Aswarliansyah et al., 2024; Derawati, 2021; Nisa & Adellia, 2023; Ramadani, 2024).

In making flowers using used gallons, LEDs (Light-Emitting Diodes) are also used. The use of LED technology in this activity is a simple, safe, and easily replicable aesthetic innovation for the community. LEDs were chosen because they have low power consumption, do not generate excessive heat, and are relatively safe to use in household-based craft products. During the training, participants were not guided through in-depth technical calculations of the circuit, but instead focused on a practical understanding of the correct and safe installation of LEDs to support the visual appearance of the flower crafts.

The lighting system has been designed and tested in advance by the KKN team to ensure stability and safety, so participants need only follow the simplified installation steps. This is important to ensure that the innovations introduced do not create obstacles but instead increase the community's confidence in producing crafts independently. Thus, LED technology in this activity is not positioned as the primary technical aspect, but rather as a supporting element that enhances the product's visual appeal and selling value. The main focus remains on the community's ability to implement the technology safely and sustainably after the training is complete.

This community service activity was conducted as a thematic Community Service Program (KKN) in July–August 2025 in Gumpang Village, Kartasura District, Sukoharjo Regency, specifically in RT 02A RW 03. The activity was conducted with the approval of the Head of Gumpang Village and included village officials, residents, and youth organizations. The location was chosen based on the existence and potential of the Reduce, Reuse, and Recycle Waste Management Facility (TPS3R) as the village's center for inorganic waste management.

The implementation method consists of the following stages. The first stage is a site survey to identify problems and opportunities in plastic waste management, particularly the availability of mineral water gallon waste, the readiness of community partners, and opportunities to develop plastic waste-based handicraft products. The survey was conducted on July 6, 2025, by a thematic community service team under the direction of RG OLE, through field observations and interviews with TPS3R managers and a TPS3R worker in Gumpang Village.

The second stage is a waste management education activity that aims to raise public awareness of the potential of plastic waste as a raw material for crafts with economic value. This activity was conducted once at the beginning of the KKN program, on July 22, 2025, at the Gumpang Village Hall. The material

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was presented by Ahmad Marzuki, S.Si., Ph.D., with a focus on introducing the concept of 3R-based waste management and opportunities for utilizing plastic waste in creative economic activities.

The third stage is flower craft training for the PKK women's group in Gandikan Hamlet, RT 02A, RW 03. The training was conducted in several sessions, each lasting approximately two hours, on July 29 and 30 and August 5, 6, and 7, 2025. The training included demonstrations and hands-on practice in making flowers from used gallons, covering cutting the materials, forming and assembling the petals, and applying optical fibers as decorative elements. Optical fibers were attached to the flowers and connected to a low-power LED lighting system to create an attractive visual effect. All stages of the training used simple tools and materials to ensure safety and to facilitate independent replication by the community after the activity ended.

RESULTS AND DISCUSSION

The activity aimed to educate residents of Gumpang Village on waste management and plastic waste utilization, and to introduce the community service activities to be carried out. The amount of plastic waste at the TPS3R is substantial, and increased plastic waste can negatively impact people. The long-lasting nature of plastic makes it difficult to decompose. However, plastic use is increasing due to its light weight, practicality, and durability. Plastic is commonly used for product packaging and shopping bags.

This training is intended specifically for women in PPK Dukuh Gandikan, RT 02A, RW 03. The flower-making training consists of four sessions covering the initial stages to the completion of flower crafts. The first session focuses on preparation, with the team having already prepared the tools and materials. The second session focuses on making and coloring flower petals. The third session focuses on attaching the stems and electrical wires. The fourth session focuses on attaching the flowers and electrical wires to the pots. The residents are very diligent and enthusiastic in participating in the training, as shown in **Figure 1**.

Figure 1. Atmosphere of flower craft making training
Source: Author Documentation 2025

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Preparation Steps

The first step is to prepare the tools and materials. The main material used is mineral water gallons. Other tools and materials include wire, scissors, cutters, candles, paper tape, duct tape, cables, batteries, resistors, pilox, LEDs, and acrylic, as shown in **Figure 2**.

Figure 2. Tools and materials used
Source: Author Documentation, 2025

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Second Steps

The second step is to form the petals. Cut the gallon of mineral water according to the desired petal pattern. Generally, one flower consists of five petal patterns. The finished petal patterns are then shaped by burning the edges with a candle. This burning process aims to harden the petal patterns and shape the petal curves. After that, arrange the petals into a flower. The flower is assembled by attaching each petal to the LED using hot glue (see **Figure 3**). After that, the LED is connected with a wire to form the stem. After the petals are attached, coloring is done. The paint can be acrylic or spray paint (see **Figure 4**).

Figure 3. The Process of making a flower petal and burning the edge of the pattern
Source: Author Documentation 2025

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Figure 4. Coloring Process
Source: Author Documentation 2025

Third Steps

The third step is installing optical fiber. The protective layer at the end of the optical fiber is removed with a cutting tool, allowing light to be emitted not only from the end but also from the edge. The optical fiber is then installed at the end of the LED. **Figure 5** shows the installation of optical fiber at the end of the flower, which will replace the visual stamen of the flower.

Figure 5. Installation of fiber optics on LED
Source: Author Documentation 2025

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Fourth Steps

The fourth step is to assemble the flower arrangement with the electrical circuit. The LEDs are connected to resistors, batteries, and switches. To make the LEDs shine brightly, resistors are installed on each LED. The circuits between the lights are made parallel. After that, tidy up the stems. The wires are wrapped with paper tape and then colored to resemble the real stems. To make the flowers look nicer, place them in a pot or an acrylic container (see **Figure 6**).

Figure 6. Installation of electrical circuits and Fiber flower that has been packaged in acrylic
Source: Author Documentation 2025

Through this community service activity, residents acquired the skills to create flower crafts from mineral water gallon waste using fiber-optic technology. Based on the evaluation, the community still needs assistance with the flower craft-making process, particularly with electrical wiring. The community tends to be more proficient at the petal-making and shaping stages and the flower petal assembly stage. It is hoped that this activity can continue and that new UMKM can be established in Gumpang Village.

Discussion

The results of community service activities indicate that training in making flower crafts from mineral-water gallon waste, combined with fiber-optic technology, has had a positive impact on the skills, knowledge, and environmental awareness of the Gumpang Village community. The residents' ability to process plastic waste into handicraft products demonstrates the successful application of the 3R principles within 3R-based waste management. This finding is in line with the national waste management policy that emphasizes waste reduction through reuse and recycling, as stipulated in the Peraturan Menteri Negara Lingkungan Hidup Nomor 13 Tahun 2012 tentang Pedoman Pelaksanaan Reduce, Reuse, dan Recycle Melalui Bank Sampah and Peraturan Presiden Nomor 97 Tahun 2017 tentang Kebijakan dan Strategi Nasional Pengelolaan Sampah Rumah Tangga dan Sampah Sejenis Sampah Rumah Tangga (Marlina, 2025).

From a technical skills perspective, the evaluation results show that the community was quicker to master non-technical stages, such as making and assembling flower petals. This indicates that creativity-based craft activities are relatively easy for the community to accept and adopt, as research shows that crafting from plastic waste is highly creative and manual-intensive (Astuti et al., 2022). However, the electrical

https://doi.org/10.17509/dedicated.v3i2.92823

circuit installation stage is a significant obstacle because it requires a basic understanding of electronics, including how resistors function and how LEDs work. This finding indicates a technical skills gap that needs to be addressed through ongoing mentoring and tiered training.

The integration of fiber-optic technology into flower crafts made from used gallons demonstrates the practical application of the reuse and recycling principles in 3R-based inorganic waste management. Plastic waste, previously considered valueless, is transformed into decorative products with aesthetic and economic value, supporting the view that inorganic waste can be used as a valuable alternative resource when managed creatively (Ratnaningsih et al., 2021; Insusanty et al., 2024). This finding reinforces the theory that 3R-based waste management not only reduces waste volume but also shifts public perception of waste from discarded material to valuable material.

From a creative economy perspective, the use of fiber optic lighting adds significant value to handicraft products. Simple innovations in design and function can enhance visual appeal, create product differentiation, and strengthen the competitiveness of plastic waste-based handicrafts in the market. This is in line with the concept of the creative economy, which places creativity and innovation as the main sources of added value, where the value of a product is no longer determined by its raw materials, but by its design, uniqueness, and additional functions (Astuti et al., 2022; Putra et al., 2022; Rahmawati et al., 2022). The integration of optical fibers as an aesthetic element also supports prior research, which finds that light-based technology can be used in unconventional ways to enhance the visual and commercial value of creative products (Bai & Tan, 2013; Chamoin et al., 2022; Chen et al., 2020).

From a community empowerment perspective, the high level of resident motivation to develop flower crafts as a business opportunity indicates that training activities have strengthened the community's capacity and confidence. Practical training enables the community not only to understand waste management and handicraft concepts in theory but also to acquire practical skills that can be developed independently. Additionally, using simple technology in community empowerment activities is more effective at improving program sustainability than applying complex technology (Rachmatsyah, 2025; Aji et al., 2024). This aligns with the theory of community empowerment, which emphasizes that increasing knowledge, skills, and active participation underpins economic independence based on local potential (Nuriramadhana, 2024).

The success of this activity was also influenced by the community's active participation at every stage, from training to product development discussions. Active collaboration between the KKN team and the community aligns with the principle of community service, enabling the community to adopt this simple technology (Yuliyanti et al., 2025). This participation strengthens the program's sense of ownership and creates opportunities to sustain activities through local MSME development. These findings align with research indicating that direct community involvement in empowerment activities significantly impacts attitude change, increases environmental awareness, and strengthens the community's social and economic capacity (Karmeli et al., 2020; Nurdin et al., 2023).

Overall, the results of this community service activity confirm that managing inorganic waste through innovative crafts based on simple technology is an effective and sustainable approach. This approach not only supports plastic waste reduction through the 3R principle but also strengthens community empowerment and community-based creative economic development.

CONCLUSION

The conclusion of the community service activities is that waste from the TPS3R in Gumpang Village can be used to produce fiber-optic flower crafts, which are expected to have high commercial value. The production of flower crafts is divided into five stages: making and shaping the flower petals, coloring, installing fiber optics, assembling the flowers, and assembling the flower arrangements with electrical

https://doi.org/10.17509/dedicated.v3i2.92823

circuits. The flower-making training was successfully conducted. The residents participated enthusiastically and produced the flowers well, but they still require guidance from the RG OLE and KKN teams during the electrical circuit installation stage.

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