



Triple helix synergy: Segregation of household hazardous and toxic waste in the Banjar Serasan community

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ARTICLE INFO	ABSTRACT
<p>Article history Received: 2023-06-04 Revised: 2023-06-12 Accepted: 2023-06-13 Published: 2023-07-20</p> <p>Keywords Climate action Hazardous and toxic waste Triple helix</p>	<p><i>As the human population increases, the need for daily living also increases. This has an impact on increasing the amount of waste produced, including hazardous and toxic waste. However, public awareness of managing hazardous and toxic waste is still low. Many people do not separate hazardous and toxic waste from other waste due to a lack of awareness and knowledge about hazardous and toxic waste management. Based on this background, this Community Service activity was carried out to socialize the segregation of household hazardous and toxic waste in the Banjar Serasan community. The method used in this activity is using a case study approach, pre-test, lecture, discussion, and post-test. Before the presentation of material from the resource persons, there were still participants who did not know what household hazardous and toxic waste was, its types, and how to manage it, namely 8 out of 18 participants. After the material was given, all participants managed to understand what hazardous and toxic waste was and ways to apply the management and application of reduce, reuse, and recycle in handling it. Through this activity, it is hoped that it can support increased education for the public regarding the issue of hazardous and toxic waste that is relevant to the SDGs points including point 13, namely climate action.</i></p>
<p>Kata Kunci Limbah bahan berbahaya dan beracun Tiga Heliks Penanganan Perubahan Iklim</p>	<p>Sinergi triple helix: pemilahan limbah Bahan Berbahaya dan Beracun (B3) rumah tangga di kalangan masyarakat Banjar Serasan. Seiring bertambahnya populasi manusia, kebutuhan hidup sehari-hari juga meningkat. Hal ini berdampak pada peningkatan jumlah limbah yang dihasilkan, termasuk limbah bahan berbahaya dan beracun. Namun, kesadaran masyarakat untuk mengelola limbah bahan berbahaya dan beracun masih rendah. Banyak masyarakat tidak melakukan pengelolaan limbah bahan berbahaya dan beracun dari limbah lainnya karena kurangnya kesadaran dan pengetahuan tentang pengelolaan limbah bahan berbahaya dan beracun. Berdasarkan latar belakang tersebut, kegiatan Pengabdian Kepada Masyarakat ini dilakukan untuk menyosialisasikan pemilahan limbah bahan berbahaya dan beracun rumah tangga pada masyarakat Banjar Serasan. Metode yang digunakan dalam kegiatan ini menggunakan pendekatan studi kasus, <i>pre-test</i>, ceramah, diskusi, dan <i>post-test</i>. Sebelum pemaparan materi dari narasumber, masih ada peserta yang belum mengetahui apa itu limbah bahan berbahaya dan beracun dari rumah tangga, jenisnya, dan cara pengelolaannya yaitu 8 dari 18 peserta. Setelah materi diberikan, seluruh peserta berhasil memahami apa itu limbah berbahaya dan beracun serta cara menerapkan manajemen dan penerapan <i>reduce</i>, <i>reuse</i>, dan <i>recycle</i> dalam penanganannya. Melalui kegiatan ini diharapkan dapat mendukung peningkatan edukasi kepada masyarakat terkait isu limbah bahan berbahaya dan beracun yang relevan dengan poin SDGs termasuk poin 13 yaitu penanganan perubahan iklim.</p> <p style="text-align: right;">Copyright © 2023, Patriani, et al This is an open access article under the CC-BY-SA license</p> <div style="text-align: right;">  </div>

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INTRODUCTION

One of the most studied and debated contemporary environmental issues is global warming and climate change (Loo et al., 2015). As the human population increases, the need for daily activities will also increase. This will also increase the amount of waste produced, including hazardous and toxic waste. According to the Law of the Republic of Indonesia Number 32 of 2009 concerning Environmental Protection and Management, hazardous and toxic materials, hereinafter abbreviated as hazardous and toxic waste are substances, energy, and/or other components which due to their nature, concentration, and/or amount, either directly or indirectly, can pollute and/or damage the environment, and/or endanger the environment, health, and the survival of humans and other living things (Savira Ersa et al., 2023). Meanwhile, hazardous and toxic waste is defined as the residue of a business and/or activity containing hazardous and toxic waste.

You probably think of driving less and turning off the lights when you consider mitigating climate change and lowering your carbon footprint, but did you know that the waste you produce also contributes significantly to the world's greenhouse gas emissions? Living a zero-waste lifestyle lowers your carbon footprint and prevents waste from going to the landfill (Huun, 2020). This includes hazardous waste.

The amount of household hazardous and toxic waste generation in Indonesia is still relatively small. It has been proven by previous research conducted in Sleman Yogyakarta that the daily generation of household hazardous and toxic waste is 2.44 grams per person or around 0.49% of the domestic waste produced. The largest composition of hazardous and toxic waste that is disposed of by the community is electronic waste 55% (Iswanto et al., 2016). In addition, another previous study was conducted in the city of Padang and found that the daily generation of household hazardous and toxic waste was 0.5 grams per person or around 1.09% of the waste produced with the largest composition of hazardous and toxic waste, namely body care waste of 51% (Ruslinda et al., 2020).

Hazardous and toxic waste can be understood as waste or waste containing toxic and hazardous substances whose nature and concentration can directly or indirectly damage the environment, interfere with health, and threaten the survival of humans and other organisms (Taufan & Purwanto, 2018). Hazardous and toxic waste can not only be generated from industrial activities. Household activities also generate some of this waste (Meirinawati et al., 2020). Some examples of hazardous and toxic waste from households include used room fresheners, clothes bleach, laundry detergent, bathroom cleaners, glass/window cleaners, floor cleaners, wood polishers, oven cleaners, insect repellents, glue, hair spray, and batteries (Dinas Lingkungan Hidup Kabupaten Buleleng, 2019)

In line with the above understanding, it is also explained in the Government Regulations of the Republic of Indonesia. Number 101 of 2014 concerning the Management of Hazardous and Toxic Waste, contains a complete list of hazardous and toxic waste both from unspecified sources, hazardous and toxic waste from specific sources, as well as hazardous and toxic waste from expired materials, spilled materials, hazardous and toxic waste that does not meet product specifications and used hazardous and toxic waste packaging. Hazardous and toxic waste is the residue of a business and/or activity.

Hazardous and toxic waste is generated from activities/businesses from the industrial sector, tourism, health services, and from domestic households (Fazzo et al., 2017). Due to the high level of toxicity associated with hazardous waste, its management and support from human resources are necessary to minimize the risk of environmental hazards (Supriyadi & Hadiyanto, 2018). Hazardous waste has become a significant problem with detrimental effects on both the environment and human health (Hasan et al., 2020). The environment and human health can be seriously harmed by the toxic materials found in electronic waste. This is due to the possibility of chemicals and materials like mercury, arsenic, cadmium, and lead being present in electronics. Particularly lead can harm the nervous system (Espinoza, 2020).

Hazardous and toxic waste can be classified into different categories based on their hazard level and source. The first categorization is based on the hazard category, which includes Category 1 and Category 2 waste. Category 1 waste refers to waste that has an acute and direct impact on humans and the environment. This category includes highly toxic chemicals, highly reactive substances, and infectious materials. On the other hand, Category 2 waste has a non-acute effect and causes indirect impacts. It typically exhibits sub-chronic or chronic toxicity, posing long-term risks to humans and the environment.

The second grouping is based on the source of the hazardous and toxic waste. Specific source waste originates from a particular industrial process and can be specifically determined. Examples of specific source waste include hospital waste and laboratory waste. This category is further divided into general specific sources and specific sources. General specific sources encompass waste from various specific sources within an industry, such as tanning process waste and activated carbon waste. Specific sources, on the other hand, include waste generated from specific industrial processes like copper slag and nickel slag. Non-specific source waste does not originate from the main industrial processes but rather from activities like equipment maintenance, washing, packaging, and descaling. Examples of non-specific source waste are used batteries, waste resin, electronic waste, and used lubricating oil. Additionally, there is a separate category for hazardous and toxic waste expired/spilled/used hazardous and toxic waste packaging, which includes materials like methanol, methacrylate, malononitrile, and others that have expired or have been spilled or used in packaging.

Understanding the hazard category and source of hazardous and toxic waste is crucial for effective waste management strategies. By categorizing these wastes, appropriate measures can be taken to handle, dispose of, and recycle them safely. This helps minimize the potential negative impacts on human health and the environment, ensuring a safer and more sustainable waste management approach.

Hazardous and toxic waste management must be done carefully due to its hazardous and toxic nature so that every individual or business actor who produces hazardous and toxic waste is required to manage the hazardous and toxic waste produce (Exposto & Sujaya, 2021). Storage, collection, transportation, use, processing, and landfilling are all aspects of managing hazardous and toxic waste (Nurlina, 2021). Every hazardous and toxic waste management activity requires a permit from the Regent/Mayor, Governor, or the Ministry of Environment and Forestry by applicable regulations to ensure proper implementation of hazardous and toxic waste management and to facilitate supervision (Maulidya, 2020). Even though the generation of household hazardous and toxic waste looks small, hazardous and toxic waste management is a very important thing to do. Because if it is not managed properly, hazardous and toxic waste containing toxic and hazardous materials can harm the health and survival of humans and living things, life, even to the surrounding ecosystem.

However, public awareness to manage hazardous and toxic waste is still very low. There are still many people who do not separate hazardous and toxic waste from other waste either because they do not care or because they do not have sufficient knowledge about hazardous and toxic waste management (Putri et al., 2022). This waste is harmful to humans especially if it is disposed of in the yard, it will contaminate plants and groundwater around the home environment (Utami & Syafrudin, 2018).

Based on this background, the Community Service (PKM) activity aims to socialize household waste sorting of hazardous and toxic waste in the Banjar Serasan community. This topic is relevant to the goal of SDGs in point 13, namely climate action because hazardous and toxic waste is a product of public consumption and has an impact on greenhouse gas emissions that affect climate conditions.

This Community Service activity aims to socialize the sorting of hazardous and toxic waste in the Banjar Serasan community. This activity has a positive impact related to point 13 of the SDGs, namely climate change to reduce greenhouse gas emissions. The positive contribution has given is to encourage people to reduce the consumption and purchase of hazardous and toxic waste, which will cause damage to the environment.

METHOD

Through an initial interview conducted by the PKM group with the head of RW 08 Kelurahan Banjar Serasan, Mr. Jun, it was known that residents still mix all types of waste which are then transported by the waste pick-up team from the Borneo Waste Bank using Tossa, so the waste still must be sorted again. Handling unmanaged waste with the principle of segregation, especially hazardous and toxic waste, can cause environmental pollution of water, soil, and air and poses a risk to the health of the surrounding community. The risk is even greater given the location of the residential area of RW 08, Banjar Serasan Village, which is on the banks of the Kapuas River, as can be seen in Figure 1.

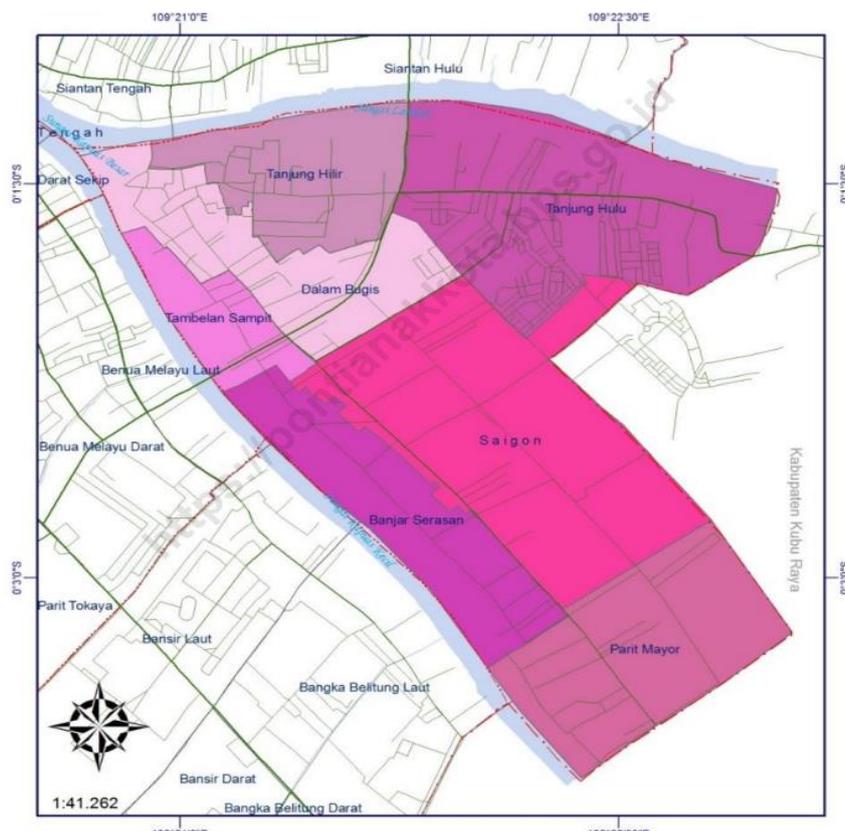


Figure 1. East Pontianak district map (BPS Kota Pontianak, 2021)

The method used in this Community Service activity is by holding socialization and the practice of sorting household hazardous and toxic waste in RW 08, Banjar Serasan Village, East Pontianak District, Pontianak City, West Kalimantan Province. This community service is divided into several phases, namely the preparation stage, field survey, implementation, and evaluation of activities.

The preparatory phase of the program was carried out for one week. This preparation includes forming a PKM team and carrying out the division of tasks for implementing PKM activities. The team contacted resource persons who would fill in the PKM materials and coordinated with the head of the local RW who is also the founder of the Borneo Waste Bank. After that, the team coordinated with the local RW in determining the activity location, setting the implementation time, and looking for participants who would take part in the PKM activities.

Based on the data obtained, the community service team conducted a review and made direct observations at the location before carrying out the community service. It is intended that the PKM team obtain accurate information about the conditions and problems that exist in RW 08, Banjar Serasan Village.

The implementation of community service begins with a lecture session. The speaker explained material on education on toxic and hazardous waste and education on handling hazardous and toxic waste. This was followed by a discussion session which was held to respond to and answer various questions from the participants. Then there was a pre-test and post-test questionnaire filling session to find out the participants' understanding. The team will distribute questionnaires that must be filled in by participants at the beginning and end of the PKM activity. The results of the answers in the initial evaluation of the participants aimed to find out the level of knowledge of the participants before getting the material about hazardous and toxic waste. After the presentation and question and answer session is over, the participants will be re-evaluated. While the post-test was carried out to measure the level of understanding of the participants after following the socialization of the material that had been delivered.

RESULTS AND DISCUSSION

The waste sector makes a major contribution to greenhouse gas emissions in the form of methane (CH₄) and carbon dioxide (CO₂) emissions. The large number and growth of Indonesia's population, as well as the consumption pattern of society as it is today, will cause the amount of waste and domestic waste to increase from time to time which will affect global climate change (Rahmat et al., 2019). Community consumption patterns will also affect the material composition of the waste and waste content, including the content of materials that are difficult to decompose naturally, and the content of materials that endanger human health and the environment. If no one pays attention to this issue, we will feel the negative impacts of climate change in the not-too-distant future, such as increasingly extreme weather, rising water levels, natural disasters such as floods, and so on (Abbass et al., 2022).

The household hazardous and toxic waste management paradigm itself then requires individual awareness and responsibility in minimizing the environmental impact of using hazardous materials at home. This paradigm emphasizes preventive actions by reducing the use of hazardous materials and choosing alternatives that are more environmentally friendly (Dinas Lingkungan Hidup dan Kehutanan Provinsi Daerah Istimewa Yogyakarta, 2019).

Several actions that can be taken in managing household hazardous and toxic waste include: First, reducing the use of hazardous materials. Look for alternatives to materials that are more environmentally friendly such as cleaning products that are safe and free of harmful chemicals. Reducing the use of hazardous materials can also help reduce the amount of hazardous and toxic waste produced. Second, is doing segregation of hazardous and toxic waste. Segregate hazardous and toxic waste from normal household waste and collect it in a safe place and keep it away from children and pets. Dispose of hazardous and toxic waste immediately in a disposal site permitted by the government. Third, recycling several types of hazardous and toxic waste such as batteries and incandescent lamps can be recycled. Choose the nearest recycling site and make sure they accept the type of hazardous and toxic waste you have.

Furthermore, hazardous chemicals used in households should not be discharged into waterways because they can contaminate groundwater and surface water. These materials must be stored in a safe place and disposed of in an appropriate disposal area. Last, use products that can be recycled. When buying products, choose products that can be recycled or have environmentally friendly packaging. Thus, the resulting waste can be more easily recycled or treated properly.

Hazardous waste can originate from the industrial, tourism, health care, and domestic household sectors which have characteristics of being explosive, flammable, reactive, toxic, infectious, and corrosive (Faturrahman et al., 2021). Among other things, dangerous goods can be corrosive, flammable, explosive, spontaneously combustible, toxic, oxidizing, or water reactive. Different colored "diamond" symbols must be used to identify hazardous and toxic waste in the workplace (State Government of Victoria, 2018). The types and symbols of hazardous and toxic waste in Indonesia can be seen in Figure 2.



Figure 2. Hazardous and toxic waste trash symbols and labels
(Dinas Lingkungan Hidup Kabupaten Kulon Progo, 2022)

The household hazardous and toxic waste management paradigm must be an important concern for every individual because a clean and healthy environment will provide great benefits for our health and that of our families as well as environmental sustainability (Ferronato & Torretta, 2019). In addition, this management requires synergy that supports change for the community, one of which is through the triple helix synergy.

Triple Helix Synergy is a concept of collaboration between government, industry, and academia to promote innovation and sustainable economic growth. This concept can be applied in household hazardous and toxic waste management to reduce environmental impacts and promote technological innovation to overcome the problem of hazardous and toxic waste (Universal Eco, 2023).

Following are some examples of the Triple Helix synergy in household hazardous and toxic waste management. First, the role of government by providing regulations and policies that support better hazardous and toxic waste management of hazardous and toxic waste. This includes providing regulations on the use of hazardous chemicals and facilitating the management of hazardous and toxic waste by providing appropriate disposal sites. Second, the industry can participate in household hazardous and toxic waste management by producing chemicals that are safer and more environmentally friendly and looking for ways to recycle household hazardous and toxic waste to reduce environmental impacts. Third, as well as the role of academics. Academics can provide research and technological innovation for more effective and environmentally friendly household hazardous and toxic waste management. For example, technology to process hazardous and toxic wastes more efficiently or technology to reduce the use of hazardous chemicals in household products.

Through the Triple Helix synergy, government, industry, and academia can work together to reduce the environmental impact of household hazardous and toxic waste and promote environmentally friendly technological innovations. It can also help create sustainable economic growth through the development of more environmentally sound industries and innovative research.

Hazardous and toxic waste originating from the household sector is an active result of daily human activities that need to be managed properly so as not to cause harmful impacts on human life and environmental sustainability (Yilmaz et al., 2017). The mechanism for managing household hazardous and toxic waste that is carried out by most people is still simply mixed with non-hazardous and toxic waste household waste (Fikri et al., 2015). This is due to the lack of knowledge and awareness of the community itself regarding the impact of inappropriate household hazardous and toxic waste management. In addition, regulations for handling household hazardous and toxic waste are still not optimal (Fitranto, 2023).

Moving on from these problems, community service activities were then carried out to increase knowledge and awareness in the community so that they could understand and understand the importance of managing household hazardous and toxic waste. This activity was carried out for the community in RW 08, Banjar Serasan Village, East Pontianak District, Pontianak City. The choice of location and target was based on observations made by the team, namely that in the RW there was a Reduce, Reuse, and Recycle Waste Management Site which is a waste management system with technological innovations of a more effective and efficient waste chopper and compost sieving machine.

In the preparatory stage, the team held a meeting to discuss the division of tasks for implementing the activity. Next, the team contacted resource persons who would fill in the materials and coordinate with the head of the local RW who is also the founder of the Borneo Waste Bank. After that, the team coordinated with the local RW in determining the location

of the activity, setting the implementation time, and looking for participants who would take part in the activity. After that, the team conducted a data and literature search and then conducted a field survey to review and directly observe the location of the activities before carrying out the community service. It is intended that the PKM team obtain accurate information about the conditions and problems that exist in RW 08, Banjar Serasan Village. Figure 3 shows the documentation of coordination as well as observation of activity locations and Temporary Garbage Shelter 3R Borneo Pontianak.



Figure 3. Coordination with the head of RW 08 Banjar Serasan and observation of Temporary Garbage Shelter 3R Borneo Pontianak

The implementation of the next service begins with a pre-test session for participants. After that, it was followed by a lecture session by the resource person who presented material on education on toxic and hazardous waste and education on hazardous and toxic waste management. The presentation of the material was delivered by three speakers, namely Dr. Ira Patriani, S.IP., M.Sc., as head of the community service activities team and FISIP academic at Tanjungpura University, Junaidi, S.Sos., M.Sc., as head of RW 08 and Temporary Garbage Shelter 3R Borneo Pontianak administrator, and Hani Alfiani, S. Sc., as an environmental activist in the waste sector who is also the Director of the Tanjungpura University Student Waste Bank and staff at the Pontianak City Environmental Service (Dinas Lingkungan Hidup Kota Pontianak). After the presentation from the resource person, then a discussion session was held to respond to and answer various questions from the participants. The activity was closed with a post-test session and submission of testimonials from the organizers, RW heads, and participants. Documentation of the implementation can be seen in Figure 4.



Figure 4. Documentation of implementation of community service activities

Before the presentation of material from the resource persons, there were still participants who did not know what household hazardous and toxic waste was, its types, and how to manage it, namely 8 out of 18 participants. After the material was given, all participants managed to understand what hazardous and toxic waste was, as can be seen in Figure 5.



Figure 5. Comparison of participant's understanding of hazardous and toxic waste: (a) before activity; and (b) after activity

Thus, there is an increase in the knowledge of the participants regarding the management of household hazardous and toxic waste as seen from the results of the pre-test and post-test given. In addition, according to the participants, in their neighborhood, there are still no hazardous and toxic waste disposal containers. The management of household hazardous and toxic waste is carried out only through direct disposal to Temporary Garbage Shelter, Waste Banks, piled up at home, or in other ways, namely to Garbage Final Processing Site which can be seen in Figure 6.

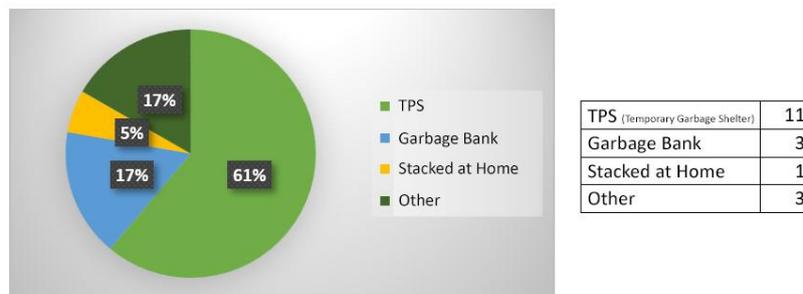


Figure 6. Where the community of RW 08 Banjar Serasan dispose of their household hazardous and toxic waste

The results of the pre-test and post-test given showed a change in the understanding and knowledge of the participants, namely the community of RW 08 Banjar Serasan regarding the management of their household hazardous and toxic waste from previously just throwing it away to being educated to carry out management according to the 3R principles. Management of hazardous and toxic waste requires the role of third parties such as the government and companies that already have permits from the Ministry of Environment and Forestry to handle hazardous and toxic waste. The equipment used for the destruction of solid hazardous and toxic waste used in certain places, such as in hospitals and companies, is an incinerator. Meanwhile, people at the household level can manage hazardous and toxic waste by sorting it according to the type of waste. For example, batteries, containers used for disinfectant, and broken glass can be collected and safely wrapped for disposal in Temporary Garbage Shelter or Garbage Final Processing Site. Meanwhile, waste such as used cooking oil and used oil can be collected in a container to be submitted to the Waste Bank.

The Waste Bank itself is a concept for collecting dry waste that has economic value, which is then sorted by management like banks in general. In the banking system, it is generally saved in the form of money. Whereas in the Waste Bank system what is saved is waste. But both still make money. In addition, the most important thing is the synergy between state actors, communities, academics, and companies in encouraging the formation of environmentally friendly behavior

(green lifestyle), namely an action or attitude directed at understanding the importance of a healthy, clean, beautiful environment and so on.

Ema Apriyani, a participant in this activity, said that she went from not knowing to knowing how to manage household waste properly and correctly. He also revealed that he just found out that there was a waste that could not be decomposed, namely styrofoam, even though previously when there were events, styrofoam was often used to wrap food. According to him, with this socialization, people can reduce or use other alternative materials in wrapping food that can be broken down and can start educating themselves first before passing on this new education to other people.

The head of RW 08 Banjar Serasan as well as the caretaker of Temporary Garbage Shelter 3R Borneo Pontianak, Junaidi, S.Sos., M.Sc., said that he welcomed and thanked the community service held by the Tanjungpura University FISIP PKM team. According to him, what was conveyed by the resource persons was very good and very useful to be implemented by the community or to be applied to the Waste Bank activities in RW 08.

Waste management has indeed become the main function of the government with its implementing agency in Pontianak City, namely the Environmental Service. In addition, the management cooperates with other agencies such as the Public Works and Public Housing Office and so on. However, the participation of the community to increase their awareness of waste management, including in this case 3R waste, is the main thing. Therefore, educating the community regarding its management is something that must be carried out simultaneously by stakeholders and through triple helix collaboration, namely by the government, academia, and the business sector which work together to support community development.

CONCLUSION

The conclusion we can draw is about the problem of improper household waste management of hazardous and toxic waste, which stems from a lack of knowledge and awareness in the community. Regulations on hazardous and toxic waste management are also considered not optimal. Responding to these problems, a community service initiative was carried out at RW 08 in Banjar Serasan Village to increase knowledge and awareness about the proper management of household hazardous and toxic waste. This initiative involves pre-test and post-test sessions, guest lectures, discussions, and testimonials. The results of the study showed an increase in participants' understanding of hazardous and toxic waste and its management, as well as the need for hazardous and toxic waste disposal containers in the surrounding environment. The students were educated about the 3R principles (reduce, reuse, and recycle), also emphasized the role of the government, companies, and individuals in hazardous and toxic waste management. The concept of a Waste Bank that collects and sorts dry waste that has economic value was also introduced.

Overall, this initiative aims to promote environmentally friendly behavior and promote a green lifestyle through collaboration between various stakeholders. The participants expressed their new knowledge and commitment to applying proper waste management practices and educating others. The head of RW 08 who is also the Temporary Garbage Shelter 3R Borneo Pontianak administrator appreciates this community service and knows the potential benefits for the community and the Waste Bank activities in RW 08.

The suggestions that our group gives for the improvement of the above conditions are as follows: (1) continuously making efforts to increase public awareness and knowledge about the management of household hazardous and toxic waste materials through the 3R principles through outreach, social campaigns, and education involving various stakeholders, such as the government, companies, universities, and the community; (2) optimizing regulations related to the management of hazardous and toxic waste including supervision and sanctions that are enforced; (3) collaboration and synergy between stakeholders to accelerate change towards environmentally friendly behavior and better management of hazardous and toxic waste; (4) development of Waste Banks as an effective solution supported by active education and community involvement; and (5) involving local institutions and communities, for example, involving environmental groups, women's communities, or youth groups.

Through the implementation of these suggestions, it is hoped that the community will have better knowledge and awareness regarding hazardous and toxic waste management, and be able to apply environmentally friendly practices in their daily lives. Collaboration between various stakeholders will also strengthen hazardous and toxic waste management efforts in comprehensive sustainable climate action.

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