The Hemisphere Project

Report Book

CONTENT

THE HEMISPHERE PROJECT

The Hemisphere Project is a social action project from Indonesia, dedicated to addressing the growing issue of plastic waste in our oceans and communities. This project focuses on research, raising awareness, promoting sustainable practice, and driving action that aims to support zero plastic waste. Through educational campaigns, innovative and continued research and development, and direct community engagement, the project seeks to contribute to environmental changes and create significant impact.

This report presents our one-year-long efforts toward contributing to environmental sustainability. Throughout the past year, we have been actively involved in various projects and campaigns designed to address plastic waste issues. The report provides an in-depth overview of the various work projects we have undertaken, the partnerships and collaboration we have fostered, and the achievements we have accomplished. Through this comprehensive review, the report highlights the scope and impact of our movement, reflecting the progress made in our mission to mitigate plastic waste and promote sustainable practice.

ACKNOWLEDGEMENTS

The Hemisphere Project would like to extend our deepest gratitude to all institutions, organisations, and foundations that have supported this programme. We are especially grateful to the IB Global Youth Action Fund through Festival of Hope, for their generous support of $1,512 USD towards our project's development. Furthermore, we extend our gratitude to Yayasan Ardhya Garini (Ardhya Garini Foundation), SMA Pradita Dirgantara (Pradita Dirgantara High School), Pusat Prestasi Nasional (Puspresnas) through Beasiswa Indonesia Maju (BIM), Direktorat SMA (High School Directorate), and Dinas Lingkungan Hidup Boyolali (Environmental Department of Boyolali) for their continued and full support for this project, which has been instrumental in achieving our goals and the success of this project.

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involvement and collaborative efforts. We are also grateful to our media and publication partners for their crucial role in promoting and expanding the reach of our project, contributing significantly to its expansion. Furthermore, we also wish to thank all the communities for their enthusiastic support and participation which have greatly enriched our project's impact on the environment. In particular, we gratefully acknowledge the assistance of the following organisations and communities that have assisted with the various phase of the programme:

our collaboration

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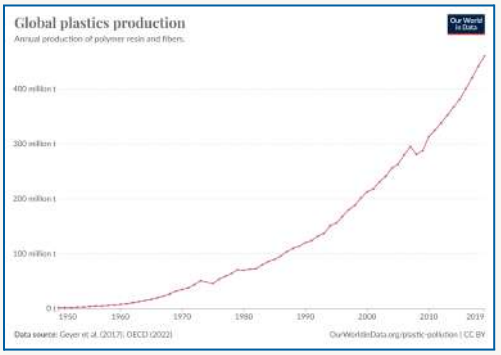
Introduction

In the past decades, plastic waste has become a major global issue with an alarmingly high scale of production and expanding amount of waste.[1] The rapid buildup of plastic waste has reached over 370 million tonnes of plastic, making up around 5-12% of the total global waste.[2] This growing problem demands urgent and immediate action to address the environmental challenges that arise.

A major contributor to this plastic waste problem comes from single-use plastic products. They are cheap, lightweight, and versatile, leading to high demands from various industries, such as for food utensils and packaging materials. This has led to an increase in production globally.[3] After their short-lived use, these plastics are frequently thrown away and end up in landfills or often mismanaged. This problem has led to an overwhelming accumulation of plastic waste and caused extensive damage to the environment.

Exhibit 1

From 1950 - 2019, global plastic production has escalated significantly, with over 100 million of plastic produced annually.[4]

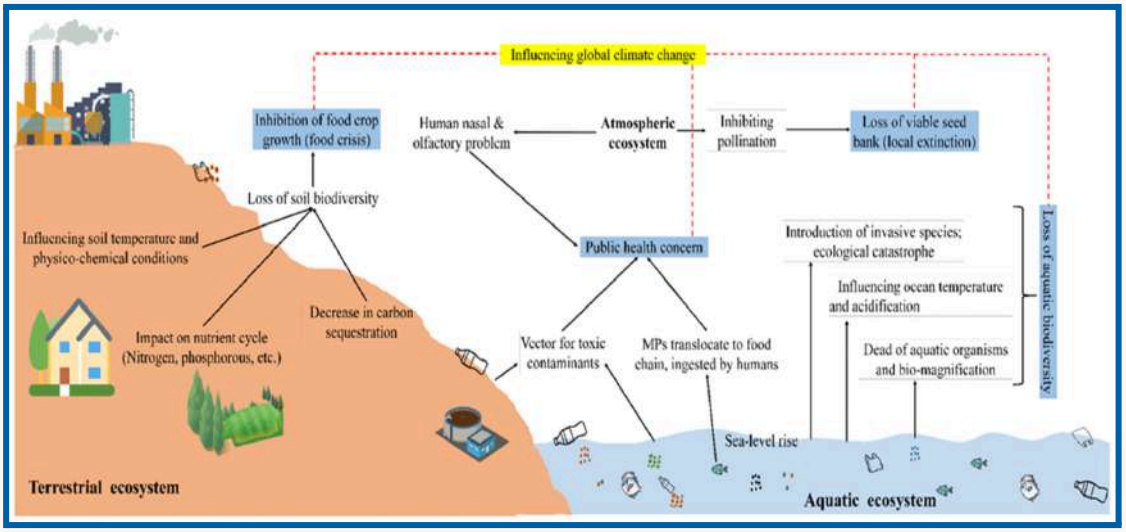


The significant buildup of plastic waste has a serious negative impact on the ecosystem, mainly by polluting the soil, air, and oceans. On land, plastic waste often ends up in landfills, where it can release toxic chemicals into the surrounding soil and have the potential to leach into groundwater or nearby water sources.[5] In the ocean, it affected both the ocean ecosystem and aquatic organisms by causing ingestion, entanglement, and chemical contamination.[6] On air, disposal of plastic waste often involves burning, a harmful process that releases dangerous substances into the air. The gas emissions have toxic effects on human environmental health.[7]

[1] Bidashimwa, D., Hoke, T., Huynh, T. B., Narkpitaks, N., Priyonugroho, K., Ha, T. T., Burns, A., & Weissman, A. (2023). Plastic pollution: how can the global health community fight the growing problem?. *BMJ global health*, *8*(Suppl 3), e012140. https://doi.org/10.1136/bmjgh-2023-012140
[2] Ziani, K., Ioniță-Mîndrican, C. B., Mititelu, M., Neacșu, S. M., Negrei, C., Moroșan, E., Drăgănescu, D., & Preda, O. T. (2023). Microplastics: A Real Global Threat for Environment and Food Safety: A State of the Art Review. *Nutrients*, *15*(3), 617. https://doi.org/10.3390/nu15030617
[3] Andrady, A. L., & Neal, M. A. (2009). Applications and societal benefits of plastics. *Philosophical transactions of the Royal Society of London. Series B, Biological sciences*, *364*(1526), 1977–1984. https://doi.org/10.1098/rstb.2008.0304
[4] Ritchie, H., Samborska, V., & Roser, M. (2023). *Plastic Pollution*. Our World in Data. https://ourworldindata.org/plastic-pollution
[5] Kibria, M. G., Masuk, N. I., Safayet, R., Nguyen, H. Q., & Mourshed, M. (2023). Plastic Waste: Challenges and Opportunities to Mitigate Pollution and Effective Management. *International journal of environmental research*, *17*(1), 20. https://doi.org/10.1007/s41742-023-00507-z
[6] Thushari, G. G. N., & Senevirathna, J. D. M. (2020). Plastic pollution in the marine environment. *Heliyon*, *6*(8), e04709. https://doi.org/10.1016/j.heliyon.2020.e04709
[7] Pathak, G., Nichter, M., Hardon, A., & Moyer, E. (2024). The Open Burning of Plastic Wastes is an Urgent Global Health Issue. *Annals of global health*, *90*(1), 3. https://doi.org/10.5334/aogh.4232

Exhibit 2

Macroplastics and nanoplastics are invading our environment and threatening three mediums: terrestrial, aquatic, and atmospheric environments.[8]



Plastic waste has disrupted our environment in multiple ways, causing extensive and widespread damage on a global level.

[8] Kumar, R., Verma, A., Shome, A., Sinha, R., Sinha, S., Jha, P. K., Kumar, R., Kumar, P., Shubham, Das, S., Sharma, P., & Vara Prasad, P. V. (202). *Impacts of plastic pollution on ecosystem services, Sustainable Development Goals, and need to focus on circular economy and policy interventions.* MDPI. https://www.mdpi.com/2071-1050/13/17/9963

Indonesia is one of the countries that has an alarming plastic pollution crisis. The country generates approximately 12.54 metric tons of plastic waste annually, with 3.22 metric tons poorly managed.[9] This issue is particularly concerning as the country has the highest diversity of reef and coral fish globally, which are vulnerable to the negative impact of plastic waste.[10]

The effect of plastic waste goes far beyond damaging the marine biodiversity and ecosystem; it also affects coastal and island communities that rely on vibrant marine ecosystems for their food, livelihoods, economic stability, cultural practices, recreational activities, and spiritual fulfilment.[11]

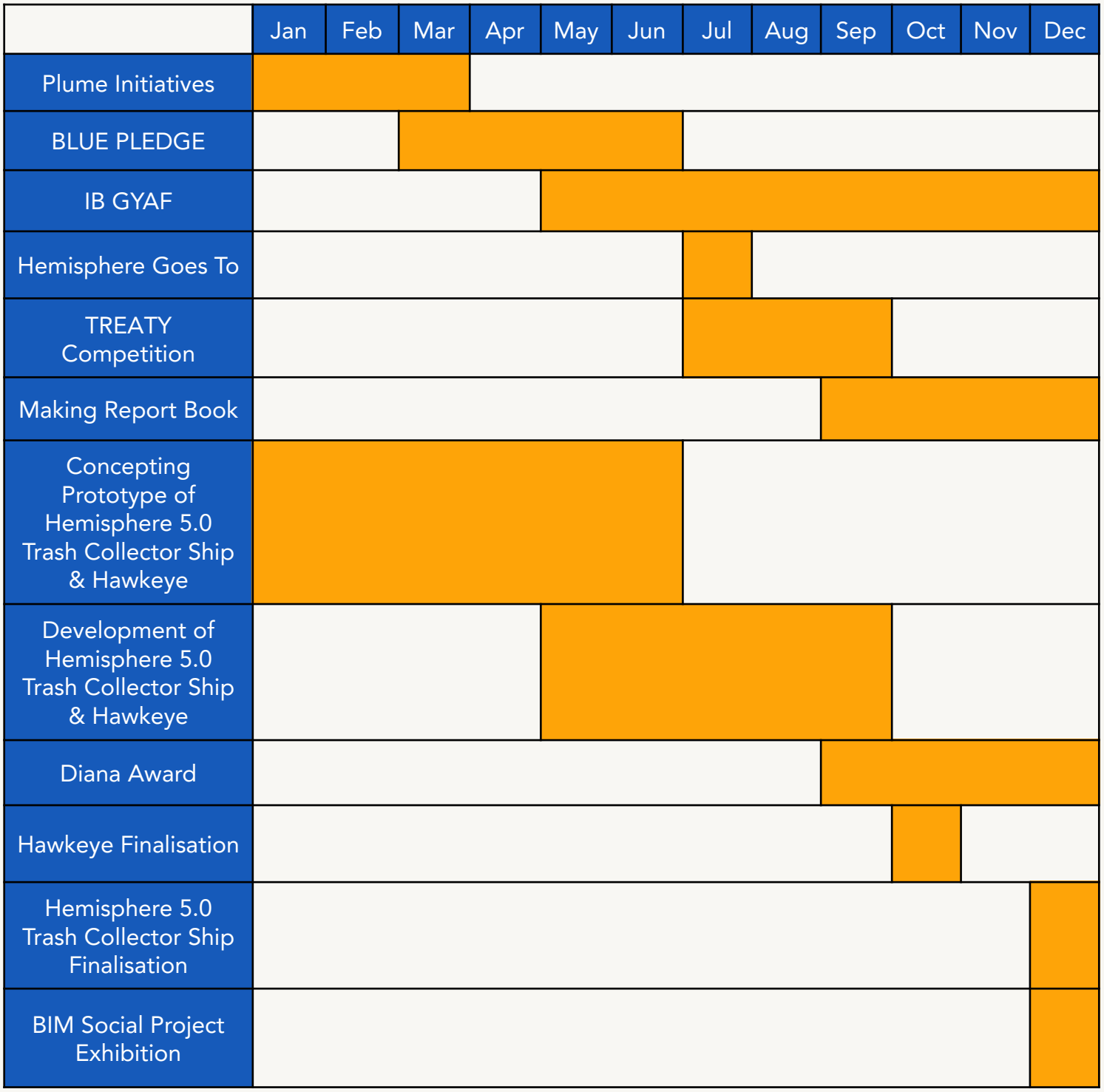
Following the urgency in addressing the plastic waste problem, The Hemisphere Project presents as a social action programme that aims to tackle the plastic waste issue in Indonesia as its main goal. This project embodies a proactive approach to tackling plastic pollution through innovative strategies and grassroots mobilisation. By harnessing the energy and creativity of youth, the Hemisphere Project not only raises awareness but also fosters community engagement and promotes sustainable practices. Its contribution is pivotal in driving both local and national efforts towards effective waste management and reduction. As the younger generation takes the lead, their commitment and actions are poised to catalyse broader change, offering a hopeful path toward mitigating Indonesia's plastic waste crisis and achieving long-term environmental sustainability.

[9] KLHK (2021) Sistem informasi pengelolaan sampah nasional (SIPSN). Capaian kinerja pengelolaan sampah. Kementerian Lingkungan Hidup dan Kehutanan. https://sipsn.menlhk.go.id/sipsn
[10] Hoegh-Guldberg, O. (2015). Reviving the Ocean Economy: the case for action. Google Scholar
[11] Phelan, A. A., Ross, H., Setianto, N. A., Fielding, K., & Pradipta, L. (2020). Ocean plastic crisis-Mental models of plastic pollution from remote Indonesian coastal communities. *PloS one*, *15*(7), e0236149. https://doi.org/10.1371/journal.pone.0236149

Overview of Our Approaches

The pie chart shows the distribution of our actions and works. The chart shows that 60% of our efforts goes to Social Action & Initiatives, such as PLUME Project and BLUE PLEDGE, which reflect our commitment to engage public participation and drive long-lasting impact within our community. The other 40% focuses on Research & Development programmes, including Hemisphere 5.0 Trash Collector Ship and Hawkeye, emphasising our dedication in creating innovative solutions to solve environmental challenges.

The Hemisphere Project's Timeline



The Rationale of Our Movement

The main objective of Hemisphere Project is to contribute in resolving Indonesia's plastic waste crisis while also supporting these following key initiatives:

SDG 12 (Responsible Consumption and Production)

The Hemisphere Project aligns with SDG 12 by promoting the 3Rs—Reduce, Reuse, Recycle. By encouraging these practices, we aim to optimise resource utilisation, minimise waste, and promote a circular economy, thereby reducing the environmental impact of our consumption

SDG 14 (Life Below Water)

The Hemisphere Project supports SDG 14 by tackling marine plastic pollution through targeted waste reduction strategies. By minimising plastic waste and promoting better waste management practices, we aim to protect marine ecosystems and preserve ocean health

Zero Waste 2030

The Hemisphere Project aims to help realise Zero Waste 2030 initiatives by creating programmes that foster waste reduction, promote recycling behaviour and engage communities in sustainable practice

Indonesia Clean Waste 2025

The Hemisphere Project aims to support achieving the Indonesia Clean Waste 2025 goal by developing innovative solutions that make a significant contribution in reducing our plastic waste

Beasiswa Indonesia Maju (BIM)

The Hemisphere Project is part of Beasiswa Indonesia Maju (BIM) project programme, which aims to empower Indonesia's youth by providing educational opportunities and a platform to address national issues. Aligning closely with BIM's mission, the project encourages collaborations between students, youth, and local communities to create sustainable and impactful solutions that benefit the environment

The Impacts & Frameworks

Collaborating with **Duta SMA (National High School Ambassador) in 37 provinces** through the hyrid campaign "BLUE PLEDGE" action againts plastic and fostering green school in **53 schools all across Indonesia**

Organising Trash to Treasure (TREATY) Competition 2024 with participation from over **30 Teams from SD Angkasa (Angkasa Elementry School)**, particularly focusing on the offline programme in SD Angkasa SMO

Securing project funding through international competition **Global Youth Action Fund IB Organization, Swiss** with the total up to **$1512 USD**

Partnering with Interact Rotary consisting of **10 volunteers** to help collect and donate **19 kg of plastic waste** to Bank Sampah Lintas Winongo dan Paste Lab

Supporting SMA Pradita Dirgantara in achieving the **Sekolah Adiwiyata Jawa Tengah 2024 (Adiwiyata School Award for Central Java)**

Utilising social media to connect with youths and communities, attracting **more than 1000 followers**, with each post generating between **100 - 1000 likes**, and accumulating up to **37,500 views** on Instagram

Our Social Action & Initiatives

Tackling the plastic waste problem demands more than individual effort—-it calls for the strength of community participation. Recognizing the pivotal role of communities, The Hemisphere Project creates social programmes that go beyond raising awareness. We aim to create hands-on public participation and foster creative collaborations, empowering each individual to take action on this problem. Through these initiatives, we strive to build a movement that drives lasting environmental change.

PLUME PROJECT
(Pradita's Lifelong Commitment to Unifying, Managing, and Educating on Plastic Use)

Our first project is based on the principle that every action, even a small one, can significantly impact the fight against the plastic waste problem. Through our observations, we have noticed that our school currently does not have proper waste management due to the absence of an effective waste bin that differentiates between various types of waste. That is the start of our first innovative waste bin project: PLUME (Pradita's Lifelong Commitment to Unifying, Managing, and Educating on Plastic Use).

In this project, we collaborate with Interact, an organisation affiliated with Rotary International that was established as a platform for students to become volunteers in various actions and activities, fostering empathy and awareness towards community issues. It marks the beginning of our collaboration with others in our movement for change.

THE PLUME WASTE BIN

Active socialisation

As a starting point, we conduct socialisation for all students and teachers in SMA Pradita Dirgantara on waste management practices, focusing on teaching the proper way to dispose of waste according to its type. This programme is routinely conducted to ensure good understanding of waste management. Afterward, we implemented a one-month trial of waste management practice in our school, in efforts to foster the habit of disposing of waste according to its types for all students and teachers in our school.

Sorting Waste

Our programme didn't stop there; we are also working on broadening the reach of this programme by sorting all the wastes we have collected. The result of this project will later be donated to Bank Sampah Lintas Winongo and Paste Lab, further expanding the scope of the PLUME Project.

Waste Donation

Through this programme, we have collected over 20 kilograms of waste and generated approximately 15 kilograms of plastic waste that will be donated. While this only marks our initial movement; we take great pride in what we have achieved through the PLUME Project. This represents our first milestone in motivating the community to actively participate and make a direct impact by donating the waste to several organisations. In the future, we aspire this programme to grow and create ongoing, meaningful impact on the community, fostering sustainability and greater involvement in waste management efforts.

BLUE PLEDGE

Young people are the **catalyst and pioneers** of their generation. Hence, **it is vital to engage the youth** in the effort of motivating their peers–and even beyond–to take action.

This is our special collaboration with **Duta SMA 2023** (National High School Ambassador 2023).

In this remarkable collaboration, we invite **34 ambassadors** from **34 provinces all across Indonesia** to take action in tackling the plastic waste problem.

We allow them to freely initiative their own action based on their creativity, encouraging their peers and other young individuals to become part of the movement.

From this collaboration, we hope to inspire and spread awareness to students and youngsters all across Indonesia about the waste problem.







LIKE, SHARE, AND ACT: EMPOWERING MOVEMENT ACROSS SOCIAL MEDIA

We recognise the powerful role social media plays in our modern world. Connecting millions of people worldwide, we use this platform to share impactful posts that become our online movement, whether through collaborative posts or webinars, we aim to raise awareness and address plastic waste problems.

Hemisphere Project x Muda Harus Beda (MHB)

We collaborate with Muda Harus Beda (MHB) to hold conversations about The Hemisphere Project, introducing ourselves to a broader audience and highlighting our objectives to empower youth in addressing and tackling plastic waste problem.

Hemisphere Project x IISMA Awardee

We collaborate with several IISMA awardees to address the impact of plastic waste on our mental health. Through collaborative Instagram posts, we want to raise awareness around the issues that are often overlooked in the discussion of the plastic waste problem.

Hemisphere Project x Sarasija

We collaborate with Sarasija, a youth organisation focused on sustainability and eco-green life. In this Instagram Live session, we discuss the role of youth in achieving SDG goals and tackling global issues, while emphasising on the importance of collaboration among youth to drive change for the environment and sustainability.

Hemisphere Project x Genali

We partnered with Genali, an organisation that served as a platform for aspirations for the young generation. In this discussion, we talk about how we deal with the climate crisis, emphasising on proactive action and collaborative efforts. We discuss the importance of renewable energy sources and implementing sustainable practices across various sectors, and inviting young people to participate and take action in the efforts against climate change.

HEMISPHERE GOES TO BANK SAMPAH LINTAS WINONGO

Bank Sampah Lintas Winongo is a local waste bank focused on waste management, operating in Bumijo Village, Jetis District, Yogyakarta. Established in 2008, this initiative aims to raise public awareness and encourage local participation in waste management by providing economic benefits to residents.

The concept was introduced to promote and persuade the community to implement waste management practices, enabling residents to independently sort and manage their waste at home.

"On March 2, 2024, HEMISPHERE visited Bank Sampah Lintas Winongo and donate **15 kg of plastic waste"**

Our visit served as an educational experience on waste management, facilitated by Bank Sampah Lintas Winongo. Through this partnership, we acquired valuable knowledge regarding best practices in waste management, such as sorting, recycling, and efficient resource utilisation.

This well-organised system has motivated us to adopt their method in our programme to increase sustainability and active public participation.

ADMINISTRATION

This division is responsible for collecting data from residents of Bumijo village who donate waste to the bank, as well as tracking the total amount received, focusing on accurate record-keeping.

This well-structured system, which emphasises organised and systematic process, has inspired us to develop a waste management guideline for the PLUME project that will serve as a foundation for its future development.

PLUME GUIDELINE BOOK

WASTE COLLECTION SITES

The waste collection team directly handles the waste donations from the local community, ensuring proper sorting and verification that the accepted waste complies with the bank's standards and for determining the value of each item donated.

It inspired us to create a more efficient record-keeping system, which ultimately led to the development of HawkEye, our revolutionary software design to track waste collection.

RECYCLING MANAGEMENT

This division focuses on processing waste collected from the community that are not accepted by the waste collection points (TPS). In response, Bank Sampah Lintas Winongo has developed creative solutions to transform this waste into useful and marketable products.

It motivates us to apply their recycling ideas, such as ecobrick, in our visitation to SD Angkasa. By adopting these ideas, we aim to educate others about the practical applications of plastic through our own creativity.

HEMISPHERE GOES TO PASTE LAB

Paste Lab is a local service that focuses on innovating waste by transforming it into high-value artistic products. Located in Ngaglik, Sleman, Yogyakarta, it converts waste into functional items like phone holders, glasses, chairs, and tables. These products are custom-made based on customer requests, catering to individuals, local restaurants, and well-known companies.

Established to reduce waste pollution in Yogyakarta, Paste Lab aims to turn discarded materials into modern, functional goods. In addition to product creation, it actively raises awareness about plastic pollution through educational activities and workshops, striving to inspire positive change in waste management within the local community.

> "HEMISPHERE donate **19kg** of plastic waste to Paste Lab"

Our primary goal for this visit is to explore and gain insight into the advanced method of recycling plastic, while also donating plastic waste as part of our PLUME project. Paste Lab is widely recognised for its creative and effective methods of transforming plastic into practical and marketable products. Their work exemplifies the significant role creativity plays in recycling plastic, demonstrating that it is not only an essential environmental practice but also economic opportunity.

Through this experience, we hope to learn valuable techniques and strategies that will help advance our mission of promoting sustainability and responsible waste management in our community.

"We believe this partnership has the potential to grow even further. Therefore, we are dedicated to fostering further collaboration which opens possibilities to distribute the plastic waste we produce to Paste Lab for their production needs, establishing a partnership and creating a circular business that benefits both parties."

- Nayla Faizha Efendi, Project Leader, The Hemisphere Project

TREATY (TRASH TO TREASURE) COMPETITION

In our efforts to support the campaign of plastic waste management and ecosystem preservation, we recognise the importance of raising public awareness and participation, particularly among the young generation. As the future leader of Indonesia, the young generation plays a key role in addressing environmental issues, hoping to bring Indonesia towards a more sustainable and environmentally conscious future.

The TREATY (Trash to Treasure) Competition is one of our initiatives to educate and increase young people's participation in plastic waste issues. This competition is designed for all students in SD Angkasa (Angkasa Elementary School) all across Indonesia and challenges them to creatively turn plastic waste into useful and marketable products, with the theme “Creative Innovation: Transforming Waste into Valuable and Marketable Product”.

The competition has successfully brought together approximately 33 teams from all over Indonesia. Each team has showcased its unique creativity in transforming plastic waste into something useful and has marketable value. Below are some examples of the impressive crafts created by our participants, highlighting the variety of repurposed plastics and the creativity of the students.

TREATY COMPETITION CRITERIA

Criteria	Percentage	1	2	3	4
Functionality	40%	The product does not have a clear distinct function and cannot be used	The product has a limited function or not a clear distinct function	The product has quite good function, but has limitation	The product has good function and can be utilise
Aesthetics	30%	The product does not have an attractive appearance and poorly made	The product has little attractive appearance, but poorly made	The product has quite attractive appearance and is well made	The product has strong attractive appearance and is well made
Effectiveness	30%	The product is not effective in delivering message align with the competition	The product is somewhat effective, but the message is unclear	The product is quite effective in delivering message align with the competition	The product is very effective in delivering message align with the competition

THE *WINNERS*

1.

SD Angkasa 9 Halim Perdanakusuma

2.

SD Angkasa 1 Husein Sastranegara

3.

SD Angkasa 5 Halim Perdanakusuma

4.

SD Angkasa 7 Halim Perdanakusuma

5.

SD Angkasa 1 Halim Perdanakusuma

We hope the TREATY Competition will empower children to raise awareness about waste issues while fostering their creativity in tackling waste issue challenges. By participating, we aim to encourage critical thinking and develop innovative solutions for environmental sustainability.

HEMISPHERE GOES TO SD ANGKASA

As part of our mission to encourage community participation in addressing the plastic waste problem and raising awareness, it has driven us to engage directly with the public. This led us to visit SD Angkasa (Angkasa Elementary School), where we focused on educating young children, as the next generation, to foster awareness about waste issues from an early age.

During our visit, we focused on one key aspect: educating through interactive play. We designed a variety of activities for students in 1st to 6th grade, making sure each activity was suitable for their age while conveying valuable lessons about plastic waste. To ensure the learning experience was engaging, we wrapped the educational content into fun games—such as plastic waste-themed colouring sessions for younger students, and more challenging, interactive station-based games for those in higher grade. This approach allowed the children to actively participate in an enjoyable and entertaining way while learning the significance of reducing and managing plastic waste. Through this hands-on experience, we hoped to educate about environmental responsibility in the upcoming generation.

School Cleanup

For our first activity, we divided the students into several groups and spread out across the school to collect plastic waste and other types of trash. We used this activity as an opportunity to educate the children about different types of waste by teaching them to sort trash according to its type, such as plastic waste, organic waste, and non-organic waste. Through this approach, we aimed

to raise the students' awareness of waste issues, starting from their immediate environment, while also helping them to learn about waste management practices.

Colouring Competition

To engage younger students, we organised a special activity specifically for the 1st and 2nd graders. We organised a colouring contest with a theme centred around the environment. While the children do the activity, we engage them in conversations, to make the activity more interactive. During these talks, we slipped an important message about the importance of reducing plastic waste and protecting our environment. The contest was designed to be fun and age-appropriate, making sure the message about caring for the environment was delivered in a way they could understand.

Ecobrick Station

For the older students, we created a more challenging activity that still included a fun and interactive element. We grouped the 4th to 6th-grade students into teams and had them move through several game stations. One of the stations was focused on ecobrick, where they worked together to create ecobrick by stuffing small cut-up pieces of plastic into a plastic bottle. The challenge was to make the ecobrick as hard as possible. While they worked, we took the opportunity to explain that the waste they were using came from everyday household items, such as shampoo packets, soap

wrappers, and plastic bags. Our goal was to increase their awareness about how much plastic is consumed in daily life and the importance of reducing plastic consumption. Through the ecobrick activity, we want to emphasise that plastic waste, when properly recycled, can be turned into something useful.

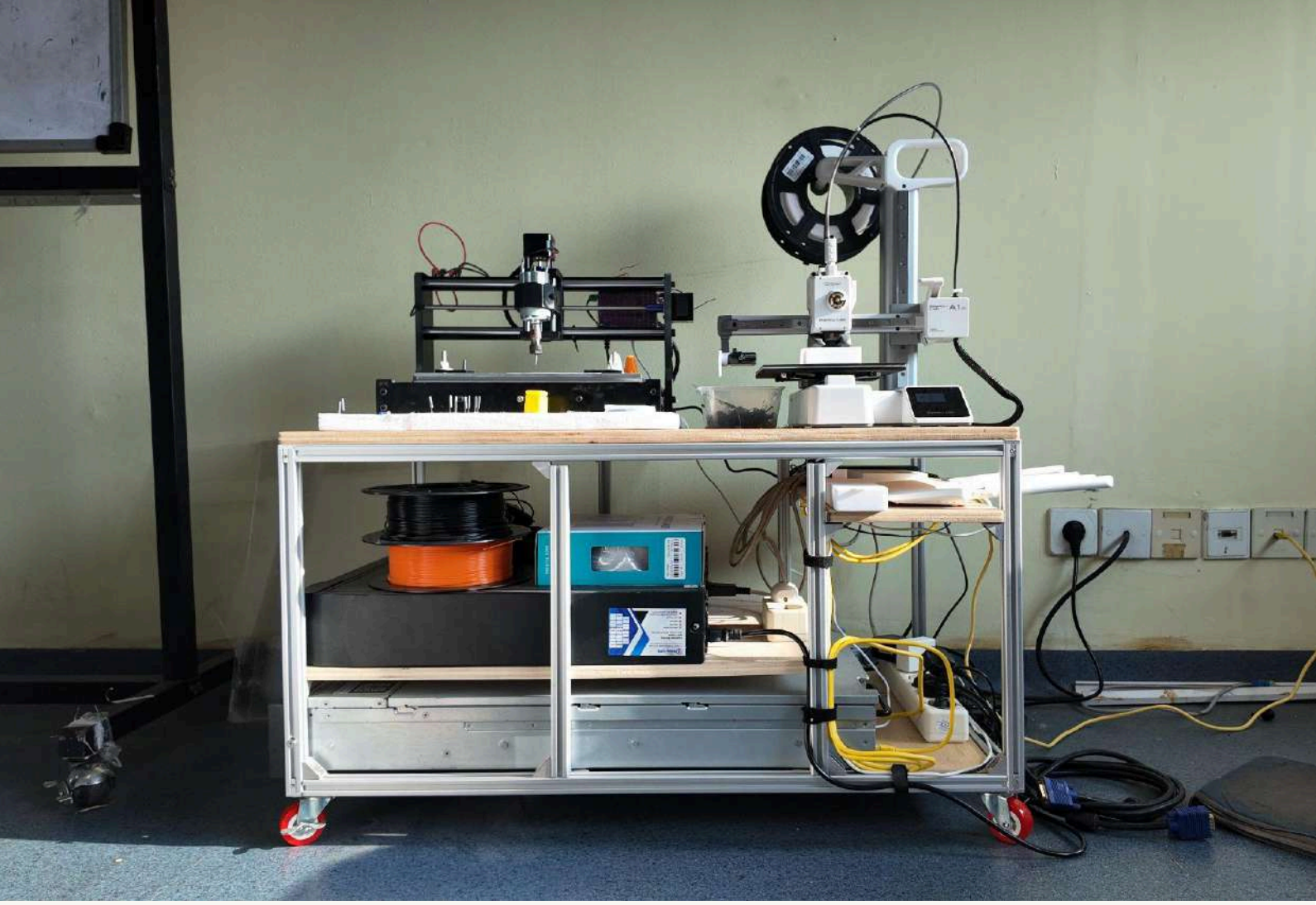
Plastic Station

The plastic station is designed to educate students about different types of plastic waste through simple and entertaining games. In this activity, several groups will compete to collect the most plastic waste and sort it according to its type. Students will also learn to build teamwork and communication in accomplishing this game. This activity serves as a practical application of the lessons they received earlier about various types of plastic waste. By making the learning process interactive and fun, we aim to develop students' ability to identify and differentiate between different

types of plastic waste. This approach encouraged students to engage actively with the subject matter, making it easier for them to retain and apply what they have learned.

Snakes and Ladders Station

The snakes and ladders station is an engaging activity aimed to evaluate the students' understanding of waste and environmental issues. Each student will play individually, competing to reach the highest ladder at number 100. Throughout the game, they will answer quizzes featuring questions about various environmental topics, such as what is the effect of waste on the ecosystem, how to reduce plastic consumption, and many more. This activity not only tests their knowledge surrounding environmental issues but also provides an opportunity to educate them in a fun and interactive manner. Our goal is to ensure that the students leave with a deeper understanding of environmental issues and simple practical solutions they could apply at home, hoping to inspire them to take action on this issue from a young age.



Hemisphere's Research & Development

The Hemisphere project reached far beyond social action; we advanced through research & development programs by creating innovative solutions. By harnessing the latest technologies and developing innovative approaches, we aim to use advanced tools that enable us to explore new ways to tackle plastic waste problems. Through our research efforts, we aim to revolutionise our approach for addressing environmental challenges and improving sustainability of future generations.

Hemisphere 5.0 Trash Collector Ship

Rivers are a major source of plastic waste in the oceans. It is estimated that more than 1000 rivers contribute 80% of global emissions, which range between 0.8 million and 2.7 million metric tonnes per year.[12] As a result, approximately 1.15 to 2.41 million tonnes of plastic waste enters the ocean through rivers.[13] This waste includes solid waste, macroplastics, and microplastics, all of which contribute to the growing pollution problem in aquatic environments.[14]

Image 1. River plastic emission to the world's ocean

This pollution problem has severely affected the environment, wildlife, plants, and humans. The accumulation of plastic waste drastically degrades water quality, severely polluted by toxic chemicals from industrial processes, posing a serious threat to aquatic life.[15] Additionally, rivers polluted by plastic waste lead to ingestion, suffocation, starvation, ultimately resulting in the death of marine life.[16] Water pollutants also have detrimental effects on human health, serving as a source of numerous

[12] Meijer, L. J. J., van Emmerik, T., van der Ent, R., Schmidt, C., & Lebreton, L. (2021). More than 1000 rivers account for 80% of global riverine plastic emissions into the ocean. *Science advances*, *7*(18), eaaz5803. https://doi.org/10.1126/sciadv.aaz5803
[13] Lebreton, L. C. M., van der Zwet, J., Damsteeg, J. W., Slat, B., Andrady, A., & Reisser, J. (2017). River plastic emissions to the world's oceans. *Nature communications*, *8*, 15611. https://doi.org/10.1038/ncomms15611
[14] Li, Y., Zhang, Q., Baartman, J., van Wijnen, J., Beriot, N., Kroeze, C., Wang, M., Xu, W., Ma, L., Wang, K., Zhang, F., & Strokal, M. (2023). The Plastic Age: River Pollution in China from Crop Production and Urbanization. *Environmental science & technology*, *57*(32), 12019–12032. https://doi.org/10.1021/acs.est.3c03374
[15] Hama Aziz, K. H., Mustafa, F. S., Omer, K. M., Hama, S., Hamarawf, R. F., & Rahman, K. O. (2023). Heavy metal pollution in the aquatic environment: efficient and low-cost removal approaches to eliminate their toxicity: a review. *RSC advances*, *13*(26), 17595–17610. https://doi.org/10.1039/d3ra00723e
[16] Thushari, G. G. N., & Senevirathna, J. D. M. (2020). Plastic pollution in the marine environment. *Heliyon*, *6*(8), e04709. https://doi.org/10.1016/j.heliyon.2020.e04709

diseases, such as diarrhoea, and increasing the likelihood of exposure to infectious and parasitic diseases.[17]

Despite the significant impact of waste pollution in rivers, efforts to address the issue remain limited and primarily conventional. The vast amount of plastic waste makes manual collection of waste impractical, mainly expensive, labour intensive, and limited supporting arrangements to facilitate waste collection.[18] Furthermore, more advanced methods, such as mechanical techniques (e.g. skimmers and booms), are not entirely effective and require high maintenance.[19] As a result, these current methods present a significant challenge in effectively reducing waste pollution in the river.

The growing production of waste, especially plastic waste, has outpaced current efforts to manage and reduce it effectively. As global consumption increases, massive amounts of plastic waste enter our ecosystem, particularly rivers and aquatic environments, and continue to increase at an alarming rate.[20] This situation highlights the urgency to develop advanced technology to address the river waste issue. In the efforts to manage this complex problem, such technology should go beyond removing waste; it must also support comprehensive data collection, long-term environment monitoring, and data-driven decision-making, ensuring long-term progress in the fight against the plastic waste problem.

As a result, it has driven us to create innovative technology specifically designed for managing and reducing plastic waste in the river. Thus, we proudly present the Hemisphere 5.0 Trash Collector Ship, a transformative technology developed to combat this urgent plastic waste

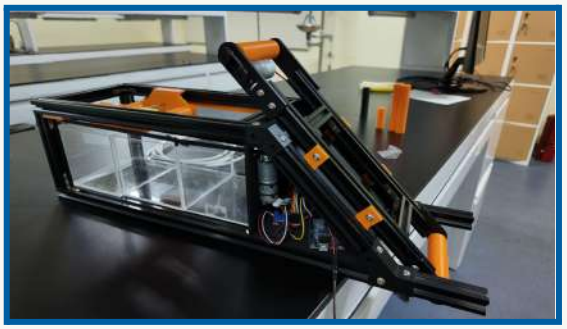
[17] Lin L., Yang H., Xu X., (2022) Effects of Water Pollution on Human Health and Disease Heterogeneity: A Review. https://doi.org/10.3389/fenvs.2022.880246

[18] Kibria, M. G., Masuk, N. I., Safayet, R., Nguyen, H. Q., & Mourshed, M. (2023). Plastic Waste: Challenges and Opportunities to Mitigate Pollution and Effective Management. *International journal of environmental research*, *17*(1), 20. https://doi.org/10.1007/s41742-023-00507-z

[19] Committee on the Effects of the Deepwater Horizon Mississippi Canyon-252 Oil Spill on Ecosystem Services in the Gulf of Mexico; Ocean Studies Board; Division on Earth and Life Studies; National Research Council. An Ecosystem Services Approach to Assessing the Impacts of the Deepwater Horizon Oil Spill in the Gulf of Mexico. Washington (DC): National Academies Press (US); 2013 Dec 20. 4, Oil Spill Response Technologies. Available from: https://www.ncbi.nlm.nih.gov/books/NBK201624/

[20] Kibria, M. G., Masuk, N. I., Safayet, R., Nguyen, H. Q., & Mourshed, M. (2023). Plastic Waste: Challenges and Opportunities to Mitigate Pollution and Effective Management. *International journal of environmental research*, *17*(1), 20. https://doi.org/10.1007/s41742-023-00507-z

problem. The Trash Collector Ship is an advanced IoT (Internet of Things) enabled autonomous vessel designed for river cleanup initiatives. This vessel operates independently to effectively and efficiently gather plastic waste and other debris from our waterways. The Hemisphere 5.0 Trash Collector Ship is a representation of our commitment to address the critical challenge of plastic waste in aquatic ecosystems, ultimately contributing to the preservation of our ecosystem and long-term sustainability.



The main components of the ship:

Trash barrier

- Functions to guide and redirect debris to its front collection area, located in the front of the vessel
- Designed to cover the width of the river, ensuring wide range of waste materials covered
- Ensuring waste collected efficiency and minimising impact on aquatic life and water flow

Slider

- Mechanical slider at the end of the conveyor distributes waste into storage bins
- Allocates debris to prevent overfilling of any single bins
- Ensures even distribution, optimising vessel's load balance
- Control waste flows to maximise operational time without frequent unloading

Container/ Trash Bin

- Multiple containers store debris for disposal and recycling
- Advanced sensors monitor fill levels of each container
- Automatic sensor send alerts when bin reach capacity for timely removal
- Automation prevent delays from overfilled bins
- Optimises workforce efficiency

IoT Connectivity

A key feature of this river cleanup vessel is its integration with Internet of Things (IoT) technology, which enables real-time monitoring, remote fleet management, and intelligent alert systems. The vessel is equipped with a suite of IoT-enabled sensors and communication modules that collect and transmit operational data to a centralised management platform.

Each vessel in the fleet is connected to a cloud-based network, allowing operators to monitor its status and performance remotely. This includes real-time updates on waste collection levels, operational efficiency, vessel location, and system diagnostics. The integration of GPS technology allows for precise tracking of the vessel's position, enabling fleet managers to coordinate the movement and positioning of multiple vessels across different sections of the river.

The system's IoT capabilities extend to automated alert generation. If a vessel experiences mechanical issues, overflows, or other operational anomalies, immediate notifications are sent to the maintenance team via mobile devices or computers. Similarly, when a waste container reaches its fill capacity, the sensors onboard communicate this data to the fleet management system, which can dispatch collection teams to empty the bins in a timely manner.

By utilising IoT technology, fleet operators can optimise the scheduling of maintenance, reduce downtime, and improve overall operational efficiency. Moreover, the ability to remotely monitor and control the fleet reduces the need for constant manual intervention, leading to significant cost savings and enhanced environmental sustainability. Over time, data gathered from the vessels' operations can also be analysed to identify patterns and trends, such as peak waste collection times, which can inform future strategies for improving waste collection efforts.

Hawkeye: Digital Revolution in Smart Waste Management Solution

BACKGROUND

Indonesia is one of the countries with an alarming plastic waste crisis that demands urgent attention. Every year, the country generates approximately 7 million tons of plastic waste, with around 4.9 million tons mismanaged and released into the environment.[21] This alarming situation resulted in Indonesia holding its position as the world's second-largest contributor to marine debris. The crisis is expected to worsen, with projections estimating that 3.4 billion tons of solid waste will be mismanaged by 2050.[22] This has severely polluted our environment and negatively impacted wildlife inhabiting it, all leading to animal death and the deterioration of health.[23] As a country with enriched diversity, Indonesia faces significant challenges in seeking innovative solutions and effective strategies to tackle plastic waste problems and protect our rich biodiversity.

One of the primary challenges in facing plastic waste issues lies in the lack of proper waste management. Effective waste management plays a role in reducing the toxic effects of plastic waste on both humans and the environment.[24] Furthermore, it can foster positive waste management behaviour and encourage people to adopt the 3Rs practice (reduce, reuse, recycle). A study by Chun T'ing L, et al. shows how human behaviour significantly influences the effectiveness of actions aimed at reducing plastic waste. The research reveals that households with better access to recycling facilities are more likely to adopt better recycling practices.[25] This suggests

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[21] Bagastyo, A. Y., Anggrainy, A. D., & Maharani Wiguna Hidayat Liang, M. S. (2023). Assessment of attitude and participation level among the households and local merchants toward single-use plastic waste management: A case study in Balikpapan Municipality, Indonesia. *Case Studies in Chemical and Environmental Engineering*, *7*, 100361. https://doi.org/10.1016/j.cscee.2023.10036

[22] Ardiansyah, Damar, A., Machfud, & Hariyadi, S. (2022). Roles and interrelation between variables : a study case of plastic waste management in Jakarta Bay. *Journal of coastal conservation*, *26*(5), 41. https://doi.org/10.1007/s11852-022-00888-x

[23] Ziani, K., Ioniță-Mîndrican, C. B., Mititelu, M., Neacșu, S. M., Negrei, C., Moroșan, E., Drăgănescu, D., & Preda, O. T. (2023). Microplastics: A Real Global Threat for Environment and Food Safety: A State of the Art Review. *Nutrients*, *15*(3), 617. https://doi.org/10.3390/nu15030617

[24] Adeniran, A. A., & Shakantu, W. (2022). The Health and Environmental Impact of Plastic Waste Disposal in South African Townships: A Review. *International journal of environmental research and public health*, *19*(2), 779. https://doi.org/10.3390/ijerph19020779

[25] Chun T'ing, L., Moorthy, K., Yoon Mei, C., Pik Yin, F., Zhi Ying, W., Wei Khong, C., Zhao Chern, G., & Zin Lin, T. (2020). Determinants of 3Rs behaviour in plastic usage: A study among Malaysians. *Heliyon*, *6*(12), e05805. https://doi.org/10.1016/j.heliyon.2020.e05805

that individuals are likely to implement the 3Rs concept and waste management practice if the necessary facilities are made available and more accessible. Therefore, it indicates how human behaviour plays a pivotal role in the challenges surrounding the plastic waste problem and its waste management.

Based on our observation, this signifies that understanding human behaviour is crucial in developing suitable and innovative solutions. This includes understanding the challenges individuals face when trying to implement waste management practices, as well as identifying the type of plastic commonly used, the frequency with which they integrate plastic in daily life, and the overall amount of waste typically produced. This behavioural pattern is important to observe because it can be the base for developing an innovative solution that is suitable with the community's problems and needs. However, only a few studies have explored these human behaviours, limiting our understanding of how to effectively address the plastic waste crisis with the appropriate solution.

Driven by our recognition of the major role human behaviour has in tackling plastic waste problem, we are inspired to create advanced technology that can support this analysis. This has led the Hemisphere Project to develop Hawkeye, an integrated and publicly accessible web app dashboard system that collects real-time data on the accumulation of waste from a variety of different waste bins. Through this technology, we aim to collect data on how people interact and handle plastic waste, which could pave the way for establishing the foundation for creating more innovative and effective solutions in tackling our waste problems. Through Hawkeye, we are driven to play a role in developing cutting-edge technologies aimed at contributing to tackling plastic waste issues in our country.

DISCUSSION

The Hawkeye system operates on two key functionalities. First, it analyses and reveals the patterns related to the waste accumulation within a community by providing a chart of the accumulated waste over the course of the day. Second, the dashboard functions as a tool for optimising waste collection routes. By centralising data on waste accumulation from various sources, this information can be used to identify optimal collection time and locations for collection trash. This targeted approach not only enhances operational efficiency but also contributes to more effective waste management practices within communities.

In the development of this technology, The Hawkeye IoT device is composed of a NodeMCU ESP8266 as the microcontroller, an Ultrasonic Ranging Module HC-SR04 as the sensor, and the enclosure of the IoT device was 3D printed using a Bambu Lab A1 mini. The sensor operates by calculating the "fullness" of a trash can by measuring the distance between the sensor and the trash accumulated in the trash can. The distance is then divided with the size of the trash can. As the distance between the sensor and the trash gets closer, the percentage of fullness gets larger.

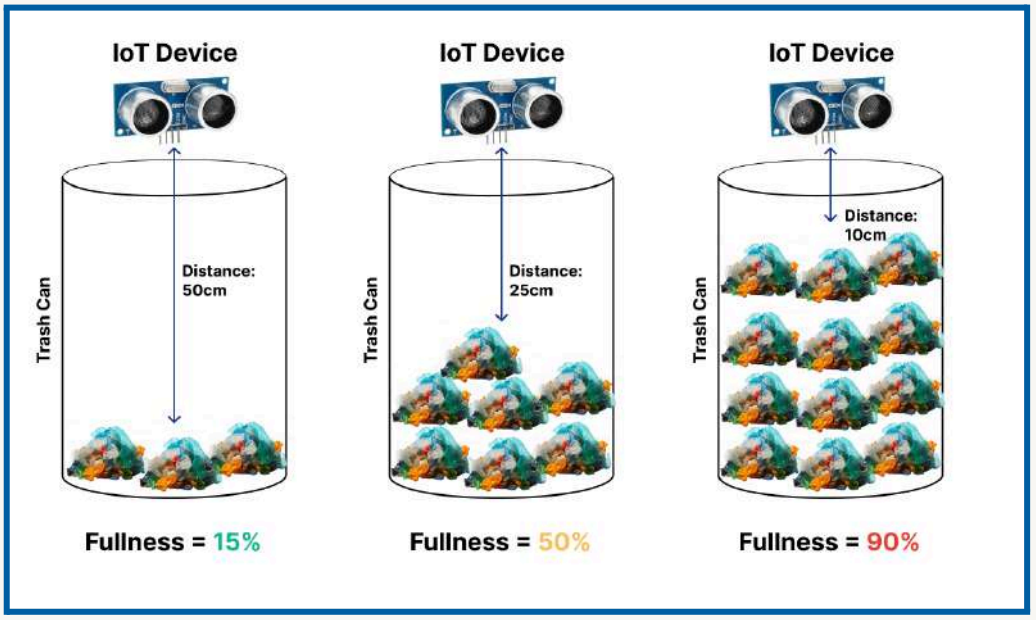


Image 1. Illustration of the sensor's operational mechanism

The microcontroller transmits data regarding the trash can's fullness via WiFi in one-hour intervals to the Hemisphere Project's server as the database. The system utilises two databases for effective data management. One, the influxDB, serves as the open-source time series database developed by InfluxData. This database allows collection of large data which can be easily accessed by timestamps (based on specific dates, time ranges, etc.)

There are two databases used in Hawkeye: For the database, we used InfluxDB, which is an open-source time series database developed by InfluxData. This database allows for the collection of large amounts of data which can easily be accessed by timestamps (based on specific dates, time ranges, etc.). This data stored will then be displayed in the monitoring dashboard available via hawkeye.hemisphereproject.com

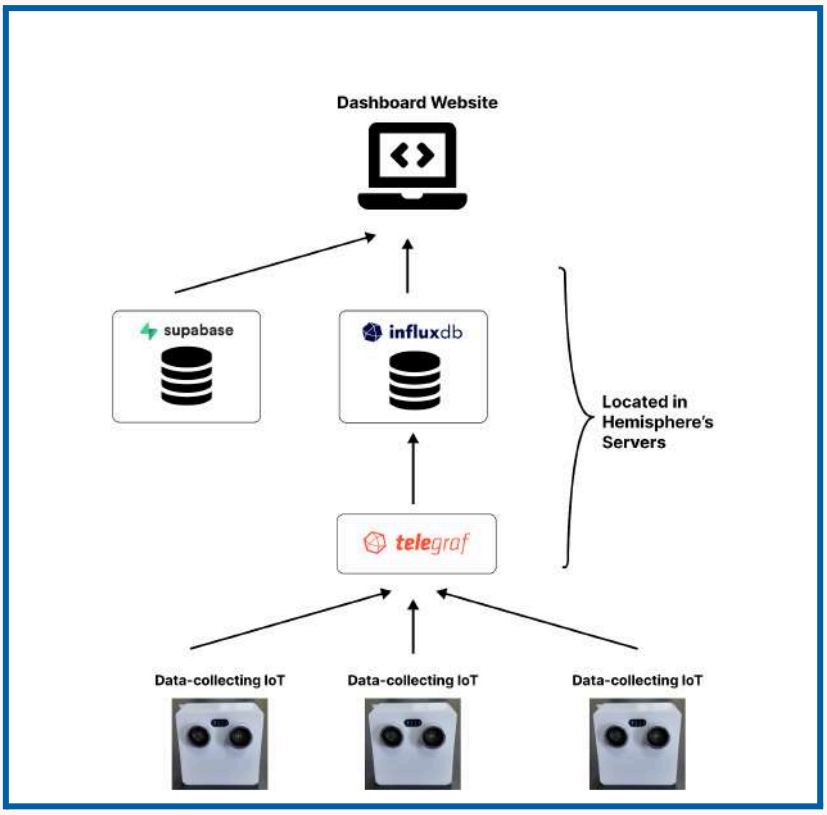


Image 2. Technology stack diagram

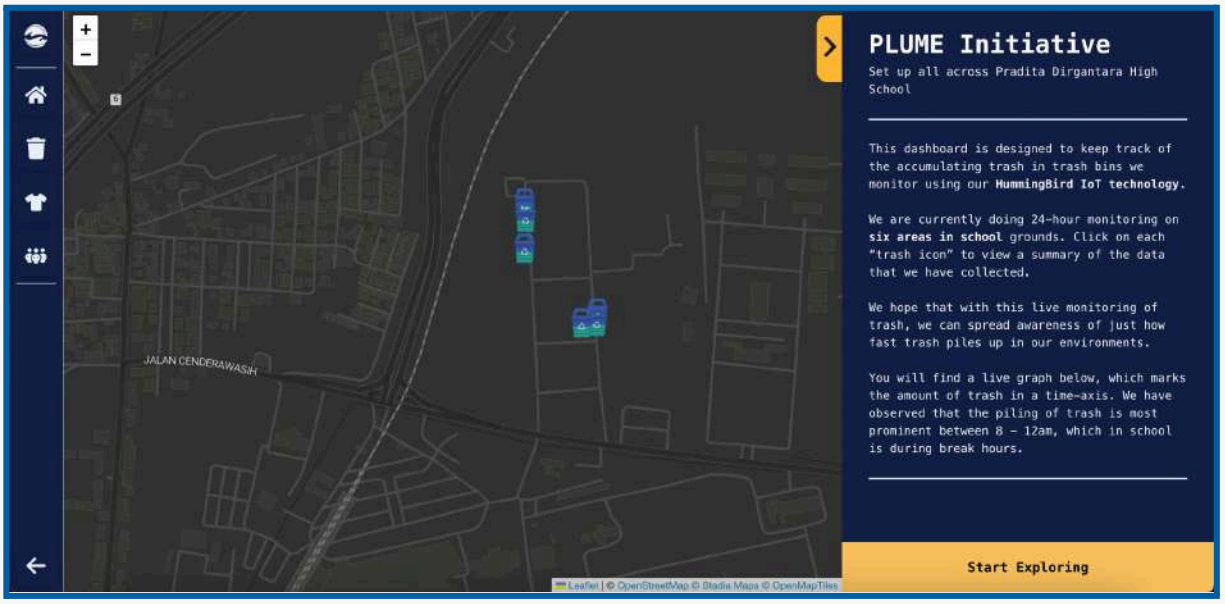


Image 3. Snapshot of the Hawkeye map dashboard website

The monitoring dashboard web app was developed using NextJS, an open-source web development framework created by Vercel, which allows for user-friendly static websites. The dashboard itself displays a map of all the trash cans that are currently being monitored by Hawkeye, and clicking on each map allows for the display of the trash can data.

Image 4. Front view of IoT device

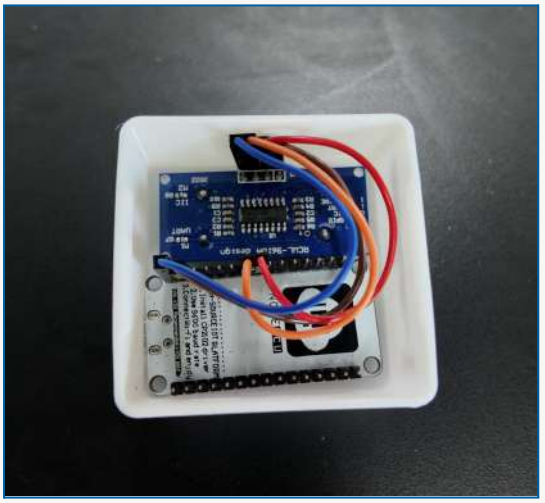
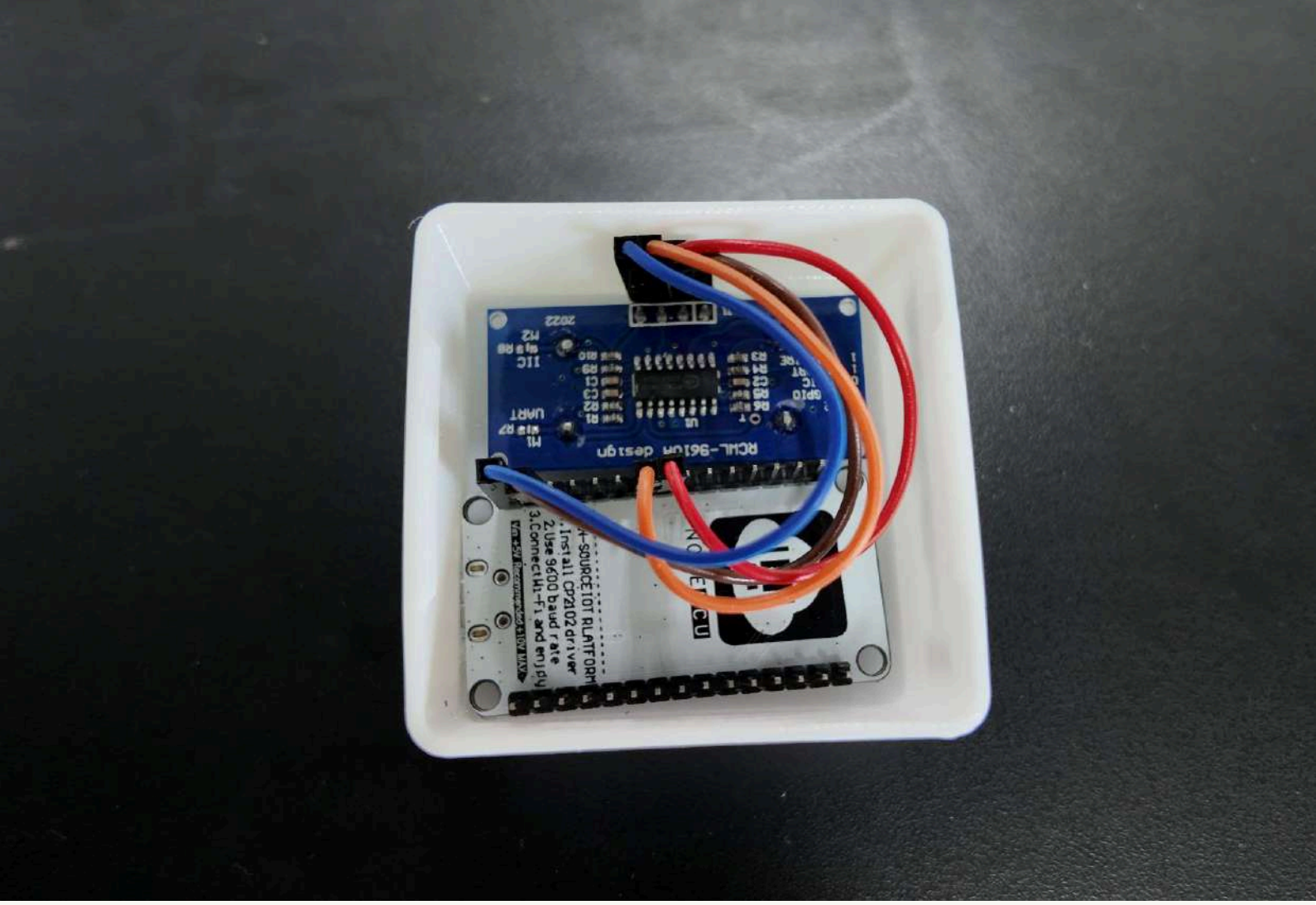


Image 5. Exposed back view of IoT device

Image 6. Example of trash can monitored by Hawkeye

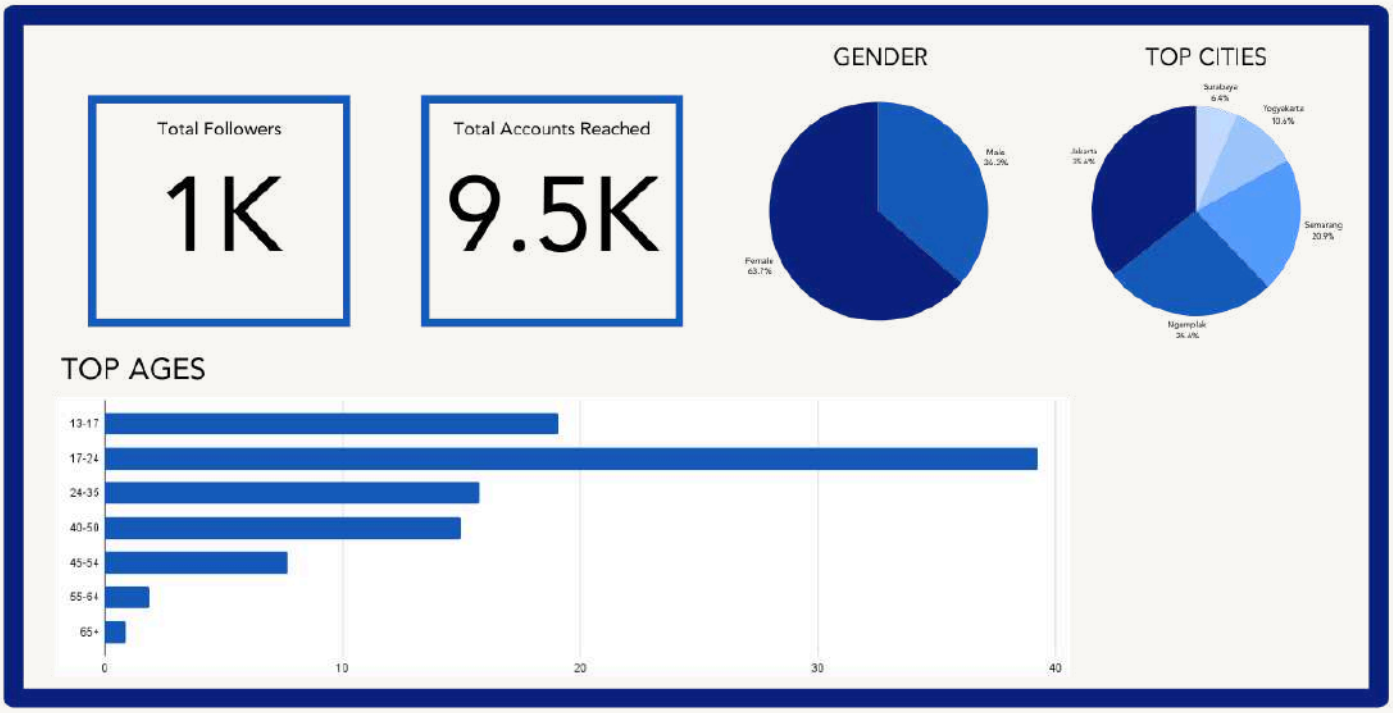
Image 7. Sample trash accumulation chart



The Hemisphere's Media & Website Engagement

We recognise the power of the internet and social media in our modern world. Embracing this dynamic, we are committed to utilising these platforms to create a powerful movement that engages people worldwide. By harnessing various social media platforms and establishing our own website, we aim to expand our outreach and connect with a broader audience. Together, we want to transform online engagement into real-world action.

INSTAGRAM REPORT



WEBSITE REPORT