DINAMISIA: Jurnal Pengabdian Kepada Masyarakat Vol. 8, No. 4 Agustus 2024, Hal. 1224-1232
DOI: https://doi.org/10.31849/dinamisia.v8i4.21902

Implementation of Shokyakuro-FTU Incinerator to process residual waste towards Unisba's zero-waste campus

Implementasi Incinerator Shokyakuro-FTU untuk mengolah limbah residu menuju Unisba *zero-waste campus*

Endang Prasetyaningsih[1], Yan Orgianus Najamudin[*2], Mohamad Satori[3], Hirawati Oemar[4], Putri Aulia Susilo[5],
[1,2,3,4.5]Universitas Islam Bandung
E-mail: endangpras@gmail.com[1], yorgianus@yahoo.co.id [2*], mohamad_satori@yahoo.com[3]
hirawatio@yahoo.co.id [4], putriass1203@gmail.com[5]

Abstract

Unisba's waste problem was solved by establishing a compost hut to sort organic, recyclable, and residual waste, which the Clean and Green Team managed. Organic waste is composted; recyclable waste is separated, cleaned, and sold to Bandung City's main waste bank; and residual waste is processed by a third party, i.e. the Cleaning Technical Unit (UPTD) Bandung City. Unisba has launched a long-term program to become a zero-waste campus by managing waste independently. Hence, Unisba is responsible for its own residual waste management. This study aims to implement the Shokyakuro-FTU Incinerator machine in processing residual waste at Unisba Campus 2 in Ciburial District, Bandung Regency toward Unisba's Zero Waste Campus program. The implementation process began with relocating the machine to Campus 2 Unisba Ciburial, followed by testing the machine to process residual waste, and finally training all cleaning staff at Campus 2 Unisba Ciburial using the Demonstration method and direct practice method. The trainer demonstrates how to operate the machine, and then the participants practice using it. The findings revealed that the participants had no difficulties operating the machine. The implementation concluded by providing the machine operating procedure to help cleaning staff operate the machine in the future.

Keywords*: residual waste, zero-waste campus, incinerator*

Abstrak

Permasalahan sampah di Unisba diatasi dengan mendirikan pondok kompos untuk memilah sampah organik, sampah daur ulang, dan sampah residu yang dikelola oleh Tim Clean and Green. Sampah organik dikomposkan, sampah daur ulang dipilah, dibersihkan, dan dijual ke bank sampah induk Kota Bandung, dan sampah residu diolah oleh pihak ketiga, yaitu Unit Pelaksana Teknis Kebersihan (UPTD) Kota Bandung. Unisba telah mencanangkan program jangka panjang untuk menjadi kampus zero waste dengan mengelola sampah secara mandiri. Oleh karena itu, Unisba bertanggung jawab atas pengelolaan sampah residunya sendiri. Studi ini bertujuan untuk mengimplementasikan mesin Insinerator Shokyakuro-FTU dalam mengolah sampah residu di Kampus 2 Unisba Kecamatan Ciburial Kabupaten Bandung menuju program Kampus Zero Waste Unisba. Proses implementasi diawali dengan relokasi mesin ke Kampus 2 Unisba Ciburial, dilanjutkan dengan uji coba mesin pengolah sampah residu, dan terakhir pelatihan kepada seluruh petugas kebersihan di Kampus 2 Unisba Ciburial dengan menggunakan metode Demonstrasi dan praktik langsung. Pelatih mendemonstrasikan cara mengoperasikan mesin, lalu peserta berlatih menggunakannya. Hasil temuan menunjukkan bahwa peserta tidak mengalami kesulitan dalam mengoperasikan mesin. Implementasi diakhiri dengan memberikan prosedur pengoperasian mesin untuk membantu petugas kebersihan mengoperasikan mesin di masa mendatang.

Kata kunci*: sampah residu, zero-waste campus, incinerator*

1. INTRODUCTION

The growing global awareness of environmental and sustainability issues has made the "Zero-waste" concept extremely relevant, particularly among higher education institutions. The Zero-waste Campus initiative aims to reduce the amount of waste that ends up in landfills by implementing reduction, reuse, and recycling (3R) strategies. This initiative not only benefits the

DOI: https://doi.org/10.31849/dinamisia.v8i4.21902

environment but also serves as a powerful educational tool for students and staff, inspiring more sustainable behavior change (Zaman & Lehmann, 2013).

Adopting a zero-waste strategy at a campus requires a commitment to sustainability and a circular economy perspective. This should be gradually integrated into university programs and routine actions. There are several options for developing a path that aligns universities with sustainability principles (Moreira & Rutkoskwi, 2021). The zero-waste program on campus entails various activities, including food waste management, recycling, and composting (Song et al., 2015), in addition to educational campaigns and campus community participation (Kaza et al., 2018). To establish a green campus, student involvement in producing organic fertilizer from campus and canteen waste is necessary, as demonstrated at Lancang Kuning University (Sari et al., 2018). The campus community can benefit from zero-waste processing education, which is already being implemented in the Jakarta Coastal Area (Wijaya et al., 2024). Furthermore, implementing zero-waste on campus can reduce operational costs over time and create a healthier learning environment (Cox et al., 2010).

Many campuses around the world are beginning to embrace this idea as part of their commitment to sustainability. The University of Massey in New Zealand led the NIZAC - Nexus for International Zero-waste Academic Collaboration, while three Santa Catarina universities in Brazil created NIZAC Brazil in 2018 (Mason et al., 2003). The collaboration included the University of Massey, UNICAMP, and PUC from Rio de Janeiro (Moreira & Rutkoskwi, 2021). Several campuses in Indonesia have also implemented a zero-waste strategy, including ITB and UII. ITB applies the Masaro system to generate zero waste. Instead, it produces, primarily used in agriculture, livestock, and fishery, promoting a circular economy with zero-waste (Abidin et al., 2023). FCEP (Faculty of Civil Engineering and Planning) Universitas Islam Indonesia (UII) has implemented a zero-waste program since 2016, but in 2018 only 80% were aware. Despite 20% not understanding, the majority support the program (Kasam et al., 2018).

Several previous studies have shown waste management steps through a structured approach that includes several main activities aimed at optimizing the waste management process such as education, and collaboration with local initiatives (Popescu, et. al, 2016). Diponegoro University manages the collected waste in 3 ways that can be done, namely by piling it in one place, combining it, and the last is recycling it (Fadhillah et al, 2011) while the Muhammadiyah University of Mataram minimizes waste and maximizes recycling and composting of waste with an integrated management system with the concept of zero waste 3R (Reduce, reuse, recycle) 4R or 5R (Rahmawati et al, 2021). The use of incinerators as a tool for destroying waste residue has been applied in several places such as the Sukawinata Palembang TPA (Dewi, et. al, 2020), Mustika Ikhlas TPST (Utami et al, 2022), Cempaka Waste Bank (Muldiani, 2024), Universitas Galuh, Ciamis Campus (Abid, et. al, 2023).

In the long-term program, Universitas Islam Bandung (Unisba) will implement independent waste management based on the Zero-waste Campus principle. This is consistent with the City of Bandung's current policy of limiting waste disposal to landfills, so the waste problem has become a challenge for the Unisba Eco Campus program. To achieve this, Unisba has established the Unisba's Clean & Green Team. Unisba has two campuses: Campus 1, located on Jalan Tamansari 1, Bandung City (Campus 1 Unisba Tamansari), and Campus 2, located in Ciburial Village, Cimenyan District, Bandung Regency (Campus 2 Unisba Ciburial). Almost all teaching and learning activities take place on Campus 1 Unisba Tamansari, except for Islamic boarding schools (pesantren) for students/graduates and pre-service for new lecturers/education staff, which take place on Campus 2 Unisba Ciburial.

Unisba's Clean & Green Team was established to manage waste generated on Campus 1 Unisba Tamansari. Organic waste is converted into compost at Unisba's Compost Hut using the "Bata Terawang Composter," a rectangular tub made of red brick with holes and a 4-inch pipe (see Figure 1). Meanwhile, valuable recyclable waste is sorted and cleaned at Unisba's compost hut

DOI: https://doi.org/10.31849/dinamisia.v8i4.21902

before being sold to the Bandung City Main Waste Bank. The UPTD Bandung City then transports the residual waste twice a week.

Meanwhile, waste management at Campus 2 Unisba Ciburial is currently carried out by burning it in a rubbish box made of brick buildings (see Figure 2), following the separation of marketable waste. Given that Campus 2 Unisba Ciburial is only occasionally used for activities, the majority of the waste generated is from tree leaves and twigs. Except for large-scale events, there is relatively little organic waste. The land on Campus 2 Unisba Ciburial is quite large, so it could be used to manage residual waste from Campus 1 Unisba Tamansari. This has encouraged the Unisba Industrial Engineering Study Program's Community Service Team to work with Unisba waste managers to manage residual waste, which is currently handled by UPTD Bandung City to achieve a Zero-waste Campus.

Campus I Unisba Tamansari currently generates approximately 563 kg of waste per day (see Figure 3), of which 20 kg is organic waste processed into compost, 12 kg is waste suitable for recycling processed by the waste bank, and 531 kg is residue transported to landfill. Meanwhile, when there are activities, Campus 2 Unisba Ciburial generates approximately 300 kg of waste per day, with only 2% of it being saleable, so the remainder is burned. Meanwhile, when there are no activities, Campus 2 Unisba Ciburial generates only about 10 kg of waste, the majority of which is garden waste.

Figure 1. Bata Terawang Composter

Figure 2. burning of waste at Campus Unisba

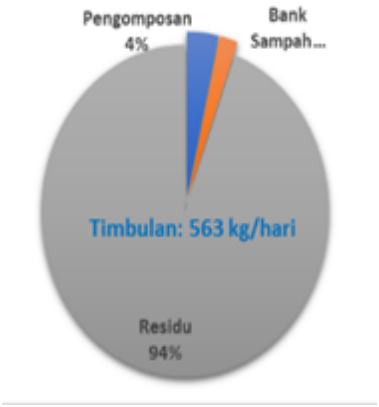

Figure 3: waste at Unisba Campus I

Organic waste includes kitchen waste, rotten fruit and vegetable peelings, food leftovers, leaves and garden trimmings, straw and hay, crop residues, and so on. Solid waste contains non-organic components such as glass, coal and cinders, ash, stone and bricks, plastics, rubber, and ferrous and non-ferrous metals (Merrington et al., 2010). Meanwhile, residual waste consists of recyclable and recoverable waste (Maria et al., 2013), such as used tissue, damaged plastic packaging (torn, dirty, or destroyed), and used packaging of coffee, instant noodles, etc.

In 2022, Unisba received an incinerator machine grant from Hikari Shoji, a Japanese incinerator machine manufacturer, which was later patented under the name Shokyakuro-FTU Incinerator machine. Based on the results of trials at the Cicabe Recycling Centre (PDU), Bandung City, and evaluations conducted, this machine still requires several modifications to its components and structure to adapt to machine conditions in Indonesia. As a result, it is necessary to relocate the machine to Campus 2 Cibural Unisba for additional research and development. This prompted the Unisba Industrial Engineering Study Program's Community Service team (Unisba PKM EI Team) to install the Shokyakuro-FTU Incinerator machine at Campus 2 Unisba Ciburial as a waste processor for Campus 1 Unisba Tamansari, which is managed by the UPTD Bandung City. This implementation is expected to be the first step towards developing environmentally friendly incinerator machines and establishing a Zero-waste Campus. Figure 4 shows the Shokyakuro-FTU Incinerator machine.

DOI: https://doi.org/10.31849/dinamisia.v8i4.21902

This study aims to implement the Shokyakuro-FTU Incinerator machine to process the residual waste from Campus 1 Unisba Tamansari by relocating the machine from PDU to Campus Unisba 2, training the cleaning staff who will operate the machine and provide the machine operating procedure.

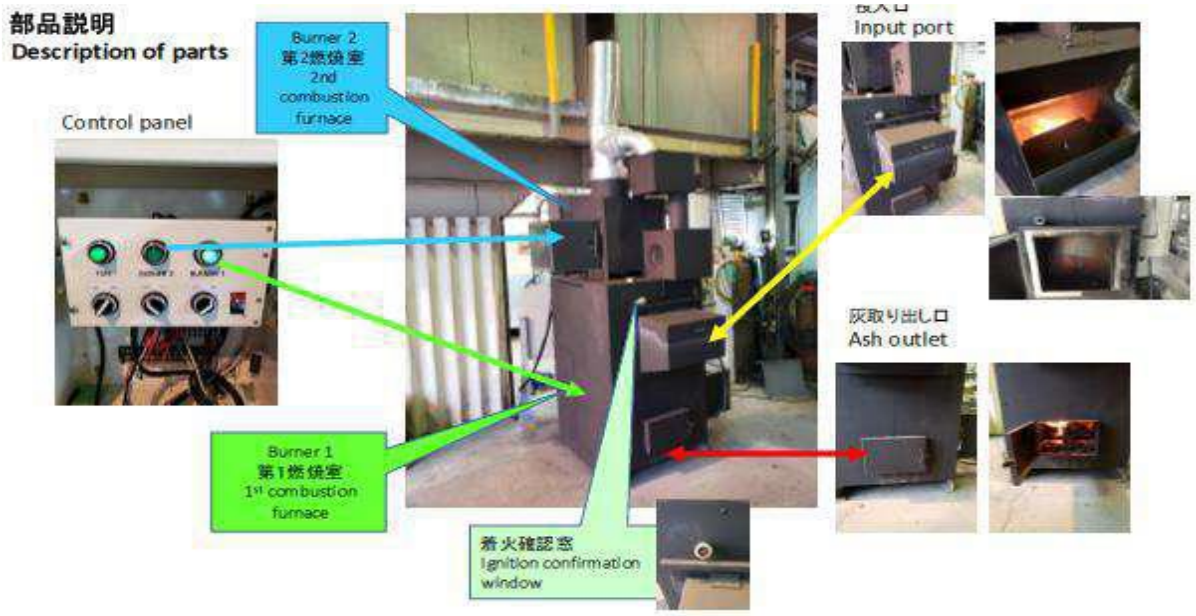

Figure 4. Shokyakuro-FTU Incinerator

The Shokyakuro Incinerator is a thermal waste disposal technology with two burners combustion system whose function is to burn waste in the main burner and clean gas from the chimney in the second burner due to equipped with a fan to suck in and remove the gas produced from the main combustion chamber. With these 2 combustions, there will be a reduction in black smoke and dioxin formation, it can burn 20-30kg of waste in one hour and can be used to burn waste and wood simultaneously with economical fuel use (Satori et al., 2023).

2. METHOD

This study uses the Demonstration method and the direct practice method (Hands-on training). The demonstration method is a teaching method where the instructor or trainer shows how to use the machine directly or through the use of teaching media that are relevant to the subject matter (Sumirah et al, 2023). Demonstration is a teaching method by demonstrating and showing students about a particular process, situation, or object, whether it is just an imitation. Training participants can see the operational steps, how to handle potential problems and understand the safety procedures that must be followed. Meanwhile, the direct practice method is a method where participants are allowed to directly operate the machine under the supervision of the trainer. The purpose of this method is to show directly how the stages are by applying the methods recommended in this community service activity. This method allows participants to gain direct experience and strengthen their skills (Pawara et al, 2022).

The PKM activity began with an initial visit/survey to ensure the availability of space for placing the machine and to provide a comprehensive activity plan. This activity involved the Islamic Education Foundation (YPI) which oversees Unisba in determining the location of the Shokyakuro-FTU Incinerator machine and appointing a machine operator. At this point, the

DOI: https://doi.org/10.31849/dinamisia.v8i4.21902

machine was also prepared. Figure 5 illustrates the stages involved in the application of the Shokyakuro-FTU Incinerator machine in this PKM activity.

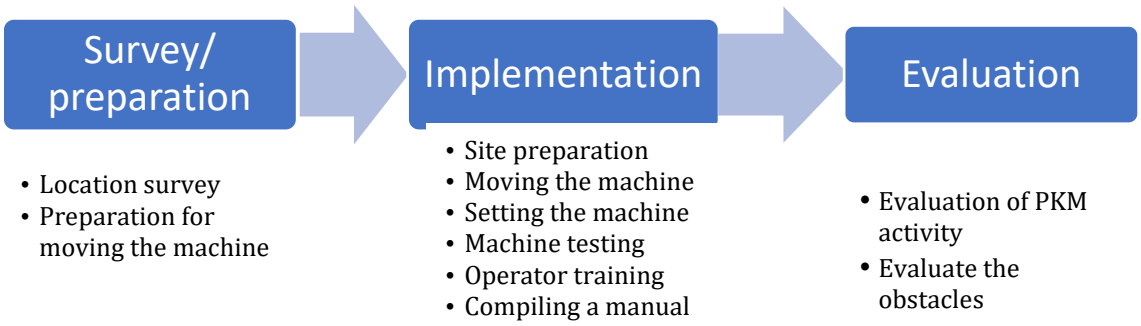

Figure 5. Implementation stages

The next step is to implement PKM during May and June 2024. PKM activities for waste processing with the Shokyakuro-FTU Incinerator machine begin with site preparation activities such as placing the machine, moving it to a predetermined location, setting up the machine, testing it, preparing the Shokyakuro-FTU Incinerator machine, operator training, and provide an operation manual.

In the final step, the Unisba PKM EI Team evaluated the PKM implementation process. The evaluation was conducted to determine the ease of operation of the machine for operators, the obstacles encountered by operators, and other obstacles associated with the implementation of the Shokyakuro-FTU Incinerator machine. The findings of this evaluation will be used to inform future developments in the use of the Shokyakuro-FTU Incinerator machine to support the Zero-waste Campus program.

3. RESULT AND DISCUSSION

PKM activities began with a survey of Campus 2 Unisba Ciburial to determine the location of the Shokyakuro-FTU Incinerator. After careful consideration, it was decided to place the Shokyakuro-FTU Incinerator machine on a flat and open top that was large enough to accommodate waste and machinery. Aside from that, the initial survey determined that all cleaning staff at Campus 2 Unisba Ciburial would receive practical training on the operation of the Shokyakuro-FTU Incinerator machine. These two things have been approved by the Islamic Education Foundation (YPI), which oversees the management of the Unisba Campus.

Aside from determining the location and appointing officers, the initial step includes machine preparation for moving. Large and heavy machines must be disassembled into smaller parts to make them easier to transport (see Figure 6). Five people moved the Shokyakuro-FTU Incinerator machine with trucks from the Bandung City Environmental Service.

After arriving at Campus 2 Unisba Ciburial, the Shokyakuro-FTU Incinerator machine was reassembled (see Figures 7, 8, and 9). During the reassembly process, several components, including the burner, temperature gauge, and several knobs, were discovered to be defective or required replacement. Hence, the defective components must be modified or replaced. Initially, used fuel oil will be used; however, there is a prohibition on the use of used oil because, unlike diesel or petrol, used oil cannot achieve complete combustion, making it non-flammable. This results in no fogging like fuel in general, so it requires additional treatment to become a fuel (Prayitno et al., 2021). Therefore, used fuel oil is replaced with LPG.

Simultaneously with the reassembly of the Shokyakuro-FTU Incinerator machine, a machine protection building made of light steel poles and uPVC covers was constructed. After the Shokyakuro-FTU Incinerator machine has been reassembled and the protective housing has been

DOI: https://doi.org/10.31849/dinamisia.v8i4.21902

constructed, the next step is to test the machine with waste around the machine location, i.e. dry leaves. Trials were repeated several times until easy operation was achieved and the machine was declared ready for use.

Figure 6. Disassembling of machines at PDU Cicabe, Bandung City

Figure 7. The machine arrives at Campus 2 Unisba Ciburial

Figure 8. Reassembling the machine at Campus 2 Unisba Ciburial

Figure 9. Setting up the machine

The next step is to organize training for the cleaning staff who will be responsible for implementing residual waste processing with the Shokyakuro-FTU Incinerator machine. The training was held on Thursday, June 6, 2024, from 9:00 a.m. to 11:30 a.m. at Campus 2 Unisba Ciburial, and was attended by 12 training participants, the PKM team, and Foundation representatives. Mr. Dr. Yan Orgianus Najamudin, the PKM Team Leader, opened the training, followed by Mr. Dr. Mohamad Satori, who explained the Shokyakuro-FTU Incinerator machine, its functions, and benefits to Unisba. The training participants were then shown how to operate the Shokyakuro-FTU Incinerator machine (see Figures 10, 11, and 12). The Shokyakuro-FTU Incinerator machine operates in the following order:

1) Provide the LPG
2) Fill the combustion chamber with waste until it reaches 75% capacity through the top door and close it again.
3) Turn on the 1st burner and fan for initial waste burning. If the fan and burner fail, check the power source, burner nozzle, and diesel tank for issues.
4) Turn on the 2nd burner to burn fly ash that doesn't burn out on the 1st burner, especially when the smoke from the chimney is black.
5) The combustion temperature is crucial for complete combustion and should be monitored using a door panel display, with the required temperature for plastic waste burning being 600-700^{o}C.
6) Put the waste into the incinerator every 15 minutes continuously after the combustion process, ensuring a consistent waste disposal process.
7) Turn off the first burner after burning all waste, allowing the flame to burn until it extinguishes.
8) To determine if the waste in the combustion chamber is fully burned and the fire is still burning, check the door, turn off the second burner and fan, and let the fire extinguish.
9) After ten hours, remove the ashes from the incinerator, place them in a sack, weigh them, and record the results.

DOI: https://doi.org/10.31849/dinamisia.v8i4.21902

Figure 10. Training participants

Figure 11. Opening of training

Figure 12. Explanation of machine operation

Figure 13. Participants practice operating the machine

The training concluded with several participants practicing operating the Shokyakuro-FTU Incinerator machine by the manual that had been created (see Figure 13). Trainees who operated the machine reported no difficulties. However, balancing waste volume and the size of the fire to avoid excessive black smoke could be a potential stumbling block.

The Shokyakuro-FTU Incinerator machine is intended to replace the role of UPTD Bandung City in handling residual waste generated at Campus 1 Unisba Tamansari, including the Dean Building, Rectorate Building, Medical Faculty Building, LPPM Building, Foundation Building, Mathematics and Natural Sciences Building, and Postgraduate Building. The presence of a manual and the ease of the Shokyakuro-FTU Incinerator machine operation are expected to aid cleaning staff in the processing of residual waste.

The PKM activity went smoothly, so it is hoped that the Shokyakuro-FTU Incinerator machine can be used to process residual waste continuously. However, there are still obstacles in the form of chimney construction that require improvements, such as the addition of an air filter system and the elevation of the chimney to avoid the appearance of smoke in the air.

4. CONCLUSIONS

The implementation of the Shokyakuro-FTU Incinerator Machine was carried out by relocating to Campus 2, Unisba Ciburial, appropriately modified to suit the environmental and operational conditions in Indonesia. The machine has undergone testing and demonstrated its ability to process the residual waste. Several cleaning staff members have been trained and are now capable of operating the Shokyakuro-FTU Incinerator machine easily.

However, further modifications are still required for the Shokyakuro-FTU Incinerator to minimize combustion smoke, ensuring it operates in a more environmentally friendly manner and aligns with sustainability goals.

ACKNOWLEDGMENT

The authors express gratitude to the Research and Community Service of Bandung Islamic University for financial support, the Islamic Education Foundation for infrastructure, and training participants for active participation.

REFERENCES

Abid, Z. A., Syamsuri, H., & Herdiana, A. (2023). Perancangan Sistem Insinerator Sampah Plastik Layak Bakar Ramah Lingkungan Di Kampus Unigal Ciamis. *Jurnal Ilmiah Teknologi Infomasi Terapan*, *9*(2), 265–268. https://doi.org/10.33197/jitter.vol9.iss2.2023.1041

Abidin, A. Z., Alfiandi, A., & Abidin, T. (2023). Zero waste di ITB. *The 2nd International Symposium of Indonesian Chemical Engineering 2021*. https://doi.org/https://pubs.aip.org/aip/acp/article-abstract/2667/1/060008/2877113/Waste-management-design-based-on-masaro-technology?redirectedFrom=fulltext

Cox, J., Giorgi, S., Sharp, V., Strange, K., Wilson, D. C., & Blakey, N. (2010). Household waste prevention - A review of evidence. *Waste Management and Research*, *28(3)*(193–219). https://doi.org/https://doi.org/10.1177/0734242X10361506

Dewi, R., Hadinata, F., Sriwijaya, U., Palembang, K., & Selatan, S. (2020). Sistem pengolahan sampah domestik dengan menggunakan incinerator drum bekas. *Seminar Nasional AVoER XII 2020*, *November*, 891–896. https://doi.org/http://ejournal.ft.unsri.ac.id/index.php/avoer/article/view/303/237

Fadhilah, A., Sugianto, H., Hadi, K., Firmandhani, S. W., Woro, T., & Pandelaki, E. E. (2011). Kajian Pengelolaan Sampah Kampus. *Modul*, *11*(2), 62–71. http://eprints.undip.ac.id/32520/1/2.Jurnal_Kajian_Pengelolaan_Sampah_Kampus_-_Edo_dkk.pdf

Kasam, Mulya Iresha, F., & Ajie Prasojo, S. (2018). Evaluation of solid waste management at campus using the "Zero Waste Index": The case on campus of Islamic University of Indonesia. *MATEC Web of Conferences*, *154*. https://doi.org/https://doi.org/10.1051/matecconf/201815402004

Kaza, S., Yao, L., Bhada-tata, P., & Woerden, F. Van. (2018). *What a waste 2.0: A Global Snapshot of Solid Waste Management to 2050*. https://doi.org/https://doi.org/10.1596/978-1-4648-1329-0

Maria, F., Di, Micale, C., Sordi, A., Cirulli, G., & Marionni, M. (2013). Urban mining: Quality and quantity of recyclable and recoverable material mechanically and physically extractable from residual waste. *Waste Management*, *33(12)*(2594–2599). https://doi.org/https://doi.org/10.1016/j.wasman. 2013.08.008

Mason, I. G., Brooking, A. K., Oberender, A., Harford, J. M., & Horsley, P. G. (2003). Implementation of a zero waste program at a university campus. *Resources, Conservation and Recycling*, *38(4)*(257–269). https://doi.org/https://doi.org/10.1016/S0921-3449(02)00147-7

Merrington, G., Winder, L., Parkinson, R., & Redman, M. (2010). Organic Wastes. *In Agricultural Pollution*. https://doi.org/https://doi.org/10.4324/9780203302026_chapter_5

Moreira, G. A., & Rutkoskwi, E. W. (2021). Zero Waste Strategy for a Green Campus. *Journal of Sustainability Perspectives*, *1*(367–373). https://doi.org/https://doi.org/10.14710/jsp.2021.12027

Muldiani, R. F., Supriyanti, Y., Gantina, T. M., Hernita, N., Pratama, D., & Bandung, P. N. (2024). *The Implementation Of Smoke Filter Technology For Handling Exhaust Gases From An Incinerator In Waste Processing Penerapan Teknologi Filter Asap Untuk Penanganan Gas*. *10*, 117–124. https://ojs.unida.ac.id/QH/article/view/10805/5643

Pawara, M. U., & Hidayat, T. (2022). Pelatihan dan Bimbingan Metode Perbaikan dan Perawatan Mesin Darat Pada Nelayan di Desa Pejala , Kecamatan Penajam , Kabupaten Penajam Paser Utara. *Jurnal Riset &Teknologi Terapan …*, *1*(July), 55–58. https://doi.org/10.25042/jrt2k.122022.08

Popescu, D. E., Bungau, C., Prada, M., Domuta, C., Bungau, S., & Tit, D. M. (2016). Waste management strategy at a public university in smart city context. *Journal of Environmental Protection and Ecology*, *17*(3), 1011–1020. https://doi.org/https://intelligentjo.com/images/Papers/smart%20waste%20management/Waste%20management%20strategy%20at%20a%20public%20university%20in%20smart%20city%20context.pdf

Rahmawati, C., Nopitasari, B. L., Mardiyah WD, S., Wardani, A. K., & Nurbaety, B. (2020). Penyuluhan Pengelolaan Sampah Plastik Menuju "Zero Waste Kampus Ummat." *SELAPARANG Jurnal Pengabdian Masyarakat Berkemajuan*, *3*(2), 196. https://doi.org/10.31764/jpmb.v3i2.1689

Sari, M., Lestari, S. U., & Awal, R. (2018). Peningkatan Ketrampilan Mahasiswa Dalam Pengelolaan Sampah Organik Untuk Mewujudkan Green Campus Di Universitas Lancang Kuning. *Dinamisia : Jurnal Pengabdian Kepada Masyarakat*, *2(2)*(193–196). https://doi.org/https://doi.org/10.31849/ dinamisia.v2i2.1392

Satori, M., Matsuzawa, S., Aviasti, A., & Prasetyaningsih, E. (2023). Study on the implementation of Shokyakuro incinerator in waste management of Bandung municipality. *AIP Conference Proceedings*, *2824(1)*. https://doi.org/https://doi.org/10.1063/5.0158992

Song, Q., Li, J., & Zeng, X. (2015). Minimizing the increasing solid waste through zero waste strategy. *Journal of Cleaner Production*, *104*(199–210). https://doi.org/https://doi.org/10.1016/j.jclepro.2014.08.027

Sumirah, S., Binari, S., Musli, & Miftahuddin, M. (2023). Metode Pembelajaran Demonstrasi Dalam Membentuk Karakter Anak Usia Dini. *Al-Miskawaih: Journal of Science Education*, *1*(2), 397–412. https://doi.org/10.56436/mijose.v1i2.165

Utami, A. A., Zahrudin, Z., Umam, K., & Susanto, R. (2022). Analisis Biaya Layanan Pengolahan Sampah Dengan Insinerator Di Tpst Mustika Ikhlas. *JABE (Journal of Applied Business and Economic)*, *9*(1), 81. https://doi.org/10.30998/jabe.v9i1.15953

Wijaya, M., Dewi, R., Joprang, F., Spicano, Siladjaja, G. K. A., & Hananta, L. (2024). Education On" Zero Waste" Waste Management Based On The 3 R Approach In Jakarta Coastal Area. *Dinamisia: Jurnal*, *8(2)*(351–357). https://doi.org/https://pustaka-psm.unilak.ac.id/index.php/dinamisia/article/view/13295%0Ahttps://pustakapsm.unilak.ac.id/index.php/dinamisia/article/download/13295/6254

Zaman, A. U., & Lehmann, S. (2013). The zero waste index: A performance measurement tool for waste management systems in a "zero waste city." *Journal of Cleaner Production*, *50*(123–132). https://doi.org/https://doi.org/10.1016/j.jclepro.2012.11.041