NAVIGATING RISK IN IMPLEMENTING REFUSE DERIVED-FUEL: CASE STUDY IN MALANG

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Background

Indonesia has been selected as one of the 30 countries to be a part of the Open Working Group (OWG) on Sustainable Development Goals (SDGs). Indonesia is committed to reducing carbon emissions by 29% by 2030 with technical support and collaboration from foreign countries (UNFCC, 2021).

One of the infrastructures in the accelerated development program is the development of Refuse-Derived Fuel (RDF), which involves the processing of dry waste or solid fuel resulting from the separation of easily combustible waste materials such as plastic and paper waste from non-combustible waste materials like organic waste and similar items.

Refuse Derived Fuel (RDF) is an easily combustible waste that undergoes a process involving shredding, screening, and air classification. It is one of the waste management techniques that involves transforming waste into renewable fuel, capable of complementing the use of coal on an industrial scale.

RDF constitutes waste that no longer holds economic value and is, therefore, reprocessed through shredding and drying processes to regain its economic worth. The processed waste material, RDF, possesses a high calorific value. RDF can complement coal in industries such as cement kilns, thermoelectric power plants, and specific boilers (Rifa'i & Ardiatma, 2022).

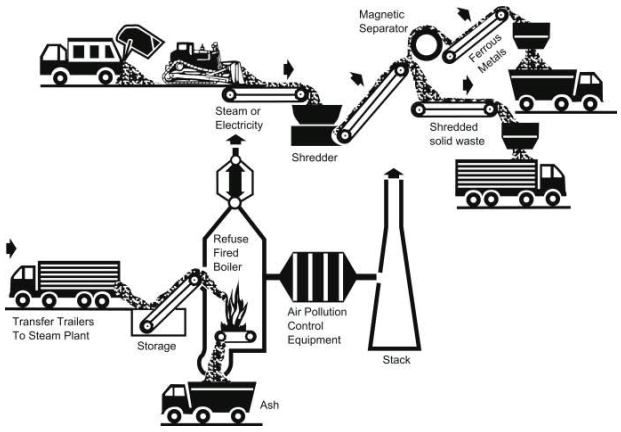

Figure 1. Refuse Derived Fuel Scheme (Marc et al., 2019)

The issue of waste management is a prevalent challenge in major urban centres, including Malang, a densely populated city where the volume of waste generated is notably significant. Waste disposal in Malang City is centralised at the Supit Urang Malang Landfill (Sudiro et al., 2018). This landfill is situated in the urban area of Malang City and has been operational since 1993 (Sholichin, 2012).

The waste disposal practices at the Supit Urang Landfill still employ open dumping. Open dumping is a disposal system lacking standards, allowing large quantities of waste to be left untreated without compaction or soil covering. Although this system is easier to operate, it has the potential to cause leachate flow and heavy metal pollution into the environment, thereby reducing the quality of soil, groundwater (Srigirisetty et al., 2017), air, and increasing health risks for the population (Aderemi & Falade, 2012).

Current State Analysis

Based on the results of the literature review, the operation of Supit Urang Landfill Malang, besides bringing benefits to scavengers, also had a negative impact on the environment. Waste management is not optimal due to the limited number of tools and personnel involved in managing waste. Thus, there is still a lot of waste untreated and directly dumped into the landfill. Supit Urang Landfill faces a challenge with the increasing amount of waste each year, leading to the depletion of available space within the landfill site. The landfill area is around 31 hectares. Currently, an area of 16 hectares is full of waste, and only 15 hectares remain, so it is estimated that in about 20 years, the landfill will be full (Sujiyanto, 2016). There is soil contamination in the area of Supit Urang Landfill due to leachate flow and piles of organic waste that have been rotting for a long time. Furthermore, the existing waste management system using the community anaerobic waste treatment system installation or known as SIKIPAS (Sistem Komunal Instalasi Pengolahan Anaerobik Sampah) has resulted in the following conditions:

Table 1. Process Specifications of SIKIPAS

Indicator	Information
Operating capacity	10 tonnes of mixed waste/day, 40m/waste/day
The number of beneficiaries	20,000 people, 4,000 families
Types of processes	Physical (sorting) and biological (anaerobic and aerobic)
Potential processed products	Solid compost (2.5 tons/day), liquid compost (50 liters/day), biogas
GHG emission reduction	8 tons CO_2/day
Land area	4000 m^3 (including supporting facilities)
Processing fee	20.000 rupiah/ton mixed waste

Source: Diartika *et al.*, 2021

The composition of waste entering the landfill is 70.5% organic, with the remaining 29.5% being inorganic. This organic waste consists of food scraps, vegetables, leaves, and similar materials. Meanwhile, the inorganic waste includes paper and paper-like materials (4.9%), wood and garden waste (9.1%), textiles and textile products (1.5%), rubber (0.8%), plastic (12.7%), iron (0.2%), glass (0.7%), and other types of waste (7.7%). The tools used in waste management at the landfill include bulldozers, excavators, compactors, vibra compactors, water tank trucks, and motorised carts. With the abundance of textile, wood, and paper waste, it is possible to create an alternative fuel from these materials known as Refuse Derived Fuel (RDF) to address unmanaged waste. RDF derived from the processing of such waste can be utilised as fuel for pyrolysis incinerators in Waste-to-Energy Power Plants.

Key Risk on RDF Utilisation

Refuse Derived Fuel (RDF) has the ability to reduce the volume of waste and serves as a co-combustion fuel employed in secondary fuel for cement industries and power plants. In the production of RDF, the easily combustible fraction of waste is typically reduced in size and dried to be used as fuel (Sudiro et al., 2016). Integrated sustainability of solid waste management must take into account aspects, stakeholders, and solid waste process flow (Scheinberg, 2001). The sustainability of RDF is determined using the Integrated Sustainability Waste Management (ISWM) approach. The potential to develop RDF in Malang involves three main stakeholders: the Malang government, the cement industry, and waste pickers.

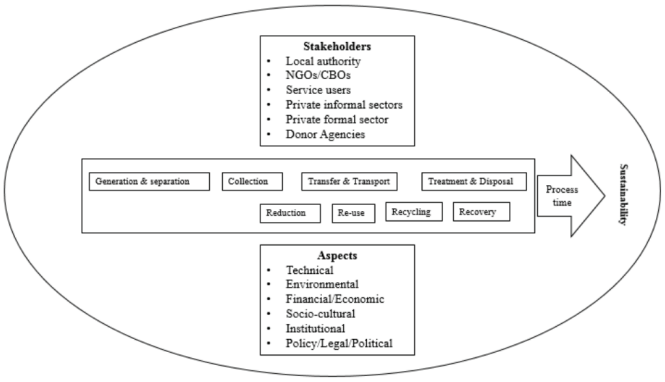

Figure 2. Integrated Solid Waste Managment (Scheinberg, 2001)

For the RDF plant, the Engineering Procurement Construction Contractor bears many of the construction-related risks. RDF sales carry multiple risks that make for a high-risk high-return project. These include cyclical price risk, RDF volume and quality acceptance risk at the sales point, and transport cost risk. The following table lays out many of the most important risks for a business of this type and provides a suggested allocation:

Table 2. Risk and Mitigations

Category	Description	Allocation	Mitigation
RDF produced volume	RDF volume extracted from landfill	Private investors	Waste Audit and Major Existing on-site refuse for Landfill Mining
General fresh waste volume	Minimum waste volume arriving at the landfill.	Municipality	Malang municipality controls collection and landfill.
RDF sales prices	Prices paid at point of sale at Cement Kiln Sold at Final Destination	Private Investors	Purchase contracts of up to 3 years with selected investors.
RDF sales volume	Cements plants often reject major portions of RDF was at acceptance point	Private investors	RDF landfill site separation to match cement plant specifications seems difficult to achieve.
Plastic, metal, and glass sales amounts and prices		Private investors	Prices are very volatile so a short or long term price collapses are probable during multiple periods over a 10 year operations life.
Performance shortfall in the plant		Individual equipment suppliers	Warranties from equipment suppliers
Minor and major maintenance risk	Costs exceeding budget	Sponsors and/or operator	Private investor is responsible for correctly estimating reliability and life of equipment in tis budget
Transport cost risk	RDF must be transported from landfill site to cement kilns	Private investors	Transport costs are significant given the distance from Malang to the llikely cement kiln buyers
Domestic inflation risk	Operating cost increase due to inflation	Municipality	Waste removal fee will be adjusted yearly based on official inflation rate
Cost overrun on operations and maintenance	Project costs exceed project budget	Private investors	Private investors must manage expenses

Source: UNFCC, 2018

Various influential factors, including governments, markets, formal and informal businesses, and technological advancements, all play significant roles in shaping the trajectory of Municipal Solid Waste (MSW) disposal or utilisation trajectory. For instance, governments possess the authority to implement policies and regulations on organisations, mandating them to reduce solid waste generation, endorse circular economy practices, finance waste-reduction initiatives, and align their actions with environmental projects or agreements to enhance the production and consumption of Refuse-Derived Fuel (RDF).

Additionally, external occurrences in commodity markets impact the RDF market due to the competition with other biofuels. If the market prices of coal or oil dip below the cost of RDF, establishing and sustaining an RDF-based economy becomes more challenging. In this context, the government's adoption of environmentally sound policies, economic incentives, and funding for Waste-to-Energy (WtE) projects assumes critical importance. These measures are instrumental in steering an economy towards alternative fuels and optimising thermochemical technologies for generating energy vectors from these feedstocks, as highlighted in the study by Cardoso et al. in 2019.

Landfilling of MSW in a certain period of time will trigger a methane gas released into the air, theoretically 50 Nm3 methane released from one ton of landfilled MSW. Referring to that number, a study by Paramita (2018) concluded that avoiding GHG emissions by the RDF initiative is 6000 Nm3/ton of landfilled waste per day or 2,190,000 Nm3/ton waste per year.

The community most probably affected by the RDF initiative is waste pickers. Based on Indonesian Public Works Minister Decree No. 13 year 2003, waste pickers should be addressed in the waste management strategy in the final disposal area.

However the social inclusion of waste pickers into structured working conditions is also challenging (Paramita et al., 2018).

Recommendation

Based on the analysis results, to drive the success of Malang's Refuse-Derived Fuel (RDF) initiative, there are several key risks that need to be addressed. A comprehensive risk mitigation plan should be developed, addressing identified challenges such as RDF produced volume, sales prices, and transport costs. Investments in advanced RDF processing technologies, improved infrastructure, and long-term contracts with stakeholders will further enhance the initiative's feasibility. Regular monitoring, ensuring social inclusion and warfare of the waste pickers around the Supit Urang Landfill, and advocacy for government funding will contribute to the initiative's success, aligning with Sustainable Development Goals and carbon emission reduction targets.

Resilience Development Initiative

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The views expressed in this op-ed are those of the author or authors of this article. They do not necessarily represent the views of RDI, its editorial committee, or the mentioned speakers' affiliation.

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References

Aderemi O. Adeolu and Otitoloju A. Adebayo. 2012. An Assessment of Landfill Fires and Their Potential Health Effects: A Case Study of a Municipal Solid Waste Landfill in La gos, Nigeria. International Journal of Environmental Protection, 2(2):22-26

Chavando, J. A. M., Silva, V. B., Tarelho, L. A., Cardoso, J. S., & Eusébio, D. (2022). Snapshot review of refuse-derived fuels. Utilities Policy, 74, 101316.

Marc J. Rogoff, Francois Screve, in Waste-to-Energy (Second Edition), 2011

Rifa'i, I., & Ardiatma, D. (2022). Potensi Sampah Landfill Mining Di Tpst Bantargebang Sebagai Bahan Baku Alternatif Refused Derived Fuel (RDF). Prosiding Sains dan Teknologi, 1(1), 539-546

Scheinberg A, (2001). Financial and economic issues in integrated sustainable waste management. Experiences from the Urban Waste Expertise Programme (1995-2001). website: www.waste.nl.

Sholichin, M. (2012). Field investigation of groundwater contamination from solid waste landfill in Malang, Indonesia. Int J Civil Environ Eng, 12(2), 74-83.

Srigirisetty S, Jayasri T, Netaji C (2017). Open Dumping of Municipal Solid Waste-Impact on Groundwater and Soil. Tech. Res. Organ. India 4(6): 26-33

Sujiyanto, S. (2016). Analisis Pengelolaan Sampah Di Bank Sampah Malang. Jurnal Ilmu Sosial dan Ilmu Politik Universitas Tribhuwana Tunggadewi, 5(3), 102218.

Sudiro, Setyawan, A., & Nulhakim, L. (2018). Model Pengelolaan Sampah Permukiman di Kelurahan Tunjung Sekar Kota Malang. Plano Madani : Jurnal Perencanaan Wilayah dan Kota, 7(1), 106–117.

Paramita, W., Hartono, D. M., & Soesilo, T. E. B. (2018, June). Sustainability of refuse derived fuel potential from municipal solid waste for cement's alternative fuel in Indonesia (A case at Jeruklegi Landfill, in Cilacap). In IOP Conference Series: Earth and Environmental Science (Vol. 159, p. 012027). IOP Publishing.

Annex

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