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PLASTIC WASTE MANAGEMENT TO SUPPORT THE CIRCULAR ECONOMY IN THE PULP AND PAPER INDUSTRY

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Abstract: The pulp and paper industry is one of the leading sectors that can grow significantly due to the application of advanced technology. The development of recycled paper follows the development of the pulp and paper industry in Indonesia. The trend towards sustainability in the pulp and paper industry drives waste paper recycling. This study aims to provide recommendations for technology in waste treatment in the pulp and paper industry from the perspective of the circular economy and Sustainable Development Goals (SDGs). This research method uses a systematic literature review with descriptive and qualitative data. The research result shows that mechanical and chemical recycling methods were found in the literature. Most of the technologies are used to make alternative use of waste, such as construction material use, pyrolysis, gas-forming, Refuse Derived Fuel (RDF), incinerator, and other alternative use. Appropriate technology applied to plastic waste management should be encouraged to support a circular economy and five potential SDGs out of seventeen goals: SDG 3, SDG 6, SDG 9, SDG 12, and SDG 13. In times of diverse growth in technologies and advanced knowledge, Internet of Things (IoT) and Artificial Intelligence (AI) may be possible for relevant future research needs or reshaping the existing research.

Keywords: circular economy, plastic waste management, pulp and paper waste management, SDGs, waste to energy

Abstrak: *Industri pulp dan kertas merupakan salah satu sektor unggulan yang dapat tumbuh signifikan berkat penerapan teknologi canggih. Perkembangan kertas daur ulang mengikuti perkembangan industri pulp dan kertas di Indonesia. Tren keberlanjutan dalam industri pulp dan kertas mendorong daur ulang kertas bekas. Penelitian ini bertujuan untuk memberikan rekomendasi teknologi dalam pengolahan limbah di industri pulp dan kertas dari perspektif ekonomi sirkular dan Tujuan Pembangunan Berkelanjutan (SDGs). Metode penelitian ini menggunakan tinjauan pustaka sistematis dengan data deskriptif dan kualitatif. Hasil penelitian menunjukkan bahwa metode daur ulang mekanik dan kimia ditemukan dalam literatur. Sebagian besar teknologi yang digunakan untuk membuat alternatif penggunaan limbah seperti penggunaan bahan konstruksi, pirolisis, gasiforming, Refuse Derived Fuel (RDF), insinerator, dan penggunaan alternatif lainnya. Teknologi tepat guna yang diterapkan pada pengelolaan sampah plastik harus didorong untuk mendukung ekonomi sirkular dan lima potensi SDGs dari tujuh belas tujuan: SDG 3, SDG 6, SDG 9, SDG 12, dan SDG 13. Di saat pertumbuhan teknologi dan pengetahuan canggih yang beragam, Internet of Things (IoT) dan Artificial Intelligence (AI) berpeluang menjadi kebutuhan penelitian masa depan yang relevan atau membentuk kembali penelitian yang ada.*

Kata kunci: *ekonomi sirkular, limbah menjadi energi, pengelolaan sampah plastik, pengelolaan sampah pulp dan kertas, SDGs*

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INTRODUCTION

The pulp and paper industry is one of the leading sectors that have the potential to grow significantly due to the availability of raw materials and a large enough domestic market supported by the application of advanced technology. The opportunities for developing the pulp and paper industry in Indonesia are supported by the availability of wood raw material sources from the plantation and community forests and non-timber raw materials such as empty fruit bunches of oil palm kenaf and abaca. In addition, the tropical climate in Indonesia allows plants to grow faster than in the subtropics. Indonesia is one of the largest pulp and paper producers in the world. Currently, the national capacity of the pulp industry is 12.3 million tons/year, placing Indonesia in 8th place in the world. Meanwhile, the national capacity for the paper industry is 18.56 million tons/year, placing Indonesia as the 6th largest in the world. The export performance of the national paper industry reached USD 7.5 billion in 2021 and contributed 6.22% to non-oil and gas exports, or the equivalent of 3.84% of the processing industry (non-oil and gas) (Ministry of Industry, Pulp and Paper Industry, 2022). Currently, there are 59 industries that utilize used paper as raw material for their products in Indonesia with a capacity of 12 million tons whose investment value continues to increase, so an adequate supply of raw materials is needed, where at least more than 7.8 million tons of waste paper are needed so that the company can produce well. However, the supply of used paper as raw materials in the country is currently no more than 3.5 million tons per year, so imports are still needed to meet the shortage of used paper raw materials (Ministry of Industry, Pulp and Paper Industry, 2022).

The development of recycled paper follows the development of the pulp and paper industry. The trend towards sustainability in the pulp and paper industry envisages waste paper recycling. Increasing waste in Indonesia, especially plastic and paper, is one of the reasons the recycled paper industry has developed. The final products of recycled paper are wrapping paper, duplex board, sack kraft paper, tissue paper for industry, newspaper, kraft liner/corrugating medium, and other paper types. Development and growth in the paper and pulp industry will follow industrial activity in environmental quality caused by pollution from the generated waste, given the importance of the impact of industrial activities on the environment. The waste generated by the pulp and paper industry is classified as pulping, bleaching, washing, primary sludge, and secondary sludge, respectively. These wastes are potential air, soil, and water contaminants (Lindholm-Lehto, 2015). The produced solid waste leads to soil pollution and ultimately comes into the food chain and causes ailments like respiratory disease, cancer, irritation to the skin and eyes, heart problems with headaches, and nausea. In addition, there is environmental anxiety globally about sustaining water quality (Varjani and Upasani, 2017; Hemavathy, 2019).

Solid/Reject waste component comprises fiber (paper fragments) up to 50.75% and plastic up to 49.25% (HDPE plastic-type > 99%) regarding the metal extracted from a small quantity of wire (Setiawan et al., 2014). The rising energy price in 2022 affected the cost of production or waste management using energy. Countries are required to implement the cheapest fuel production method, which is municipal solid wastes (MSW), as an alternative fuel (AF), including refuse-derived fuels (RDF) (Grabowski and Smolinski, 2021). Governments in industrialized nations and the management of worldwide cement production enterprises are pioneering the use of RDF derived from municipal solid waste. Disposing of these materials in landfills results in health risks and other environmental problems. There is a need for viable waste reduction strategies that also play a crucial role in the production of renewable energy. Thus, waste management plays an important role in controlling pollution distribution as a wall to support the implementation of a circular economy in the industry.

The circular economy is a system solution framework that tackles global challenges like climate change, biodiversity loss, waste, and pollution. The first principle of the circular economy is to eliminate waste and pollution. Currently, our economy works in a take-make-waste system. We take raw materials from the Earth, make products, and eventually throw them away as waste. Much of this waste ends up in landfills or incinerators. This system cannot work in the long term because the resources on our planet are finite. By shifting our mindset, we can treat waste as a design flaw. In a circular economy, a specification for any design is that the materials re-enter the economy at the end of their use. By doing this, we take the linear take-make-waste system and make it circular (EMF, 2015). Even though several studies have examined waste management and its effects on the economy and the

environment. There has been little research into the contribution of alternative fuels to the circular economy and sustainable development goals. This study aims to provide recommendations for technology in waste treatment in the pulp and paper industry from the perspective of the circular economy and SDGs.

METHODS

This research is a systematic literature review using descriptive and qualitative data. This study uses analytical techniques with a qualitative approach. The systematic literature review and bibliometric analysis in this study were performed by accessing the Scopus database (https://scopus.com (accessed on 24 July 2022)). Scopus was chosen because it is one of the largest databases of abstracts and citations, journals, conference papers, and books. The following keywords were inputted into the Scopus web search: Keywords: "Plastic", "Waste", "Management" OR "Pulp", "Paper", "Ïndustry" OR "Circular", "Ëconomy". This query can be written as (plastic AND waste AND management OR pulp AND paper AND industry OR circular AND economy) AND (LIMIT-TO (PUBYEAR, 2022) OR LIMIT-TO (PUBYEAR, 2021) OR LIMIT-TO (PUBYEAR, 2020) OR LIMIT-TO (PUBYEAR, 2019) OR LIMIT-TO (PUBYEAR, 2018)) in the form of Boolean search.

The detailed systematic literature search (PRISMA) from the Scopus database is shown in Figure 1. This research is a systematic literature review using descriptive and qualitative data. This study uses analytical techniques with a qualitative approach. The systematic literature review and bibliometric analysis in this study were performed by accessing the Scopus database (https://scopus.com (accessed on 24 July 2022)). Scopus was chosen because it is one of the largest databases of abstracts and citations, journals, conference papers, and books. The following keywords were inputted into the Scopus web search: Keywords: "Plastic", "Waste", "Management" OR "Pulp", "Paper", "Ïndustry" OR "Circular", "Ëconomy". This query can be written as (plastic AND waste AND management OR pulp AND paper AND industry OR circular AND economy) AND (LIMIT-TO (PUBYEAR, 2022) OR LIMIT-TO (PUBYEAR, 2021) OR LIMIT-TO (PUBYEAR, 2020) OR LIMIT-TO (PUBYEAR, 2019) OR LIMIT-TO (PUBYEAR, 2018)) in the form of Boolean search.

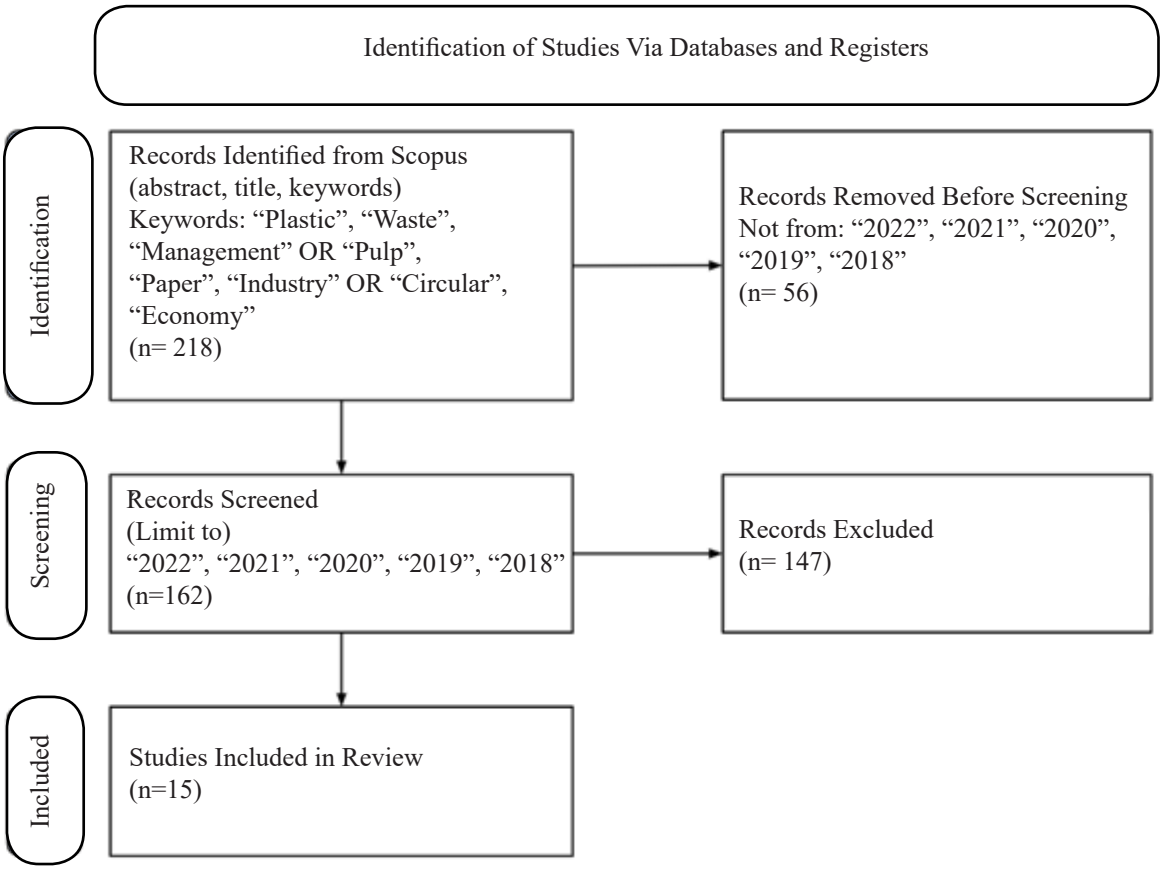


Figure 1. The Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) for this study

RESULTS

Impurities/Plastic Waste Management in Indonesia Pulp and Paper Industry

There were 47 pulp and paper companies that imported waste paper as raw materials in the year 2021. The regulation required further management of the impurities and the raw material imported. Most of the impurities were a plastic waste. Table 1 shows data impurities/plastic waste management in the recycled pulp and paper industry.

A company without industry impurities/plastic waste management may cooperate with a licensed third party. 74% or 35 companies cooperated with the third party, other 14% or12 companies have integrated impurities/ plastic waste management such as an incinerator, pelletiser, pyrolysis, pelletiser and boiler, RDF, and Boiler. There is one company that has a disposal permit from the authority. Most third parties have a permit to dispose of the impurities to the final landfill managed by the local government.

The Characteristics of Research

A total of 184 documents related to the keywords plastic AND waste AND management OR pulp AND paper AND industry OR circular AND economy research for the last five years (2018-2022) from the Scopus database were considered. Further screening was done to limit exact keywords with 162 document results. The obtained data were categorized into different document types, as shown in Figure 2. Journal articles were predominant and accounted for 69.8%, respectively, followed by review papers, conference papers, book chapters and editorial by 14.8%, 13.6%, 1.2% and 0.6%. The volume of documents increased with a quite constant uptrend from the year 2018 to year 2021 and allegedly to increase in the year of 2022 as shown in Figure 3. One possible reason for the rise in research was the continuous advocacy for sustainable waste management and landfill issues. As such, waste-to-energy is recognized as a sustainable waste management option and well as GHG emission reduction from landfills. The gradual increase of publications in the last 5 years represents a growth trend in interest in the field and research communication in the plastic waste management area.

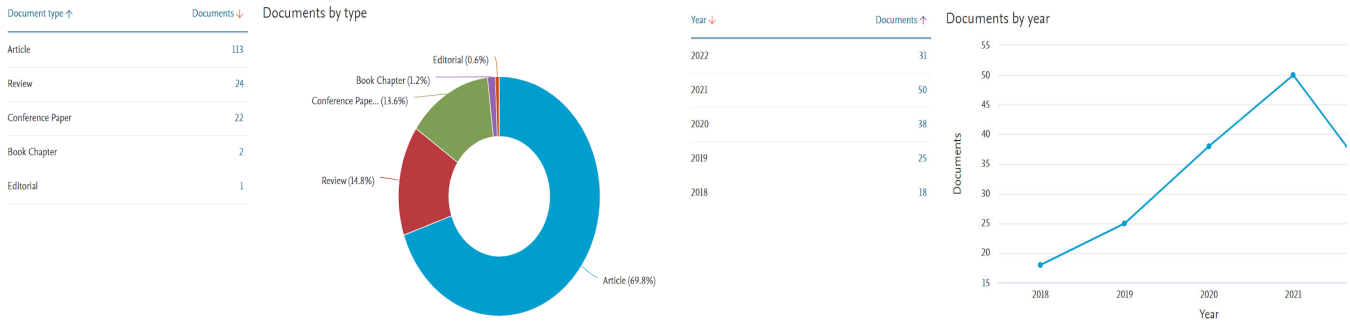
The Subject Area Covered

The research with the keywords plastic waste management, pulp and paper industry and circular economy was covered in 11 subject areas as shown in Figure 4. The top five subject areas in terms of publication are environmental science (35%), energy (12.5%), engineering (11.4%), social science (8.2%), and business, management and accounting (6.7%). As seen, Plastic waste management has been a researcher of environmental science. The energy document indicates that energy recovery from waste is rated highly as an environmental mitigation measure. To this end, research and development projects have been launched recently to determine which conditions and type of machinery could be deemed most appropriate to recover paper mill waste. An effective approach to waste management would enable the production of gas that could be returned to the production cycle through an innovative, highly technological process. The paper industry would then be able to close the circle and finally meet circular economy requirements (Ouadia et al. 2013; Toczyłowska-Mamińska, 2017).

Table 1. Plastic waste management done by the company in Indonesia

Impurities/Plastic Waste Management	Number of Company	Percentage
Third party cooperation	35	74
Incinerator	4	9
Pelletizer	2	4
Pyrolysis	2	4
Pelletizer and Boiler	1	2
Refuse Derived Fuel (RDF)	1	2
Boiler	1	2
Disposal permit	1	2

Source: Ministry of Industry, Pulp and Paper Industry (2022)



a) b)

Figure 2. a) Document by type, and (b) Number of publication

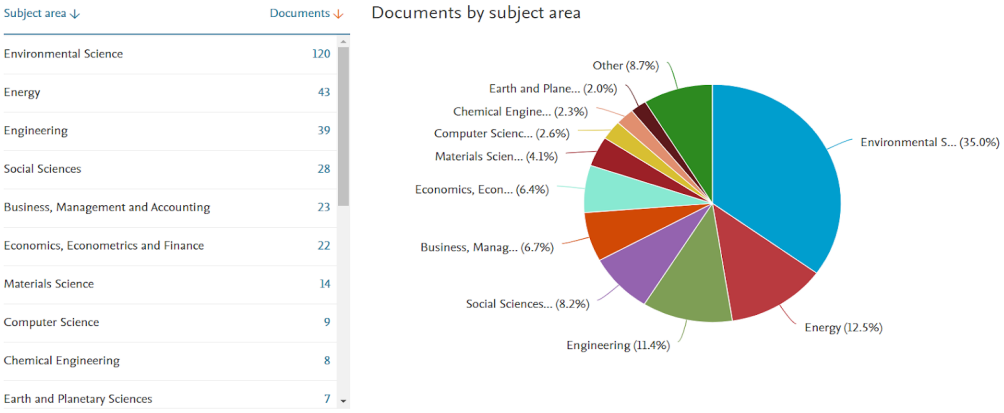


Figure 3. Proportion of publication documents by subject area

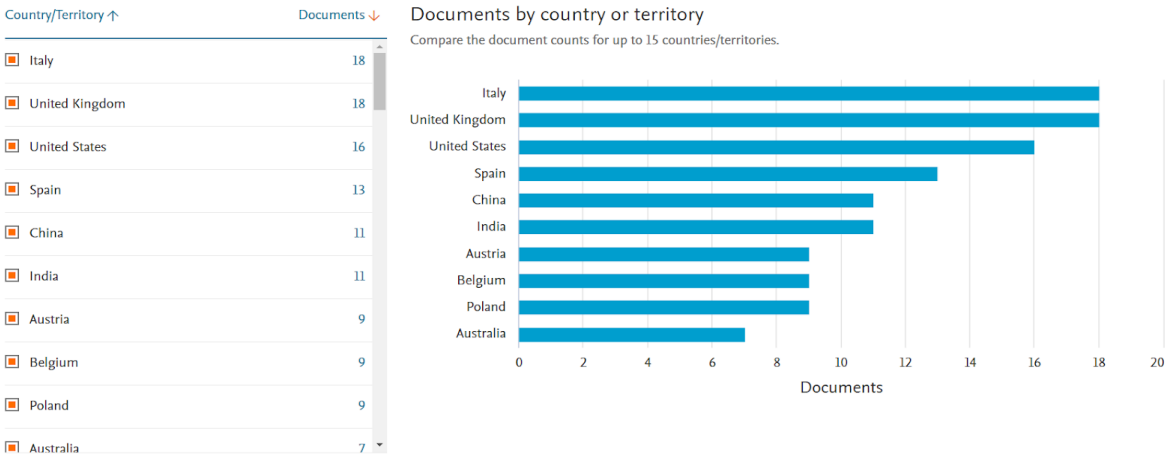


Figure 4. Number of publication by country

Contribution

Figure 4, shown contribution from countries to the knowledge of keywords plastic waste management, pulp and paper industry and circular economy. The most publications were found from Italy and the United Kingdom with 18 publications each. The United States has published 16 documents for the last 5 years. Asian countries; China and India also published quite a view publication as of 11 documents each. The other countries were from Europe. The introduction of regulations in the European Union directives such as zero landfill within the EU strengthened the research of alternative fuel and its valorization. As such, energy recovery and GHG emission reduction from waste draw more attention in these countries. This shows that research in this subject area was mostly contributed by the western country. This shows a gap in literature from another area of the world's perspectives.

Source and Institutional Contribution

The source type of publication was Journal articles, review papers, conference papers, book chapters and editorials. Most of it was published in five top journals as shown in Figure 5 (a). Most of the journals and affiliations originated from Europe Union and the United Kingdom (Figure 5 (b)).

Type of Plastic Waste Handling

There are several types of plastic waste handling methods, one of them is recycling. Recycling plastic waste is collected, sorted, and processed to be used again in the production of new plastic products. Based on the 15th journal review, the type of handling of plastic waste was to have alternative use of waste by recycling it, as shown in Table 2.

The recycling of plastic waste will help to improve the economy by decreasing the production cost. Not only economically viable but also will help to eradicate infectious diseases that are transmitted through polluted air and water (Evode et al. 2021). The waste materials or side streams generated by paper and board mills that are considered are defined as follows (Bousios, 2017): Rejects (ragger, heavy, coarse, and fine); formed during the utilization of PFR (paper for recycling), which may comprise fiber lumps, plastics, metals, sand, and glass. Deinking sludge; formed while deinking of PFR; it typically includes short fibers/fines, inorganic fillers, and ink particles.

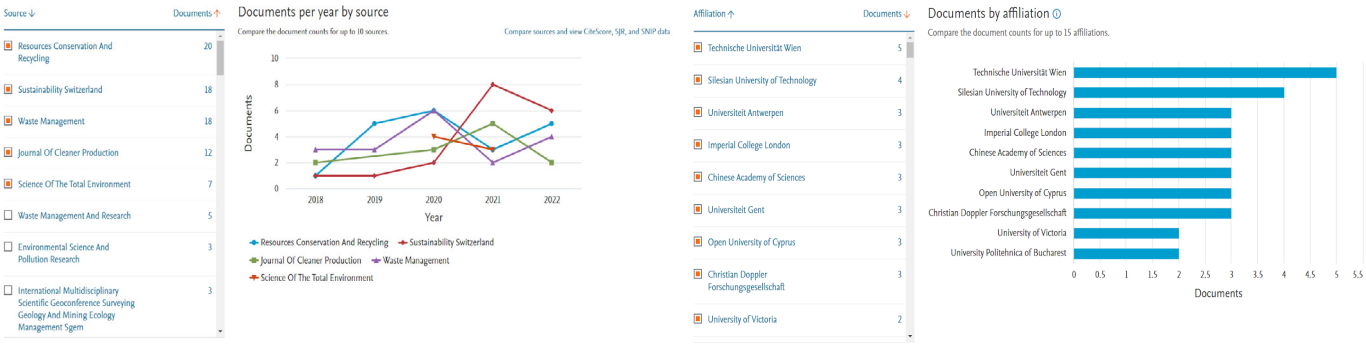


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Figure 5. (a) Proportion of publication documents by year, and (b) Most of the journal and affiliation originated

Table 2. Plastic waste management type of handling literatures

Type(s) of Handling	Type of Wastes	Results	Reference
Alternative use of waste	Plastic waste	Scheme that facilitates the reuse of recyclable plastics in Taiwan.	Lai and Lee (2022)
Alternative use of waste	Plastic waste	Plastic sand as a construction material: bricks, blocks and paving.	Al-Sinan and Bubshait (2022)
PW management and recycling	Plastic waste	PW management and recycling is the primary concern in India, and the implementation of Extended Producer Responsibility (EPR) is the primary task that needs to be fulfilled. As EPR requires manufacturers and importers to interact directly with the supply chain, recycling-oriented product design should prioritize these stakeholders.	Hossain et al. (2022)
Alternative use of waste (Concrete based on limestone and plastic waste)	Limestone and plastic waste	The exploitation of waste, or byproducts, as alternative aggregate in concrete results in a reduction in the exploitation of scarce natural resources. On the other hand, productive use of waste leads to a reduction in the landfilling of waste material by transforming waste into a resource. The experimental results indicate that using limestone quarry and plastic waste is possible within significant percentage ranges, having recognized a limited reduction of concrete strength that makes concrete appropriate for different practical applications.	Ferrotto et al. (2022)
Alternative use of waste analysis	Plastic from cable waste from automotive industry	Adding 5 wt % of polyethylene-grafted maleic anhydride (PE-g-MAH) as a compatibilizer to the ASR mixture significantly increases the homogenization of the components in the ASR matrix. The results obtained demonstrate that the hot-pressing with the pre-blending with r-LDPE and compatibility of the ASR based waste provides a high gain in mechanical and usage properties, enabling the circular economy of plastics from automotive cable.	Czarnecka-Komorowska et al. (2021)
Alternative use of waste (construction material) analysis	Tyre, glass and plastic waste from landfill	At present, crumb rubbers (from tyres) and glass sands (from crushed waste glass) are being used in concrete and road constructions while plastics are often used in manufacturing civil structures. However, only 10% of tyres, 19.5% of plastics and 21% of glass are currently recycled globally. New options for recycling waste tyres, plastics and glass in construction are also presented to provide practical and economical solutions to extract maximum value and ensure their continued use in a closed loop system.	Ferdous et al. (2021)
Alternative use of waste (energy-pyrolysis) A review	Plastic waste	The resulting articles (n = 670) show that Spain is the most productive country in terms of total output and that there is an increasing number of researchers focused on this topic worldwide. The results also highlight the current landscape and future directions of plastic pyrolysis research based on the following hot topics: i) kinetic triplets as a vital component of plastic pyrolysis and scaling up processes, ii) catalysts syntheses and performance, iii) co-pyrolysis of plastic/biomass mixtures, and iv) reactor design and reaction parameters	Armenise et al. (2021)
Alternative use of waste and disposal	Plastic waste	This review outlines the current state of plastic waste production and management in Malaysia, including options for landfill, recycling and incineration. Outlines key plastic waste management policy initiatives (including plastics alternatives such as biodegradable plastics) and highlights key constraints on the success of these. Significant internal constraints stem from the inconsistent application of policy initiatives by state governments, in addition to the lack of public awareness and interest in household recycling.	Chen et al. (2021)

Table 2. Plastic waste management type of handling literatures (continue)

Type(s) of Handling	Type of Wastes	Results	Ref
Alternative use of waste (The gasiforming: methanol)	End-of-life plastic waste	The process has been mainly developed in silico using Aspen HYSYS V10 with support from experimental data where simulation could not provide reliable information such as the gasification step.	
		Consolidated kinetic models are used both for the reforming and methanol synthesis steps, while the pre-reforming reactor is simulated at the thermodynamic equilibrium.	Prifti et al. (2021)
Alternative use of waste (Pyrolysis and RDF) analysis	Municipal Solid waste i.e., cartons, fabrics, kitchen waste, paper, plastic, rubber, PAP/AL/ PE composite packaging (multi-material packaging also known as Tetra Pak cartons), and wood.	Pyrolysis experiments were completed using eight types of organic waste and their two RDF mixtures. The Supplementary Material contains the mass yield, energy densification ratio, and energy yield results of the pyrolysis process.	Świechowski et al. (2020)
Alternative use of waste (plastic granule)	Recycled greenhouse covering film.	This paper reports upon findings from a combined Life Cycle Assessment (LCA) of single environmental issues (i.e., energy and water consumption, and GHG emissions) applied to a Sicilian firm, representative of APW collection and recycling to obtain Low-Density Polyethylene (LDPE) granules.	Cascone et al. (2020)
		The installation of a wind power plant would lead to around 56% and 85% reduction in NRPE resource exploitation and GHG emission, respectively. Finally, despite the huge consumption of water and NRPE resources and the resulting GHG emissions, the production of recycled-LDPE granules is far more sustainable than the virgin counterpart.	
Alternative use of waste (Waste to Energy/ incinerator) analysis	Plastic waste	The study has also found that, in some cases, energy recovery is the only way of further utilization.	Horvath et al. (2018)
		This system property needs to be highlighted because the energy from burned (recyclable) plastic waste is much less than the amount needed for the production of plastic products from virgin materials.	
Disposal	Plastic waste and marine debris	Reducing plastic waste before mismanagement occurs may also aid in the reduction of some diseases and help prevent flooding, particularly in urban areas	Jambeck et al. (2018)
Alternative use of waste (construction)	Plastic waste	This paper presents findings from a transdisciplinary research project focused on developing resources and capacity for the construction of affordable homes in a low-income community in Nigeria.	Oyinlola (2018)
		The findings demonstrate the benefits of tackling global challenges from a transdisciplinary perspective. This has implications for researchers focused on developing technical solutions for low-income communities.	
Alternative use of waste (flakes or pellets)	Plastic waste from municipal waste	Efficient collection of waste, increased recycling, and recovery can improve waste management, improve the welfare of waste pickers and ultimately reduce environmental risk in Ghana.	Bening et al. (2022)
		Recommend future studies to understand better the actual steps towards and barriers for the implementation of MSWM systems taking into account the cost data insights from this study.	

Alternative use of plastic waste was studied in publications such as mechanical and chemical recycling. Mechanical recycling turns plastic waste into construction material (brick, block, paving, and concrete) and Pelletization. The chemical recycling methods of plastics are cracking, depolymerization, pyrolysis, gasification (the production of alternative fuels from plastic waste), and combustion—for example, in waste incinerators. The heat of combustion plastic waste can be used to produce electricity or steam (Kijo-Kleczkowska, 2022).

Circular Economy and Sustainable Development Goals Achievement

SDGs Potential Achievements

This work contributes to at least five potential Sustainable Development Goals (SDGs) out of seventeen goals. Details of the achievement of those five goals created from waste management are described below:

SDG 3 – Good Health and Wellbeing

A good, clean, and healthy environment is an essential component of sustainable development globally. In recognition of this concern, SDG 3 can be achieved through the following. The proposed smart and sustainable waste management system is one innovation that has potential solutions to solve waste management issues in the community and industry. The ability to manage waste properly and to conduct waste treatment appropriately in the proposed waste management system offers direct and indirect advantages to the global population's good, clean, and healthy environment, which would significantly contribute to sustainable development.

SDG 6 – Clean Water and Sanitation

A strong interrelation exists between waste and water in the waste management system. This new waste management system uses various treatment technologies to transform waste into valuable materials and resources, which could significantly reduce the amount of waste. The reduction of the toxins, residues, emissions, and pollution created from waste could correspondingly reduce the water contamination in the land.

SDG 9 – Industry, Innovation, and Infrastructure

Develop quality, reliable, sustainable, and resilient infrastructure, including regional and transborder infrastructure, to support economic development and human well-being, focusing on affordable and equitable access for all. Support domestic technology development, research, and innovation in developing countries, including by ensuring a conducive policy environment for, among other things, industrial diversification and value addition to commodities through technology innovation on waste management.

SDG 12 – Responsible Consumption and Production

One of the SDG targets is reducing pollution, emissions, and waste through waste prevention, reduction, recycling, and reuse. This SDG is strongly connected to the implementation of circular economics. This new system offers appropriate, automated, and integrated waste collection, separation, and treatments which could significantly reduce these environmental problems.

SDG 13 – Climate Action

Optimizing waste collection, segregating waste at the source, applying appropriate treatment technology, and reducing waste headed to the landfill are essential activities. These actions allow waste to be controlled and monitored, and using the right technology will reduce CO2 emissions generated from the waste. This solution will help mitigate aspects of climate change.

Managerial Implications

This study also has important managerial implications to firm managers. First, the study shows the number of published documents increased significantly for the last five years. It means there were increase of environmental awareness among stakeholders such as enterprises, government, community, and market. Better environmental performance and better financial profitability is also consistent with the view that financial performance and environmental performance are both related to the quality of management. Excellent managers interested in their firm's long-term targets, accept their firm's social responsibility, and adopt proactive strategies to control environmental pollutions. Second, many technology innovations of

plastic waste management found in the literatures. Green innovation can improve economic performance, and firms should attach importance to the role of green innovation, increase investment in R&D, and promote the innovative development of green products and green processes.

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

Indonesia's pulp and paper industry is still facing impurities/plastic management issues. 74% of 47% operated companies still manage the waste by disposal in the landfill cooperated with a third party. In the long term, the third part will face issues on limited land capacity. Proper impurities/plastic waste management is needed. Based on the literature review, most of the publication was initially urged by Europe Union, the United Kingdom, and the United States. China and India were Asia's most productive countries to publish documents on plastic waste management. This shows the need for improved efforts toward research collaboration within the field. This would improve the limited research contribution from especially developing countries and related implementation issues and help solve the environmental issues.

There were mechanical and chemical recycling methods found in the literature. Most of the technologies used to make alternative use of waste such as construction material use, pyrolysis, gasiforming, Refuse Derived Fuel (RDF), incinerator, and other alternative use. Appropriate technology applied to plastic waste management should be encouraged to support sustainable development goals. It contributes to at least five potential Sustainable Development Goals (SDGs) out of seventeen goals: SDG 3, Good health and wellbeing, SDG 6, Clean water and sanitation; SDG 9, Industry, innovation and infrastructure; SDG 12, Responsible consumption and production; and SDG 13, Climate action. Furthermore, in recent times, circular economy and sustainability are highly rated and have become the direction of most research. In times of diverse growth in technologies and advanced knowledge, AI and IoT may be possible for relevant future research needs or reshaping the existing research.

Recommendations

Implementing strategies for sustainable waste management in the pulp and paper industry requires continuous collaboration among stakeholders as a facilitator. The implementation of waste management methods can be used as a reference to assist the government in formulating appropriate policies or regulations. For further studies, it can be reviewed in more detail regarding the benefits by calculating real financial feasibility. In addition, further studies could also include research about waste management, pulp and paper industry, and circular economy topics as a framework to fill the research gap contribution from developing countries.

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