

UTILIZATION OF OFFICE PAPER WASTE AS RAW MATERIAL FOR BRIQUETTES: A LITERATURE STUDY FROM AN ENVIRONMENTAL MANAGEMENT PERSPECTIVE

Rizky Ernando¹, Kelvin Dwiki Nugraha², Bernard Hasibuan³

^{1,2,3} Sekolah Pascasarjana Sahid, Jakarta Indonesia

E-mail: rizkyernando@gmail.com¹, kelvindwiki1702@gmail.com², bernard_hasibuan@usahid.ac.id³

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Abstract

Office paper is a type of solid waste, and its volume continues to increase due to its widespread use in administrative activities. If not managed properly, this waste can cause environmental problems. One alternative use is as a raw material for briquettes, which can serve as a renewable energy source. This study aims to analyze the potential of office paper as a raw material for briquettes, evaluate the production process and quality of briquettes based on a literature review, and develop a sustainable waste management strategy. This study used a literature review method, collecting and analyzing various scientific literature, including journals, books, conference proceedings, and related publications. The results showed that waste paper has a high cellulose content, making it a potential raw material for briquettes. The briquette production process involves crushing the waste into pulp, mixing it with a binder, molding, and drying. According to several studies, waste paper briquettes have a calorific value between 3000-5000 kcal/g, a relatively low moisture content, and good combustion performance, but their ash content remains high compared to some other biomass. Briquette quality is influenced by factors such as paper type, material composition, binder type, pressing pressure, and drying process. From an environmental management perspective, the use of waste paper for coal briquette production aligns with the principles of a circular economy, the 3R principle (reduce, reuse, recycle), and the conversion of waste to energy. Therefore, the use of waste office paper as a raw material for coal briquettes effectively reduces waste volume while producing an alternative energy source that is economical, efficient, and environmentally friendly.

Keywords: office paper waste, briquettes, alternative energy, environmental management, circular economy.

1. Introduction

1.1 Background

Today's office operations rely heavily on paper as the primary medium for administrative management, record-keeping, and communication. Despite rapid digital advancements, paper consumption in *office environments* remains high, particularly for archives, reports, and official documents. This high paper consumption directly leads to a continuous increase in the volume of paper waste generated daily. Office paper waste is often still viewed as useless, so its disposal is usually limited to throwing it away or selling it as a conventional recycling raw material with relatively low economic value. However, paper waste contains a high concentration of cellulose, making it potentially reusable as a substitute raw material for various products, one of which is briquettes as a renewable energy source.

Briquettes are solid fuels produced through the compaction of carbon-containing materials, such as biomass and organic waste. The use of waste paper as a raw material for briquettes is an innovative solution in waste management based on the principle of "waste to energy." This utilization not only reduces the volume of waste disposed of into the environment but also provides added value in the form of an alternative energy source that is more environmentally friendly than fossil fuels. In the context of environmental management, the practice of converting waste paper into coal briquettes is in line with the concept of a circular economy and the 3R principle (*Reduce, Reuse, Recycle*), which not only reduces waste but also recycles it into products that have economic value and practical functions. The implementation of this concept in the corporate environment helps create an environmentally friendly work environment and increases the efficiency of resource use. Previous studies have shown that briquettes made from paper waste have quite good properties, such as adequate calorific value, relatively low ash

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content, and ease of combustion. However, the quality of briquettes is greatly influenced by various factors, including the type of paper, the composition of the mixed raw materials, the type of binder, and the preparation method used. Based on the above analysis, further exploration is needed regarding the potential use of office paper waste as a raw material for briquettes through a literature review. This study aims to comprehensively discuss the characteristics of paper waste, the briquette-making process, the quality of the final product, and the implementation of effective paper waste management strategies in the corporate environment.

1.2 Problem Formulation

1. Based on its characteristics, how big is the potential of used office paper as a raw material for briquettes?
2. Based on literature studies, what are the preparation processes and quality characteristics of waste paper briquettes?
3. What strategies should be implemented to support sustainable environmental management through the use of briquettes in office paper waste management?

1.3 Research Objectives

1. Analyzing the potential of office paper waste as raw material for briquettes.
2. Based on the literature, researching the production process and quality of used paper briquette products.
3. Developing a waste paper management strategy that includes the sustainable use of waste paper to produce briquettes.

1.4 Benefits of Research

1. Theoretical Benefits

This research is expected to contribute to the advancement of science, particularly in the areas of environmental management and waste utilization. Furthermore, it can serve as a reference for further research on the use of paper waste as an alternative energy source, namely briquettes.

2. Practical Benefits

From a practical perspective, this research is expected to provide companies with information and solutions for managing paper waste more effectively and profitably. Utilizing paper waste as a raw material for briquettes not only reduces waste volume but also produces an economically valuable product, making it a viable alternative.

3. Environmental Benefits

This research is expected to support environmental protection efforts by reducing paper waste and implementing the "Reduce, Reuse, Recycle" (3R) principle. Furthermore, converting waste into briquettes is expected to reduce dependence on fossil fuels, thereby encouraging more environmentally friendly and sustainable development.

LITERATURE REVIEW

2.1 Office Paper Waste

Office paper waste is a type of solid waste generated in the workplace as a result of administrative, secretarial, and operational activities. Common types of used paper include HVS paper, printing paper, photocopy paper, and unused archival documents. This type of waste generally contains a high concentration of cellulose, making it potentially recyclable as a raw material for high-value-added products (Khalil et al., 2019). As noted by Bajpai (2018), paper consists of cellulose fibers derived from wood pulp and is combustible, making it suitable for conversion into energy through a thermal treatment process. However, if not managed properly, paper waste will increase the volume of waste and cause environmental pollution. Currently, paper waste is still disposed of using traditional methods, such as direct landfilling or open-air burning, which have a negative impact on the environment. Therefore, a more sustainable management approach is needed to utilize paper waste as an alternative resource.

2.2 Waste Management Concept

Modern waste management no longer focuses on disposal but instead treats waste as a reusable resource. One commonly used concept is the 3R principle (Reduce, Reuse, Recycle), which aims to reduce waste volume, reuse usable materials, and recycle waste into new products (Tchobanoglous et al., 2014). Furthermore, the concept of a "circular economy" is gaining popularity in waste management. This concept emphasizes closed cycles, where waste generated by one process can be reused as raw material for another process (Geissdoerfer et al., 2017). In the context of paper waste, compressing it into bales is one practical application of this concept. Another related approach is "waste-to-energy," which refers to the process of converting waste into usable energy. This technology not only reduces waste volume but also produces a more environmentally friendly alternative energy source (Arena, 2012).

2.3 Briquettes as Alternative Energy

Briquettes are a type of high-density solid fuel produced through the compaction of carbon-containing materials, such as biomass or organic waste. Briquettes offer several advantages, including ease of storage, high calorific value, and relatively low emissions compared to fossil fuels (Grover & Mishra, 1996). According to Onuegbu et al. (2011), briquette quality is influenced by several key parameters, such as calorific value, moisture content, ash content, and density. Calorific value reflects the energy released during combustion, while lower moisture content increases combustion efficiency. Briquettes made from biomass waste (including paper) have emerged as a promising alternative energy source because the raw materials are readily available and relatively inexpensive. Furthermore, the manufacturing process is simple and suitable for small- to medium-scale production.



Figure 2.1 Illustration of the charcoal briquette burning process

2.4 Utilization of Paper Waste as Briquettes

Paper waste contains high concentrations of cellulose and therefore can be used as a raw material for briquette production. The process of making paper briquettes generally involves several stages: processing paper into pulp, mixing with a binder, molding, and drying (Suryaningsih et al., 2020). Several studies have shown that paper waste can be processed into briquettes with quite good properties. For example, research by Rahman et al. (2021) showed that the calorific value of paper-based briquettes is quite competitive compared to other biomass sources. Furthermore, the use of binders such as starch can increase the mechanical strength of the briquettes. However, the quality of paper waste briquettes is greatly influenced by the composition of the raw materials, the type of paper, and the preparation method used. Therefore, further research is needed to optimize the production process and briquette quality.

2.5 Briquette Quality Parameters

Briquette quality is determined by several key parameters that serve as standards for evaluating solid fuels. These parameters include:

1. **Calorific Value** Calorific value indicates the total amount of energy released during combustion. The higher the calorific value, the better the quality of the briquette (Demirbaş, 2001).
2. **Moisture Content** Excessive moisture content reduces combustion efficiency because energy is first used to evaporate the water (Onuegbu et al., 2011).
3. **Ash content** reflects the residual material resulting from incomplete combustion. High ash content reduces energy efficiency and produces residue (Grover & Mishra, 1996).
4. **Density** affects the burning duration and physical strength of coal briquettes. Briquettes with high density usually have a longer burning time.
- 5.

2.6 Previous Research

Several previous studies have been conducted on the production of fuel briquettes from waste paper. Suryaningsih et al. (2020) noted that fuel briquettes made by mixing waste paper with natural binders have good strength and are highly flammable. Rahman et al. (2021) also reported that paper-based fuel briquettes have a high calorific value and can serve as an alternative household fuel. Furthermore, research by Onuegbu et al. (2011) showed that variations in raw material ratio and compaction pressure significantly affect briquette quality. Meanwhile, Demirbaş (2001) emphasized the importance of raw material characteristics in determining the energy performance of biomass

briquettes. Based on the above research, it can be concluded that waste paper has significant potential as a raw material for briquettes, although the production process still requires further optimization.

RESEARCH METHODOLOGY

3.1 Types of Research

This research uses a literature review approach, which includes a review and analysis of various types of literature related to the research topic. This literature includes scientific journals, books, conference proceedings, and other publications related to the use of waste paper as a raw material for briquettes. The purpose of this literature review is to gain a comprehensive understanding of the characteristics of waste paper, the briquette production process, the resulting product quality, and sustainable waste management strategies.

3.2 Data Sources

The data used in this study consists of secondary data obtained from various sources, including:

1. Domestic and foreign academic journals related to research topics
2. Reference book on waste management and alternative energy
3. Proceedings and research reports from relevant conferences
4. Online academic resources (Google Scholar, ScienceDirect, etc.)

The criteria for selecting literature sources include:

- Relevance to the research topic
- Published within the last 5 to 10 years
- Trusted and indexed (Sinta, Scopus, or other leading databases)

3.3 Data Collection Techniques

The data collection method used in this study is divided into the following stages:

1. Literature Search: Using keywords such as “waste paper briquettes,” “biomass briquettes,” and “waste to energy processing,” we collected various literature related to waste paper and briquettes.
2. Literature Screening: Based on the title, abstract, and content of the research, we select literature that is relevant and in accordance with the research objectives.
3. Data Grouping: Literature is grouped based on discussion topics, such as characteristics of waste paper, briquette making process, and briquette quality.
4. Data Organization: Important information from each referenced document is recorded and organized.

3.4 Data Analysis Techniques

This research uses a qualitative descriptive data analysis method, with the following specific steps:

1. Descriptive Analysis: Based on the reviewed literature, the characteristics of waste paper, the briquette making process, and briquette quality parameters are explained.
2. Comparative Analysis: Comparing the results related to briquette quality and manufacturing methods from previous studies.
3. Data Synthesis: Integrating findings from the literature to draw comprehensive conclusions regarding the potential use of waste paper as briquettes.
4. Conceptual Analysis: Exploring waste paper management strategies from the perspective of circular economy and sustainable environmental management.

3.5 Research Flow

The research flow in this literature study can be explained as follows:

1. Determining the research topic
2. Collect relevant literature
3. Filtering and grouping literature
4. Analyze and synthesize data
5. Organize the results and discuss them
6. Draw a conclusion

RESULTS AND DISCUSSION

4.1 Characteristics of Paper Waste as Raw Material for Briquettes

Based on literature studies, office paper waste is largely composed of cellulose, which is present in high concentrations, making it a potential raw material for briquettes. Cellulose is a flammable organic compound that produces heat energy during combustion. Various studies have shown that paper waste possesses the physical properties necessary for use as a fuel, such as a texture that is easily crushed, high water absorption, and the ability to be compressed into certain shapes. Furthermore, paper contains lignin, which functions as a natural binder,

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although its content is lower than other types of biomass. However, paper waste also has disadvantages, namely its relatively high ash content and the need for additional binders to increase the strength of the briquettes.

4.2 Process of Making Briquettes from Paper Waste

The results of the literature study show that the process of making briquettes from paper waste generally consists of several main stages, namely:

1. Crushing of raw materials Waste paper is soaked and crushed to become pulp.
2. Mixing of materials Paper pulp is mixed with adhesive materials such as starch or clay.
3. Briquette printing The mixture of materials is printed using a simple press.
4. Drying Briquettes are dried naturally or using an oven.

The difference in methods in each study lies in the composition of the material, type of adhesive, and printing pressure used, which directly affect the quality of the briquettes.

4.3 Quality of Briquettes from Paper Waste

The quality of briquettes made from waste paper can be analyzed based on several key parameters, such as calorific value, moisture content, and ash content. The following is a summary of the results of several previous studies:

Table 4.1 Comparison of Research Results on Briquettes from Paper Waste

No	Researchers	Raw material	Calorific Value (cal/g)	Water content (%)	Ash Content (%)	Information
1	Suryaningsih et al. (2020)	Paper + starch	3,500–4,200	5–8	10–15	Flammable
2	Rahman et al. (2021)	Paper	3,000–4,000	6–10	12–18	Stable
3	Onuegbu et al. (2011)	Paper + biomass	4,000–5,000	5–7	8–12	High quality
4	Demirbaş (2001)	Mixed biomass	4,500–5,500	4–6	5–10	Efficient

As shown in the table above:

- The calorific value of briquettes made from waste paper is quite competitive.
- The water content is relatively low, which is beneficial for the combustion process
- Compared to other types of biomass, the ash content is still relatively high.

Therefore, paper waste has potential as an alternative fuel, although the composition of the raw materials still needs to be further optimized.

4.4 Factors Affecting Briquette Quality

Based on the results of the literature review, the main factors that influence the quality of paper briquettes include:

1. Paper type: Paper briquettes made from paper with high cellulose content have a higher calorific value.
2. Type and amount of binder: Binder such as starch can increase the strength of coal briquettes.
3. Compression pressure: Higher pressure produces denser and more durable coal briquettes.
4. Drying process: Optimal drying process reduces moisture content and increases combustion efficiency.

4.5 Paper Waste Management Strategy in Companies

Based on the research findings, paper waste management strategies within companies can be implemented through a comprehensive approach, which specifically includes:

1. Collection and Sorting of Paper Waste

Companies need to build a special paper waste sorting system to facilitate further processing.

2. Making Briquettes

Collected paper waste can be processed into briquettes through a simple process, which is suitable for small and medium scale production.

3. Integration with Eco-Friendly Office Initiatives

Converting paper waste into fuel briquettes can be incorporated into green office initiatives to improve resource efficiency and reduce waste.

4. Benefit Analysis

This utilization step offers the following advantages:

- Economic benefits: Reduction of waste management costs
- Environmental benefits: Reduction of waste volume
- Energy benefits: Provision of alternative fuels

4.6 Discussion

Based on the results of the literature study, it can be concluded that office paper waste has significant potential as a raw material for briquettes. This is due to its high cellulose content and the abundant availability of raw materials in office environments. However, the quality of the resulting briquettes is still influenced by various technical factors, such as the composition of the raw materials, the type of binder, and the production process. Therefore, the production process needs to be optimized to produce better quality briquettes. From an environmental management perspective, the initiative to convert waste paper into briquettes aligns with the principles of a circular economy and "waste-to-energy." By implementing this strategy, companies can not only reduce environmental impacts but also generate added value both economically and energy-wise.

CONCLUSION AND SUGGESTIONS

5.1 Conclusion

Based on the results of the literature review, the following conclusions can be drawn:

1. Office paper waste has considerable potential as a raw material for briquettes due to its high cellulose content and ease of combustion, making it suitable for use as an alternative energy source.
2. The process of making briquettes from waste paper is relatively simple and involves steps such as cutting, mixing with a binder, molding, and drying. The quality of the resulting briquettes is influenced by parameters such as calorific value, moisture content, and ash content, as well as technical factors including paper type, raw material ratio, and production method.
3. Converting paper waste into briquettes is an effective and sustainable waste management strategy, as it reduces waste volume, increases the value of waste utilization, and supports the concept of a circular economy and environmentally friendly offices within the company.

5.2 Suggestions

Based on the research findings, the following recommendations are proposed:

1. Further experimental studies are needed to directly evaluate the quality of waste paper briquettes produced using different raw materials and production methods.
2. It is recommended that companies start implementing a comprehensive waste paper management system, including sorting waste paper and processing it into high value-added products such as briquettes.
3. Technical development and innovation in the briquette production process are needed to improve product quality and enable industrial scale implementation.

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