Implementation Analysis of the Cleaner Production Concept in Solid Waste Management among Food Businesses along Ryacudu Street, Sukarame District, Lampung Province, Indonesia

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Abstract. In the midst of city or regional growth and transformation, the establishment of fresh commercial zones often arises from the development of infrastructure and enhancements to roads, exemplified by the rejuvenation of Jl. Ryacudu in Bandar Lampung. The recent enhancements to Jl. Ryacudu, supervised by the Public Works and Construction Agency, have given rise to a thriving business center featuring an assortment of shops, cafes, restaurants, minimarkets, and various services lining both sides of the thoroughfare. Consequently, the increased activities have led to a proportional rise in waste production, especially within the food industry sector. Thus, effective environmental management is urgently required to prevent any adverse ecological impacts arising from the solid waste produced. This study aims to evaluate the current status of waste management in the food industry sector, focusing on both its effectiveness and efficiency. Additionally, the study proposes waste management strategies, emphasizing the adoption of the cleaner production concept, incorporating the principles of the 3R system (Reduce, Reuse, Recycle). The study's findings reveal that the complete implementation of the 3R system has yet to be achieved in the current setting. Nonetheless, the effectiveness and efficiency of the current solid waste management practices are considered satisfactory. Furthermore, the preparedness to adopt the 3R approach has been confirmed, indicating a promising path towards sustainable waste management practices within the restaurant industry.

Keywords: Cleaner Production, 3R System (Reduce, Reuse, Recycle), Food Industry Sector, Solid Waste Management

1 Introduction

As a city or region develops, infrastructure development and road improvement can transform an area into a new commercial district, as exemplified by Jl. Ryacudu in Bandar Lampung. The road improvements carried out by the Public Works and Construction Agency along Jl. Ryacudu, Bandar Lampung, have turned this area into a new commercial district, with various types of shops, cafes, restaurants, minimarkets, and diverse services lining both sides of the road [1]. This transformation is further facilitated by the opening of a new route that crosses this road, connecting to the Trans-Sumatra Toll Road, and the establishment of the Sumatra Institute of Technology in the area, leading to an increase in businesses, particularly in the food sector. The proliferation of food businesses can result in an increase in the amount of waste generated, necessitating an integrated waste management system based on the concept of cleaner production. Cleaner Production is a strategic approach aimed at reducing the negative impacts of business activities by adopting more environmentally friendly practices through optimizing resource utilization, reducing waste, and avoiding the use of hazardous substances[2].

Assessment of waste management performance in Bandar Lampung City, a performance score of 62% was obtained, which falls under the “good” category. This is supported by well-performing technical and institutional aspects. However, there is a need for improvement, particularly in the aspects of community and private sector participation, which scored only 50%, categorizing it as “low” due to a lack of public awareness. Effective waste management is considered good when there is an integrated and sustainable waste management plan and stronger legal frameworks for waste management enforcement[3].

This is further reinforced by the current waste conditions in Bandar Lampung City, where the amount of waste reaches 800 tons per day, consisting of 60%

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inorganic waste dominated by plastics and 40% organic waste, all of which are directed to the Bakung Landfill. The limited area of the Bakung Landfill, which is 14.2 hectares with a capacity of only 230 tons of waste per day, is insufficient to meet the current demands. Food waste is socially produced through the interactions and practices of different actors within food systems, and four symbolic processes that generate food waste at the retail-consumption interface should be considered when designing solutions to this major problem[4] Therefore, there is a need for an analysis of the implementation of the cleaner production concept in the Solid Waste Management using the Integrated 3R Method (Reduce, Reuse, Recycle) in Food Businesses along Jl. Ryacudu, Sukarame District, Bandar Lampung, Lampung.

2 Methodology

In this research, the method used is the descriptive research method. This study employs a quantitative approach, specifically utilizing interviews with questionnaires and observations. The respondents involved in the research are owners/employees/sanitation and waste staff. The population consists of 49 types of food businesses, and the sample size, determined using the Slovin formula, is 33 types of food businesses [5]. The locations of food businesses include restaurants, eateries, and cafes located on Jl. Ryacudu, Sukarame District, Bandar Lampung, Lampung. Data collection in this research consists of:

1. Questionnaires: Data will be collected through structured questionnaires that will be administered to the respondents, which may include owners, employees, and sanitation and waste management staff in food businesses. A Likert-scale questionnaire is a scale that can be used to measure an individual's or a group’s attitudes, opinions, and perceptions about a phenomenon or social phenomenon. By using the Likert scale, the variables to be measured are broken down into dimensions, the dimensions are further subdivided into sub-variables, and these sub-variables are elaborated into measurable indicators. criteria and indicators are used as guidelines or fundamental standards as references for measuring a change in an activity or an event [6,7]. The categories and indicators [8,9] are found in Table 1.

### Table 1. The categories and indicators.

<table>
<thead>
<tr>
<th>Category</th>
<th>Number</th>
<th>Indicator</th>
</tr>
</thead>
<tbody>
<tr>
<td>Effectiveness of solid waste management system.</td>
<td>1</td>
<td>The solid waste management system in restaurants and cafes allows for the reduction of the amount of waste generated.</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>The solid waste management system in restaurants and cafes allows for the reduction of negative environmental impacts.</td>
</tr>
<tr>
<td>Efficiency of solid waste management system.</td>
<td>1</td>
<td>The solid waste management system in restaurants and cafes is efficient.</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>The solid waste management system in restaurants and cafes has been able to reduce the time and effort required for solid waste management.</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>The solid waste management process in restaurants and cafes is very time and cost-efficient.</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>The solid waste management system in restaurants and cafes closely follows clear policies and procedures for solid waste management.</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>The solid waste management system in restaurants and cafes exhibits a high level of efficiency in handling solid waste, to the extent that the 3R (Reduce, Reuse, Recycle) management method can be applied.</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>The solid waste management system in restaurants and cafes has sufficient resources to handle solid waste.</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>The solid waste management system in restaurants and cafes has the support of relevant authorities for the transportation of solid waste.</td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>The solid waste management system in restaurants and cafes has an effective mechanism for handling non-recyclable or non-reusable solid waste.</td>
</tr>
</tbody>
</table>

Implementation of solid waste management with the 3R system method.

1. This restaurant and café has implemented a solid waste management system using the 3R method (Reduce, Reuse, Recycle).
2. This restaurant and café has established policies or regulations regarding solid waste management using the
3R method.

This restaurant and café has taken concrete actions to reduce the use of environmentally harmful products, such as not using single-use plastic bags.

This restaurant and café facilities for recycling solid waste, such as segregated solid waste collection or processing of organic waste into compost.

This restaurant and café engage in activities that provide environmentally friendly products, such as food or beverage packaging that can be recycled or reused.

2. Interviews: Interviews will be conducted with key stakeholders, such as business owners and relevant personnel, to gather qualitative insights and additional information related to waste management practices.

3. Observations: Researchers will make on-site observations to directly observe and assess waste management practices, infrastructure, and Type of Waste Bin [9,10] in the food businesses along Jl. Ryacudu. For data analysis and the detailed assessment of Waste segregation presented in Table 2.

Table 2. Waste segregation.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Objective Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Waste segregation (Type Waste Bin)</td>
<td>A. Organic waste (food waste and leaf/garden waste combined)</td>
</tr>
<tr>
<td></td>
<td>B. Food waste</td>
</tr>
<tr>
<td></td>
<td>C. Leaf/plant waste</td>
</tr>
<tr>
<td></td>
<td>D. Paper waste (cardboard and cardboard)</td>
</tr>
<tr>
<td></td>
<td>E. Plastic waste (plastic cups, plastic bottles, straws, etc.)</td>
</tr>
<tr>
<td></td>
<td>F. Specific waste (batteries and used lamps)</td>
</tr>
<tr>
<td></td>
<td>G. Residual waste (tissues, cloth, and cigarette butts)</td>
</tr>
<tr>
<td></td>
<td>H. Mixed waste</td>
</tr>
</tbody>
</table>

These data collection methods will provide a comprehensive understanding of waste management practices and the overall situation in the selected food businesses. For data analysis and the detailed assessment of categories and indicators of 3R-based waste management, they are presented in Table 3.

Table 3. Details of category and indicator assessment.

<table>
<thead>
<tr>
<th>Category</th>
<th>Objective Criteria</th>
<th>Measurement Instruments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Effectiveness of solid waste management system.</td>
<td>0 = Not vulnerable if the respondent's answer is &lt; the median value; 1 = Vulnerable if the respondent's answer is ≥ the median value.</td>
<td>The questionnaire uses a Likert scale.</td>
</tr>
<tr>
<td>Efficiency of solid waste management system.</td>
<td>0 = No benefit if the respondent's answer is &lt; the median value; 1 = Benefit if the respondent's answer is ≥ the median value.</td>
<td>The questionnaire uses a Likert scale.</td>
</tr>
<tr>
<td>Implementation of solid waste management with the 3R system method.</td>
<td>0 = No benefit if the respondent's answer is &lt; the median value; 1 = Benefit if the respondent's answer is ≥ the median value.</td>
<td>The questionnaire uses a Guttman scale.</td>
</tr>
</tbody>
</table>

3 Result and Discussion

3.1 Existing condition

Based on the obtained data, it is known that the types of food businesses located on Jl. Ryacudu consist of 3 categories: there are 16 eateries, 11 restaurants, and 6 Cafes. From the observations conducted, the existing condition of solid waste management in restaurants is not yet optimal. This is evident from the data on the types of segregated waste bins used by food businesses on Jl. Ryacudu, ranging from categories A to H, where 7 pairs of categories were selected by respondents (Figure 1). Most food businesses still choose category H only, which is labeled as mixed waste bins.

Fig 1. The types of segregated waste bins used by food businesses on Jl. Ryacudu.

From the existing data, it is evident that in terms of the availability of segregated waste bins, 64% of restaurants possess segregated waste bins, while 69% of eateries do not have such bins on Jl. Ryacudu. It is noticeable that the sampling locations for the count of segregated waste bin types appear to be insufficient. It is apparent that the three types of food businesses on Jl. Ryacudu predominantly falls into category C, wherein they only possess one type of waste bin, which is for
mixed waste. However, it is worth noting that based on the research findings, at least some food businesses have implemented two types of segregated waste bins.

Food businesses on Jl. Ryacudu has selected seven pairs of categories from A to H for the types of segregated waste bins utilized, as indicated by respondents. Unfortunately, for the three types of food businesses sampled for the types of segregated waste bins, they have exclusively opted for category H, denoting mixed waste bins. Detailed descriptions of the categories can be found in Table 3. It is apparent that 64% of restaurants are using segregated waste bins appropriately, in contrast to eateries where 69% are not utilizing segregated waste bins as intended.

The research findings depicted in Figure 2 indicate that the provision of segregated waste bins in food businesses on Jl. Ryacudu is more prevalent in restaurants compared to eateries. Among the three types of food businesses on Jl. Ryacudu, the chosen waste receptacle category is B, signifying semi-permanent waste bins, as opposed to open waste bins.

### 3.2 Effectivity and Efficiency of Solid Waste Treatment

The information regarding the effectiveness and efficiency of solid waste management in the restaurant was obtained from respondents who had a stake in the process, including owners, employees, or staff responsible for solid waste management. The variables related to the implementation aspects of solid waste management using the 3R method can be found in Table 3, with measurement criteria specified in Table 3.

![Fig 2. Effectiveness of solid waste management system.](image)

From the following graph, it can be observed that the average performance of various food businesses in terms of the effectiveness and efficiency of their solid waste management systems along Jl. Ryacudu is effective and efficient. This assessment is based on the criteria outlined in Table 3, which indicates that the aspects of solid waste management have been evaluated as good, in accordance with the measurement criteria.

The solid waste management practices in restaurants along Jl. Ryacudu has received a favorable evaluation in terms of both effectiveness and efficiency. Therefore, it can be concluded that these restaurants have successfully managed their solid waste. This achievement implies that these establishments have been able to reduce the negative environmental impacts of solid waste on their surroundings and efficiently utilize their solid waste resources. Consequently, these restaurants can be considered responsible businesses that prioritize environmental and community well-being.

### 3.3 Implementation of Solid Waste Management Using 3R Method

The implementation of solid waste management using the 3R method is one of the approaches used to reduce solid waste at the waste collection points (TPS). The variables related to the aspects of solid waste management implementation using the 3R method can be found in Table 3, with measurement criteria specified.

![Fig 3. Efficiency of solid waste management system.](image)

![Fig 4. Implementation of solid waste management using the 3R method in food businesses on Jl. Ryacudu.](image)
The graph shows that the percentage of restaurants implementing solid waste management with the 3R method is 79%. Therefore, it can be concluded that the implementation of solid waste management with the 3R method in restaurants is considered good. For eateries, the percentage of implementation of solid waste management with the 3R method is 71.4%, indicating a good level of implementation. Similarly, for cafes, the percentage of implementation of solid waste management with the 3R method is 85%, which also falls under the category of good implementation.

The assessment of the implementation of solid waste management with the 3R method as being good indicates that the principles of 3R (reduce, reuse, recycle) are already in practice. Although it may not be entirely systematic, as observed in the mixing of waste in the trash bins, there are already simple implementation efforts in place.

### 3.4 Strategic Recommendations for Solid Waste Management Using the 3R System Method

The researcher’s inquiry concerning the readiness of food businesses on Jl. Ryacudu in the serious implementation of the 3R (Reduce, Reuse, Recycle) paradigm among respondents is posed. This inquiry is made in accordance with the prescribed evaluation criteria as outlined in Table 3.

Among the food businesses located on Jl. Ryacudu, those who responded affirmatively (“yes”) indicate their readiness to earnestly implement the 3R principles. Conversely, those who responded negatively (“tidak”) expressed their unpreparedness, citing reasons such as the need for more time than usual and a perceived lack of efficiency due to the absence of supportive facilities.

Consequently, recommendations for the three types of food businesses on Jl. Ryacudu regarding the implementation of 3R is as follows:

1. The provision of at least two types of waste bins for proper waste segregation, such as organic and inorganic waste, should be ensured.
2. In the context of the “reduce” aspect (reusing) within food businesses, it is hoped that efforts will be enhanced to encourage the repeated use of dining utensils and glasses, thereby avoiding single-use items [11]. Additionally, reusable dining utensils should be made available for customers who wish to take them home.
3. Within the framework of “reuse” practices in restaurants and cafes, it is expected that initiatives will be taken to reduce the usage of disposable utensils and single-use plastics. It should be noted that the implementation level for the use of disposable utensils and single-use plastics in restaurants and cafes remains lower compared to that in traditional restaurants, as evidenced in Figure 4. Moreover, efforts should be directed towards efficient portion control and, in cases of food surplus, consideration of resale through applications offering leftover restaurant food at affordable prices, provided the food remains fit for consumption.
4. In the context of “recycle” practices, it is essential to establish facilities for the recycling of segregated solid waste or the reprocessing of organic waste to create compost [12]. Additionally, initiatives should be undertaken to recycle inorganic waste materials, such as transforming them into ecobricks or engaging in other suitable recycling activities. These measures can significantly contribute to waste reduction and support the advancement of a more environmentally sustainable future.

### 4 Conclusion

In conclusion, the current examination of solid waste management practices within restaurants has revealed some noteworthy insights. It is evident that segregated waste bins are primarily present, albeit with a limited variety, focusing on food and plastic waste categories. Despite this, the persistence of mixed waste bins remains a challenge. Additionally, the predominance of semi-permanent waste containers underscores the need for more durable and sustainable alternatives. Fortunately, the assessment of the effectiveness and efficiency of the existing system indicates favorable outcomes, highlighting the positive impact of ongoing efforts. Moreover, the readiness for embracing the 3R method has been ascertained, reflecting a promising trajectory for sustainable waste management practices within the restaurant industry.

Based on these findings, several recommendations are put forth for consideration. First and foremost, ensuring the availability of segregated waste bins with at least two distinct categories for sorting, particularly organic and inorganic waste, is crucial. Emphasizing the reduction of single-use items and encouraging the reuse of dining utensils through innovative customer initiatives can significantly contribute to waste reduction efforts. Strengthening initiatives aimed at minimizing the use of disposable utensils and single-use plastics is imperative. Efficient portion control and the potential resale of excess food through suitable platforms can help minimize food waste. Additionally, establishing facilities for recycling segregated solid waste...
waste, including the reprocessing of organic waste for compost production, and exploring suitable recycling avenues for inorganic materials are essential steps toward achieving a more sustainable waste management framework within the restaurant and café sector.

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