

ANALYSIS OF HOUSEHOLD WASTE MANAGEMENT USING AN ENTERPRISE RISK MANAGEMENT (ERM) APPROACH, CASE STUDY IN PEKANBARU CITY, RIAU PROVINCE**Putra Budi Ansori, Budiyanto and *Agustedi**

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Abstract

This research very different from previous studies because this study integrates waste management with enterprise risk management (ERM) which is linked to stakeholder participation. This research aims to identify and analyze the role of stakeholders in managing household waste in Pekanbaru City. Furthermore, this research aims to develop a new model for managing household waste using an ERM approach in Pekanbaru City. This research uses a qualitative approach with a case study research type and is descriptive in nature. This approach can understand in depth a case and event being studied with the facts found. This research focuses on the case of household waste in Pekanbaru City, Riau Province, Indonesia, but is seen to be related to several analysis units (stakeholders), namely; City government, packaging owner companies, waste transportation companies and the community as sources of waste. The data analysis technique for this research is the Spiral Model, namely; perform data managing, Reading and Memoing, Describing, classifying, and interpreting, and Representing and Visualizing. The results of this research show that *first*, the role of stakeholders in managing household waste in Pekanbaru City has not been effective according to the goals of waste management. *Second*, household waste management using the Enterprise Risk Management (ERM) approach succeeded in identifying 22 risk events and assessing extreme, high, medium and low risks. This risk category is useful for responding to risks by accepting, avoiding, reducing or sharing with other stakeholders. This shows that the waste management process in Pekanbaru City still has not implemented a new paradigm, namely Collect, Sort, Process and Dispose (KPOB). *Third*, this research resulted in the development of a Modified Household Waste Management Model (MMPS), which is household waste management that is strengthened with Enterprise Risk Management (ERM) elements so that the implementation of 3R (reduce, reuse and recycle) can be monitored from the source of the waste to the final processing site (TPA).

Keywords: Household WasteManagement,Enterprise Risk Management, Stakeholders.

INTRODUCTION

By 2030, the majority of the world's population is expected to live in urban areas (Prasetyono, 2017). The problem of waste is one of the main issues in developing countries, especially in cities that are experiencing rapid growth (Tsheleza *et al.*, 2017). Many countries have established public awareness programs in the form of agreements (Tasbirul Islam *et al.*, 2018). Developed countries have made the problem of waste something interesting, while in developing countries, waste is still a serious problem. Countries developed countries have made efforts to preserve and monitor the implementation of zero waste. Waste management in Indonesia is strengthened by the law on waste management, namely; Law No. 18 of 2008. Then, it is regulated in detail by Government Regulation Number 81 of 2012 concerning Household Waste Management and Types of Household Waste. Furthermore, in cities, Regional Regulations are stipulated as the basis for resolving waste problems in their respective regions. Furthermore, Pekanbaru City uses Regional Regulation No. 08 of 2014 concerning Waste Management. The Pekanbaru City Government has attempted to manage waste in a targeted and planned manner, namely by issuing Pekanbaru Mayor Regulation No. 154 in 2018 concerning Pekanbaru City Policies and Strategies in household waste management which contains: Policy Directions for waste reduction and handling, programs and guidelines for community waste management until 2025. Then the targets for reducing and handling Household Waste in Pekanbaru City include: First, the target of reducing Household Waste by 30% (thirty percent) of the Household Waste generation figure before 2025.

Second, the target for handling Household Waste is 70% (seventy percent) of the Household Waste generation figure in 2025. However, it needs to be explained that Pekanbaru City, with a population reaching 1,028,237 people in 2020 (Central Statistics Agency, 2020), experiencing rapid growth compared to 2010 which amounted to 897,768 people (Central Statistics Agency, 2010). However, this growth is not balanced by improvements in waste management which still relies on the Collect- Transport-Dispose (KAB) system or has not used the new paradigm, namely: Collect-Sorting- Process-and-Dispose (KPOB). The phenomenon of waste problems in the city of Pekanbaru from preliminary observations conducted by researchers can be summarized as follows: First, the waste collection time is not on time, the collection is carried out after 8 am.Second, it is still found that there are many illegal Temporary Disposal Sites (TPS), meaning that people throw away their rubbish carelessly. Third, still found a number of household wastes originating from outside the city of Pekanbaru. Residents living in Housing in Kampar Regency who throw away their waste when they go to work. This phenomenon shows that waste management still has a negative impact on humans and the environment. Explanation of Law No. 18 of 2008 in article 3 concerning the Definition of the principle of sustainability is that waste management is carried out using environmentally friendly methods and techniques so that it does not have a negative impact on public health and the environment, both for the current generation and for future generations. Another meaning of the principle of sustainability is waste management that takes into account the risks that occur in the future. The affirmation of waste management that takes into account risks is also described in the principle of safety and the principle of security, namely the obligation to guarantee and protect the community from the negative impacts of waste management. Until now, research on waste

management has still predominantly taken up the topic about waste management behavior influenced by norms, behavioral control, and environmental knowledge. The theory used Theory of Planned Behavior. (Wu Lingqiong *et al.*, 2022). Likewise, research by Fagariba and Song (2016) also on community attitudes and behavior towards waste in the city of Accra, Ghana. Other research on waste management associated with behavior, knowledge, attitudes and practices of waste management was conducted in Phnom Penh, Cambodia (Seng *et al.*, 2018). The results of reading the previous research above show that there is still little research that links waste management with risk management. The relationship between waste management and risk management is a step to reduce negative impacts and ensure safer, more efficient and sustainable waste management. The following is a table of research gaps in waste management that has not or has not linked waste management research with risk management, namely:

Table 1. The Research Gap in Waste Management is linked to Risk Management

No	Research Topics and Results	Researchers and year	Related to M.Risiko	No Related to M.Risiko
1	Waste management in Pekanbaru City; There is still minimal community participation in reducing waste and there are still problems with facilities and infrastructure	Ernawaty, <i>et al.</i> , 2019.	No	Yes
2	Waste management in Pekanbaru City; constrained by the fleet, lack of waste disposal sites, inadequate staff work and insufficient waste management budget	Isril, 2016	No	Yes
3	Waste management in Pekanbaru City; Collaboration with the private sector only means transportation, not waste reduction	Isril, 2019	No	Yes
4	Waste Management in Pekanbaru City; The waste management plan made by the Pekanbaru City Government is in accordance with the law, when implemented by the private sector, it has worked professionally, according to the benefits received by the community in transporting waste	Isril <i>et al.</i> , 2020	No	Yes
5	Waste Management in Pekanbaru City; The waste management policy framework will be achieved through three pillars, namely government, society and the business world.	Anugerah, <i>et al.</i> , 2020	No	Yes
6	Waste management in Brazil; offers alternative waste management by considering risks, causes, classification and offering three waste management scenarios (high, medium and low risk)	Lima and Paulo: 2017	Yes	No
7	Private companies and solid waste management (SWM) in Malang City. The company adopted a risk management framework based on ISO 31000, but it turned out that this company had not set risk management standards in company operations, employee non-compliance with safety, and low levels of workforce education.	Mathiang and Djakman; 2023	Yes	No
8	Literature study that utilizes the advantages of Geographic Information Systems (GIS) with a risk management approach in order to maximize organizational goals.	Purwoko <i>et al.</i> , 2019	Yes	No

Data Source: Research Process, 2024

Table 1 shows that there are five studies that are not related to risk management and there are three studies on the topic of waste management that are related to risk management. This shows that there is still a gap to conduct further research. This is because the three studies that are related to risk management do not use Enterprise Risk Managementt (ERM) approach, but rather using the ISO 31000 Standard; 2018 and the AS/NZS 43600 process standard; 2004. Therefore, it is hoped that this research has novelty by using the approach Enterprise Risk Managementt (ERM) Based on the problem background above, the research problems are formulated as follows: *First*, What is the role of stakeholders in household waste management in Pekanbaru City? *Second*, How to develop a household waste management model with an ERM approach in Pekanbaru City?

LITERATURE REVIEW

Understanding Waste Management

As a result of economic development and population growth, the contemporary world faces a global increase not only in the quantity of waste, but also in its quality diversity. Poorly managed waste deteriorates the environment as well as human health, sometimes causing serious health problems. Sustainable development requires proper handling of waste issues.

Meanwhile, the definition of household waste according to Law Number 18 of 2008 which comes from daily activities in the household does not include certain dirt and waste. As a result of economic development and population growth, the world is currently facing a global increase not only in the amount of waste, but also in the diversity of quality. Poorly managed waste worsens the environment and public health, and sometimes causes serious health problems. Sustainable development requires proper handling of waste problems (Ansori, PB, 2023). Waste is a dense daily human activity and/or process. Currently, most people still view waste as useless waste, not as a resource that needs to be utilized (Law No. 18, 2008). Waste management is a systematic, comprehensive and sustainable activity that includes waste reduction and management. The definition of management does not only involve technical aspects, but also includes non-technical aspects, such as how to organize, how to finance and

how to involve waste producing communities who are actively or passively involved in handling activities (Damanhuri, 2010).

The relationship between Waste Management Theory, stakeholder theory and the Enterprise Risk Management (ERM) approach

Household waste management in Pekanbaru City uses the waste management theory (Pongrácz, 2002-2006), the Enterprise Risk Management approach (COSO, 2004) and stakeholder theory (Freeman, 1984). This study is very different from previous studies, because this study will comprehensively examine the factors that influence waste management, which are associated with risk management. Furthermore, when the research results have been collected and discussed, it is also necessary to measure the level of stakeholder participation. Waste management theory provides a framework for understanding how household waste can be managed effectively. This theory helps in identifying the methods and strategies used in waste management, as well as the factors that influence the effectiveness of waste management (Pongraczew, 2002-2006). Meanwhile, stakeholder theory emphasizes the importance of involving various stakeholders in the waste management process. In this study, stakeholders are the government, community, private sector, and academics (Freeman, 1984). The use of the

Enterprise Risk Management (ERM) approach in this research also confirms that the research is research that seeks to expand existing theories (Eisenhardt and Grabebner, 2007). Expanding the use of the ERM Approach to Waste Management in Pekanbaru City by using eight ERM components, namely internal environment, objectives setting, event identification, risk assessment, risk response, control activities, information and communication, monitoring. The risks managed include strategic, operational, reporting and compliance risks and ERM covers the entire organization at all levels of the organization. The ERM approach becomes a risk management tool and also an integral strategy that supports sustainability and provides better insight into potential risks so as to be able to make informed and safe decisions. (Pramudya, 2024). It should be emphasized that this research is management science research or research on organizations that manage waste, not the waste objects. In line with the desire to focus on management studies, the main reference used is the integrative framework of ERM and managerial assessment as decision making (Crawford and Jabbour; 2023). Using this framework makes it easier to expand existing theory through research findings.

METHODS

This research uses a qualitative approach with a case study research type and is descriptive in nature. Qualitative research methods are a way to emphasize a deeper understanding of a problem (Creswell, 2016). This approach can understand in depth a case and event being studied with the facts found. This research focuses on the case of household waste in Pekanbaru City, Riau Province, Indonesia, but is seen to be related to several analysis units (stakeholders), namely; City government, packaging owner companies, waste transportation companies and the community. as a source of waste. The data analysis technique for this research is the Spiral Model, namely; perform data managing, Reading and Memoing, Describing, classifying, and interpreting, and Representing and Visualizing. (Wulansari, 2016). The informants for this research were 17 people who fulfilled the elements of stakeholders in waste management, namely government, academics, the community, packaging companies and waste transportation companies. Data collection for this research begins with observation and throughout the research process from initial interviews to re-interviews as confirmation. Next, the data will be examined or explained as it is so that an understanding is obtained. Data collection methods used in this research include interview and observation methods (Sekaran, et.al; 2017 and Sugiyono. 2018)

RESULTS AND DISCUSSION

This research was conducted in Pekanbaru City for approximately 12 months. This city is a city of trade, center of government, social, political, education and tourist destination. Pekanbaru City is the capital of Riau Province which continues to develop and progress so that it becomes an attraction for residents of other regions to move to this city. Currently the population is 1,028,237 people or 301,226 families. Pekanbaru City is divided into 15 Districts consisting of 83 sub-districts that oversee 763 Citizens' Associations (RW) and 3,081 Neighborhood Associations (RT). Furthermore, waste management in Pekanbaru City divides the authority of management into three waste transportation management zones to the Final Processing Site (TPA). Zone I (Districts overing

Marpoyan Damai, Payung Sekaki, Bina Widya and Tuah Madani Districts), then Zone II (Covering Senapelan, PKU Kota, Sukajadi, Tenayan Raya, Bukit Raya, Limapuluh, Sail and Kulim Districts) and Zone III (Covering Rumbai and Rumbai Pesisir Districts). Based on the data obtained during the research, the results and analysis of household waste management in Pekanbaru City can be compiled, namely:

The Role of Stakeholders in Waste Management

Based on the results of observations, interviews and documentation, it turns out that the identification and analysis of the role of stakeholders in managing household waste in Pekanbaru City has not been effective as the aim of waste management is to improve health and environmental quality and make waste a resource. This is caused by:

1. Community participation is not optimal, namely waste has not been sorted, there are still residents who do not participate in waste transportation, there are still residents who litter and there are still few members of the Waste Bank.
2. The role and responsibility of the city government are also not yet effective, namely regulations that have not been implemented in the field, infrastructure that is still lacking (TPS, TPS-3R, Waste Bank), has not accommodated offers of solutions from the community, financial sources for waste management from companies do not yet exist and TPA management is without waste processing.
3. RT/RW administrators in the field have participated in socialization, participated in taking action against violations, participated in the formation of Waste Banks and actively conveyed information regarding waste management. However, their authority is not explicitly stated in existing regulations.
4. The role of Waste Banks and TPS-3R has not been optimal as an instrument for waste reduction, due to the low level of public awareness in waste sorting, several waste banks are still constrained by management, the operation of Waste Banks is not yet adequate to manage waste, private sector assistance for Waste Bank management is also not optimal, and Waste Management at TPS-3R still experiences many obstacles (management, land and public awareness).
5. The role of private companies as waste transportation partners is in accordance with the contract, but this transportation contract does not have any points for waste reduction and processing. Because the payment for the transportation contract is based on the results of weighing the waste at the TPA. This means that partners cannot reduce waste in the transportation process from the TPS to the TPA, because it is not included in the clause in the contract.
6. The role and responsibility of producers have not been running effectively. There are still companies that do not understand the responsibility of producers, local governments that do not understand that the responsibility to collect commitments from manufacturing companies is the central government, while for food and beverage companies and retail companies it is the responsibility of the city government.
7. Academics have not been involved in waste management in Pekanbaru City. This can be seen from the fact that they have not been involved in the formulation of waste management policies and strategies, several concept

proposals have not been responded to by the Pekanbaru city government, academics have not been involved in education for the waste bank program, the TPS-3R program, and compost houses, academics have not been actively involved in the Waste Care Forum.

The findings of this study confirm previous research which states that stakeholders contribute ideas (concepts) for program implementation, participation of the parties and evaluation of waste management (Hodgkins, *et al.*, 2017). Because the meaning Stakeholder Theory (Freeman, 1984) is an effort to formulate and implement programs from various parties with different interests in one system that can help satisfy all stakeholders for common goals. In the context of household waste management, this theory is used to identify and integrate various stakeholders such as government, community, private sector, and non-profit organizations in efforts to manage waste more effectively and sustainably. Model quadruple helix is a collaborative approach that connects four main stakeholders in waste management: government, academics, industry (business), and society. This approach aims to create more holistic and sustainable solutions in waste management by utilizing the expertise and resources of each stakeholder (Firmansyah *et al.*, 2023).

Developing a Household Waste Management Model with an Enterprise Risk Management (ERM) approach

The following are the results of observations, interviews and documentation in this study followed by a discussion to develop a Household Waste Management model. The development of the model with the Enterprise Risk Management (ERM) approach resulted in the overall process of household waste management in Pekanbaru City still not using a new paradigm, namely Collect Sort Process and Dispose (KPOB).

The following is evidence that the current waste management of Pekanbaru City is still Collect-Transport and Dispose (KAB) as seen from the activities of the final processing site (TPA), still the final disposal activity so that it burdens the TPA. This is reinforced by evidence that:

1. It has been proven that in the past 15 years, Pekanbaru City has created two final processing sites (TPA), namely: Muara Fajar 1 which is full and Muara Fajar 2 which was operated in March 2019. Currently, Muara Fajar 2 TPA is almost full, which is estimated to be completed in 2025 at the latest.
2. Waste management has not yet carried out the process Reduce, Reuse and Recycle (3R process) from households, only a few RT/Housing areas sporadically carry out Reduce, Reuse and Recycle and has not been structured as good community behavior. The success of communities in several RT/Housing areas in managing waste should receive regular incentives as an award for community groups that have succeeded in managing waste.
3. Housing complexes have handled waste well in their environment but have not yet referred to the principles Reduce, Reuse and Recycle (3R). But only moving waste from the Temporary Disposal Site (TPS) to the Final Processing Site (TPA).

Seeing the above facts, waste management in Pekanbaru City has not used the Collect Sort Process and Dispose (KPOB) method, which means that waste is collected at TPS-3R and

then sorted according to type (organic and inorganic) and then processed into 3R waste, then the rest cannot be processed (Residue) which will be disposed of at the TPA. However, if we look at the completeness of regional regulations, waste management strategies and policies, equipment and waste reduction instruments, then it meets the requirements to use the Collect Sort Process and Dispose (KPOB) method. Next are the eight components of the approach Enterprise Risk Management (ERM) can provide the following conclusions: First, on the components Internal Environment that the implementation of waste management, namely the Pekanbaru City Environmental and Sanitation Service (DLHK), has been equipped with complete regulatory instruments to organize waste management effectively and efficiently. However, research findings show that: DLHK does not have detailed data on waste reduction, waste handling carried out by DLHK is problematic and TPA is still the final disposal site, there have been no waste processing steps or TPA has not become a Final Processing Site.

Second, the components Objective Settings the Pekanbaru City Government has determined Mayor's Regulation No.154 in 2018 concerning Pekanbaru City Policy and Strategy in household waste management (JAKSTRADA). However, the direction of the Pekanbaru city waste reduction and management policy has not become a common understanding or has not become the awareness of the community and other parties (private sector and academics) to participate. Component Event Identification then it was recorded that there were 22 events that occurred at the source waste, there were five events found in waste reduction instruments (Waste Bank, compost house, maggot, TPS-3R), there were six events found in Temporary Shelters (TPS), there were two events in transfer depots, and there were three events at the Final Processing Site (TPA). Next, in the Risk Assessment, risk categories are arranged after multiplying the probability and severity levels into low, medium, large and extreme. Low risk is an event that has a score of 1-4, then medium risk is a score of 5-9. Furthermore, high risk is an event that has a score of 10-16 and extreme risk is an event that has a score of 17-25. Based on this category, six extreme risks and eight high risks were found. Then there are two medium risks and six low risks that can be overcome by RT/RW administrators. The following are six events in the extreme category, namely:

The table below illustrates that there are six extreme risks, namely one event at TPS, two at deposit transfers and three at TPA. The existence of this extreme risk can be important data for the Pekanbaru City DPRD to carry out a comprehensive evaluation of the city's waste management model so far. Because this extreme risk occurs because there is no waste management program that reduces waste from the source and the landfill becomes a dumping ground without meaningful 3R (reduce, reuse and recycle) processing.

Furthermore, the high risk category can be detailed in the following table, namely:

Table 3 shows that there are eight high risks, namely two at waste sources, four at Waste Banks and waste reduction instruments and two risks at TPS. This high risk should be of concern to the Mayor of Pekanbaru who has assigned the Head of DLHK to monitor field developments related to this high risk incident.

Table 2. Extreme Risk Category

No	Waste Flow	Event Identification	Risk Value	Information
1	Temporary Shelters (TPS)	12. It was discovered that the weight of waste from TPS to TPA was the same, there was no processing in the form of sorting waste	20	Extreme Risk, must be evaluated by the DPRD Pekanbaru City..
2	Transfer Depo	18. Based on the cooperation contract for waste transportation, the City government will pay for the weight of the waste delivered to the landfill	20	Extreme Risk, must be evaluated by the DPRD Pekanbaru City.
		19. There is no requirement in the cooperation contract that the transportation company must sort or process waste	20	Extreme Risk, must be evaluated by the DPRD Pekanbaru City.
3	Final Processing Site (TPA)	20. There are no waste processing activities at Muara Fajar 2 TPA.	25	Extreme Risk, must be evaluated by the DPRD Pekanbaru City.
		21. The impact of landfill activities without processing has resulted in the Muara Fajar 2 landfill being almost full.	20	Extreme Risk, must be evaluated by the DPRD Pekanbaru City.
		22. There may be fraud in "weighing" the waste at the landfill	25	Extreme Risk, must be evaluated by the DPRD Pekanbaru City.

Source: Research Results, 2024

Table 3. High Risk Category

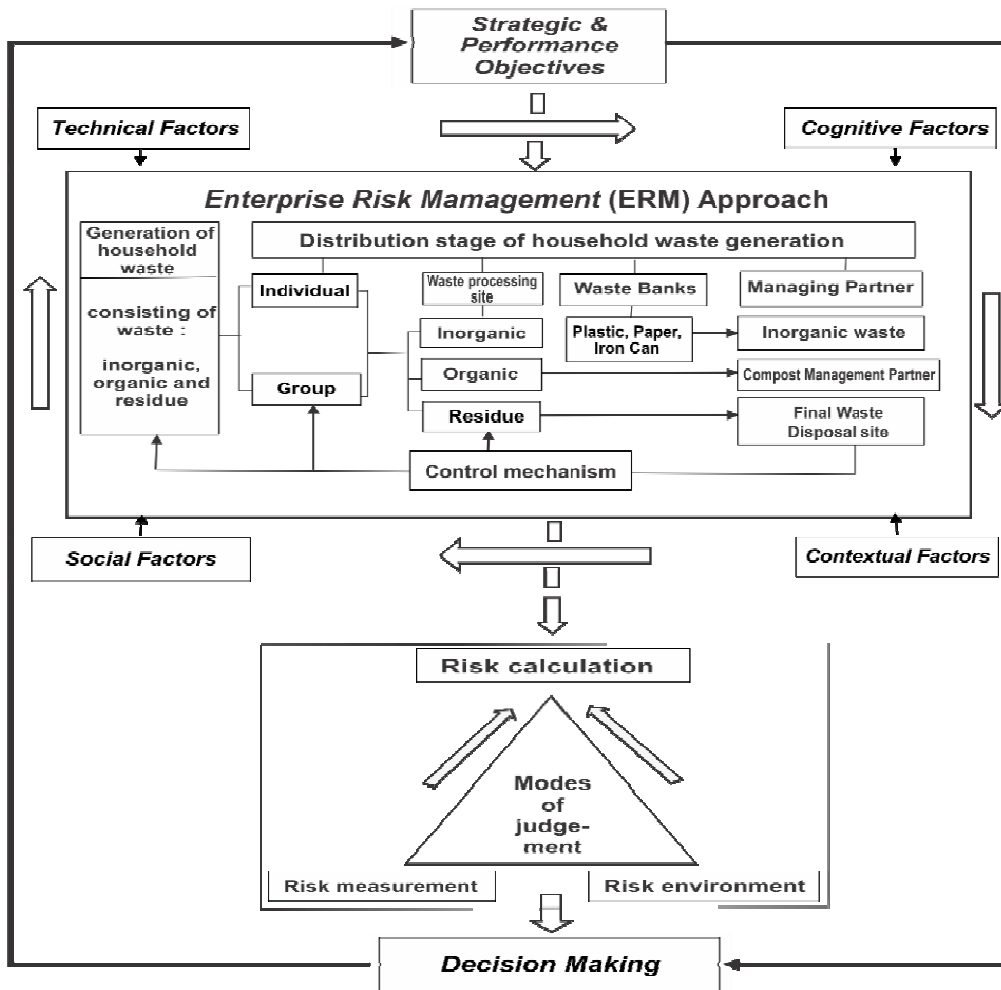
No	Waste Flow	Event Identification	Risk Value	Information
1	Waste Source	2. Society has not separated waste based on organic and inorganic waste	12	High Risk, must be the mayor's concern and Head of DLHK Service.
		3. The community carries out waste activities (Reduce, Reuse and recycle)	12	High Risk, must be the mayor's concern and Head of DLHK Service
2	Waste Bank and Waste Reduction Instruments (compost house, manggot, TPS-3R)	7. Many of the 3R TPS that have been built are not running	16	High Risk, must be the mayor's concern
		8. The Compost House is also not running	16	High Risk, must be the mayor's concern
		10. Operational assistance for the Waste Bank can revive waste bank units and workers	12	High Risk, must be the mayor's concern
		11. The operational assistance of Packaging Owner Companies has not yet been realized in waste reduction instruments	12	High Risk, must be the mayor's concern
3	Temporary Shelters (TPS)	13. Most waste cleaning officers do not use K3 standards	12	High risk, must be a concern for the head of service
		15. It is difficult to close illegal polling stations	16	High Risk, must be the mayor's concern

Source: Research Results, 2024

Furthermore, the Risk Response component ensures response options for risk assessment categories (Extreme, high, medium and low), namely Risk Avoidance, Risk Reduction, Risk Sharing, Risk Acceptance. Then the Control Activities component states that there is no control of management activities at the RT-RW level so a solution is needed in the form of an assessment by the village head regarding waste management. The Information and Communication component is not yet running involving waste management stakeholders, but the communication channels that are running are only within the Environment and Hygiene Service and communication channels with waste transportation partners. Lastly, the Monitoring Component is the final stage in efforts to achieve waste management targets and the waste management findings do not show any changes for the better, but waste management is still Collect-Transport-Dispose (KAB). After we use the eight components Enterprise Risk Management (ERM). Then the research continued with factors that influence decision making in waste management related to the ERM approach and managerial assessment as decision making.

This framework states cognitive factors, contextual factors, social factors and behavioral factors. Technical aspects make a significant contribution to all eight components Enterprise Risk Management (ERM) and can form decision considerations based on the situation and conclusions of events that exist in management. These factors can be detailed into:

First, the cognitive factor in waste management is that good knowledge will influence waste management behavior to be better. Increasing knowledge can be improved through training and routine community activities for a healthy lifestyle. Based on the results of research findings in Pekanbaru City, it shows that the level of community knowledge is still low, namely: the community has not separated organic and inorganic waste, the community has not carried out reduction, reuse and recycling activities (reduce, reuse, recycle), and people are still found to be throwing away garbage at the wrong time and not within the specified disposal time. Second, contextual factors in waste management that influence waste generation, namely population, geographical location, season, lifestyle, community habits, technological advances. In this research it was found that: Pekanbaru City still uses a management system that still collects, transports and disposes of, there is no reduction or processing. Pekanbaru City has also been equipped with Regional Regulations and Mayor regulations but they are not yet effective.. Contextual factors involve environmental aspects that influence decision making, namely: Government policies and regulations related to waste management, local and regional economic conditions that can influence resources and investment in waste management and organizational culture and values held by the community. Third, the social factor in waste management is involving the community in waste management, building community social groups (KSM) to reduce and monitor waste management and building communication so that there is an exchange of information on effective waste management methods.



Source: Processed Data, 2024

Figure 1. Modified Household Waste Management Model (MMPS)

In the research, it was found that firstly, waste reduction instruments (Trash Bank, TPS-3R, compost house) were not working due to the management being unable to develop good management and low involvement of the local community. Second, communication between the Waste Bank, Waste Bank and DLHK. Communication with the company that owns the packaging has not gone well. Fourth, technical factors in waste management in the form of waste reduction and processing systems and completeness of facilities. Based on research findings that there is a shortage of waste storage sites (TPS), final processing sites (TPA) do not have waste processing facilities and many 3R TPS are not operating for various technical reasons. Technical factors relate to the technology and infrastructure used in waste management, including: Availability and efficiency of waste processing technology, such as recycling and composting, infrastructure for collecting, transporting and processing waste, technical capabilities of the workforce in waste management. Seeing the household waste management model that as a whole the process still does not use a new paradigm, namely the Collect Sort Process and Dispose (KPOB) method, this study develops a new waste management model by adding an Enterprise Risk Management (ERM) approach as a reinforcement so that the waste collection process, the sorting process according to type (organic and inorganic) and the 3R waste processing process (reduce, reuse and recycle) can run according to applicable provisions. The following is a picture of the development of the 3R waste management model which is added with a risk approach, as follows:

The results of this research resulted in the development of a Modified Household Waste Management Model (MMPS) which is expected to be a solution for managing household waste by calculating the risks that may occur. The following is an explanation of the model above: First, Strategic and Performance Waste management in Pekanbaru City aims to create a healthy and clean environment, preserve environmental functions and public health, increase the active role of the community and business actors, and make waste an economically valuable resource through waste reduction and handling programs. The success of waste management is influenced by several factors, namely cognitive factors related to risk and management solutions, contextual factors involving environmental aspects in decision making, social factors in the form of community participation and stakeholder communication, and technical factors including technology and supporting infrastructure. Furthermore, this model can help monitor the waste management process which requires using the 3R principle (reduce, reuse and recycle) starting at the waste generation (TS), at waste reduction instruments (Trash Bank, TPS-3R and Kompos House), at the waste transfer depot and final processing site (TPA). All of these stages can monitor the implementation of 3R waste processing (reduce, reuse and recycle). The Control Mechanism in the picture above is a more detailed explanation of the Enterprise Risk Management (ERM) components, especially the Event Identification, Risk Assessment, Control Activities, Information and Communication and Monitoring components, which means a control mechanism. The final stage is

determining the level of success of waste management in Pekanbaru City by taking into account the elements of Enterprise Risk Management (ERM), namely risk calculations, environmental risks and measuring potential risks that arise. In summary, the development of a Modified Model for Household Waste Management (MMPS) is the implementation of waste management which is strengthened with elements of Enterprise Risk Management (ERM) so that the implementation of 3R (reduce, reuse and recycle) can be monitored from the source of the waste to the final processing site (TPA).

Research Contributions and Limitations

The results of this research contribute to the development of (theoretical) knowledge and practical contributions to this case study research, namely: *First*; This research integrates Waste Management Theory with Enterprise Risk Management (ERM). Waste Management Theory (Pongrácz, 2002-2006) emphasizes the importance of waste prevention to protect human health and the environment. This theory also emphasizes optimizing resource use and integrating industrial ecology concepts to achieve sustainable waste management goals. Meanwhile, the Enterprise Risk Management approach (COSO, 2004) is a process that involves identifying, analyzing, prioritizing and handling risks and opportunities that can influence the achievement of an organization's strategic goals. This research expands previous limited research using the ERM approach in financial institutions, insurance and manufacturing companies (Kallenberg, 2009) to the application of ERM in waste management public organizations in Pekanbaru City.

Second, Contribution of Stakeholder Influence in the Enterprise Risk Management (ERM) Approach. Stakeholder theory (Freeman, 1984) emphasizes that organizations must consider the interests of all interested parties (stakeholders) in their decision making. In the context of household waste management in Pekanbaru City (2024), involving various interested parties (community, government, business actors, academics and other stakeholders) in the ERM process can increase the effectiveness of household waste management and offer sustainable and fair solutions. In addition, the advantage of involving the interests of all parties involved can prevent conflict and provide full support in the form of active involvement of all parties. Furthermore, stakeholder involvement in the identification and process of Enterprise Risk Management (ERM) can help reduce social and environmental risks arising from poor waste management.

Third, the practical contribution of this research is that the Enterprise Risk Management (ERM) approach is able to identify 22 events, assessing these events into extreme, high, medium and low risk categories. Next, respond, control and monitor possible risks that may arise. The ERM approach helps ensure that all waste management processes comply with regulations, identify risks of work accidents and minimize their impact. The ERM approach also helps in planning and maintaining smooth operations and ensuring responsible, environmentally friendly and sustainable waste management practices. Furthermore, this research offers a solution in the form of a waste management model. However, on the other hand, researchers realize that the results of this research have limitations, namely: limited data and sources of information collected and the data used only covers the period November

2023 to November 2024, some DLHK data is expected to be accessible only in January 2025.

Conclusions and suggestions

Based on the results of the research above, the following conclusions can be drawn: First, the results of the identification and analysis of the role of stakeholders in managing household waste in Pekanbaru City have apparently not been effective as the aim of waste management is to improve health and environmental quality and make waste a resource. This is caused by community participation that is not yet optimal, the role and responsibilities of the Pekanbaru City government are not yet effective, and the role of the Waste Bank and TPS-3R is not yet optimal. Although the role of private companies as waste transportation partners is in accordance with the contract, the contract does not include points for waste reduction and processing. Apart from that, the roles and responsibilities of producers who own packaging have not been implemented effectively, and academics have not been involved in waste management in Pekanbaru City.

Second, the discussion regarding household waste management using the Enterprise Risk Management (ERM) approach succeeded in identifying 22 risk events in household waste management in Pekanbaru City. After assessment, the risk is categorized into extreme, high, medium and low levels. This risk category is useful for responding to risks by accepting, avoiding, reducing or sharing with other stakeholders. The results of the analysis show that the waste management process is not optimal, especially in the aspects of activity control, information and communication, as well as monitoring activities which are still not optimal. Overall, this shows that the waste management process in Pekanbaru City still has not implemented a new paradigm, namely Collect, Sort, Process and Dispose (KPOB). Third, this research resulted in the development of a Modified Household Waste Management Model (MMPS) which is expected to be a solution for managing household waste by calculating the risks that may occur.

Furthermore, this research provides suggestions for improvements in household waste management in Pekanbaru City as follows; First, the Pekanbaru City Government should start managing waste independently, which actively involves TPS-3R and the Waste Bank. Second, the Pekanbaru City Government is advised to collaborate on waste management through the Subdistrict Waste Management Institution (LPS), not with private partners as so far. Reducing and sorting waste is the responsibility of the sub-district LPS and the residue from processing this waste will be disposed of at the landfill. Third, the Pekanbaru City Government is advised to reorganize existing companies in Pekanbaru in order to increase waste levies and involve companies operating in Pekanbaru City to carry out producer responsibility activities in the form of real support for efforts to reduce plastic waste.

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