Reverse Logistics for Medical Waste During the Covid-19 Pandemic: A Literature Review

Yasmin Mauliddina*

Industrial Engineering, Institut Teknologi Indonesia, Indonesia
**Corresponding author: yasmin.mauliddina@iti.ac.id*

ABSTRACT
The Covid-19 pandemic impacted globally, mainly in healthcare aspects. The pandemic raised the call for medical service, medical equipment, and personal protective equipment (PPE). The World Health Organization (WHO) recommended people wear PPE during the pandemic. Nations also performed tremendous testing for Covid-19. In two years, The United Nations of Children, Education, and Fund (UNICEF) has shipped hundreds of millions of items of PPE worldwide. This initiative resulted in more than 100,000 tons of medical waste. However, less than half the of medical facilities worldwide are unprepared to handle the medical waste. The mishandled of medical waste might increase the infectious equipment pollution, jeopardize the environment, and elevate disease spreading. This paper provides the literature review with respect to the role of reverse logistics for medical waste during the pandemic. The reverse logistics decisions and policy for medical disposal are generally focused on minimizing the risk, reducing the budget and costs, optimizing the routes and facilities, and maximizing the collected waste. Among the insights, the results suggest that several considerations need to be heeded related to the local capacity. The role of local government, researchers, and policymaker affect the management of medical waste removal during the pandemic.

Keywords: *reverse logistics, medical waste, Covid-19, pandemic*

1. INTRODUCTION

The Covid-19 pandemic started in December 2019 and has impacted globally since then. The pandemic spread worldwide and forced the World Health Organization (WHO) to apply regulations to adapt to the pandemic situation. Although the WHO obliged the used of masks in indoor and outdoor activities, but the cases of the pandemic raised the call for medical services. The world has been passing through waves and variants of the Covid-19 which also resulted in a dramatic request for medical equipment and personal protective equipment (PPE).

For the last two years (January 2020-December 2021) UNICEF has shipped over 800 million items of personal protective equipment to 141 countries. The equipment included medical masks, N95 respirators, goggles, gloves, medical gowns, and more [1]. This initiative resulted in more than 2,0000 tons of non-infectious waste (mainly plastic), more than 700,000 liters of chemical waste, and approximately 144,000 tons of additional waste in the form of syringes, needles, and safety boxes [2]. The mishandled of medical waste treatment could lead to the risk of rapid transmission from infectious waste, which consequently, might result in a higher number of people infected.

Unfortunately, 30% of healthcare facilities worldwide are unprepared to handle the existing waste loads. This potentially exposes health workers and communities living near the mismanaged landfills, through the air and water transmission, or microorganisms [2]. The alternatives to eliminate the risk of virus transmission and conserve the environment need to be examined.

Based on this dilemma, this study aims to identify the possibility and the role of reverse logistics as one of the alternatives to handling medical waste as the impact of the pandemic. Although most of the reverse logistics applied widely mainly for the manufacturing and other commercial industry, this study was only limited to the situation of reverse logistics for medical waste during the Covid-19 pandemic.

2. METHODS

Generally, most of the studies about reverse logistics were carried out by a mathematical model, optimization method, or programming with multi-objective. On the other hand, this study was conducted by literature review. The materials are obtained mainly from the articles, and supported by additional resources from institutional portals, or other credible sources. The method consisted of 4 steps: searching, sorting, deep reading, and analyzing. The literature review seeks to discuss the combination of both areas: medical waste, and reverse logistics. But in this paper, the study will be carried out by literature review. By enlarging the legitimacy from the review, the policymaker and practitioners could rely on this basis to formulate decisions and take the initiative [3]

The first procedure of the review was searching. The researcher determined the keywords used to explore the papers. The keywords need to be consistent along with the research, to avoid any bias and inconsistency during the review. After considering the titles and abstracts, the researcher sorted out the relevant journal and conducted a deep reading. Subsequently, the researcher analyzed the adopted article and investigated the relationship with the stated problem.

3. RESEARCH and DISCUSSION

The reverse logistics for medical disposal generally aims for two aspects: network optimization and location optimization. Network optimizations were including hospital, collection centers, transit centers, processing centers, and disposal sites construction. The reverse logistics theory considers the location of the facility and waste flow arrangement and balances the operational costs and the affected environment. Optimizing in selecting the area using a multi-objective and multi-period method, with the purpose of minimizing operating costs and less environmental damage. This optimization method is based on the quantity of healthcare waste generated. [4]

From the reverse logistics standpoint, the treatment of medical waste particularly during the Covid-19 pandemic needs to be prompt, effective, and safe, to minimize the virus spreading and the risk to humans. Due to the exponentially quick spread of the disease at the first stage, the development of infectious medical waste as well as other healthcare dangers may be substantially increased in no time. This leads to a significant challenge for the reverse logistics system of medical waste. [5]

The hospitals, laboratories, clinics, cemeteries, and residential areas produced medical waste during the pandemic. The infectious waste generated in clinics, laboratories, and residential areas was approximately 0.5 kg, 0.3 kg, and 4 kg per patient per day respectively. The excess for burring each deceased outpatient is around 5 kg per patient per day. In a hospital, the number of infections received and the trash generated per bed were proportional to the quantity of medical waste and healthcare hazards generated [6]

The problem created corresponding to the reverse logistics for medical waste during the pandemic was unlike normal conditions. The obstacle in the epidemic outbreak has the characteristics as follows [5] :

1. Short planning horizon (within several weeks or months)
2. Significant waste generation parallel with the widespread disease
3. Temporary facilities installation are strongly recommended
4. Risk control plays more dominant role compared to costs, with the aim to minimize the disease transmission

Yu et al. (2020) and Kargar, Pourmehdi & Paydar (2020) proposed a framework regarding the reverse logistics network for successful health hazard treatment during the pandemic. The authors suggested the existence of temporary or existing waste treatment as the first site directly when the waste is transported out from the hospital or clinics or laboratories. This initiative is proposed to eliminate the risk and reduce the risk of the outbreak.

The objective shifts from the regular reverse logistics which aimed to cut down the expense to risk and safety prioritization. Yu et al (2020) stated the additional concern in optimizing the decision regarding the

time and locations for arranging temporary facilities, actively responsible for the increase of medical waste within the planning period and bringing down the threat of epidemic spread. These considerations are primarily needed during the collecting and transporting the medical waste and healthcare hazards.

As mentioned above, risk has become the primary concern in medical waste management during the Covid-19 pandemic. With the aim of reducing the potential of disease spreading, the idea of location purpose shifting was proposed by [5] as one of the alternatives to immediately manage the biohazardous waste. The availability of transfer stations for municipal solid waste has the potential to be converted to processing medical waste with proper technology.

The research performed by [7] proposed the transportation of medical waste chain as follows:

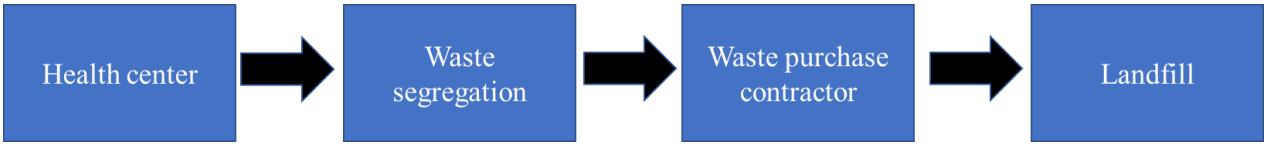

Figure 1. Medical Waste Chain [7]

The researchers suggested waste segregation as the installation to diminish the waste and restore them to the waste purchase contractor. Recovering medical waste such as plastic and metals can benefit the environment and reproduce the manufacturing cycle and support the circular economy and sustainable development.

Yu et al (2020) suggested the four policy recommendations related to the reverse logistics for biohazardous waste:

1. Rapid increase of medical waste can be managed significantly by the reverse logistics network with temporary facilities
2. The selection of facility location is significant to risk control and cost management
3. Installation of temporary facilities is vital importance
4. The increase in budgetary limitation may result in a better risk control

Although the idea of a shifting objective and strategy in dealing with reverse logistics during the pandemic, the goal remained unchanged. The reverse logistics network design for medical waste treatment study conducted by [6] aims to minimize the total expenses, and mobility, and maximize the amount of uncollected waste. The reverse logistics network supported the control of the spread of the virus.

4. CONCLUSION

This paper investigates the role of reverse logistics during the Covid-19 pandemic. The study used the literature review as the method to tackle the issue. The literature review aims to present an overview of the current condition as a policy review. The selected paper for the materials were from 2019 to 2022, specifically presented the reverse logistics during the pandemic concern.

The common goal for reverse logistics is to minimize the fee, and optimize the network, and location optimization. Although those primary common goals still count during the focus of assessing the reverse logistics, the implementation of reverse logistics during the outbreak shifts to minimize the risk and optimize waste treatment facilities. Problem characteristics and policy recommendations related to medical waste management during the pandemic were also described.

The limitation of the study is that the study only conveys the medical waste during the pandemic. The number of papers addressing the reverse logistics for medical waste during the pandemic is limited. The recommendation for further studies may apply the mathematical model to illustrate better the optimization of reverse logistics of medical waste in certain areas.

ACKNOWLEDGEMENT

This paper has been presented in International Conference on Science, Engineering and Technology, University of Sarjana Wiyata Tamansiswa Yogyakarta, Special Region of Yogyakarta, Indonesia, in June 2022.

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