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# CAUSAL LOOP DIAGRAM AS APPROACHING MODEL ANALYSIS IN INCREASING THE WASTE VOLUME AT THE COVID19 PANDEMIC PERIOD

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## *Abstract*

***Introduction:*** *The current Covid19 pandemic has overgrown, as reported statistics show. It causes multiple effects in human life, which one a majority of them doing all activities from home that increase the domestic waste production. The inadequate conventional handling management and a large amount of waste generated thrown away by open dumping.* ***Methods:*** *This study was carried out with a descriptive qualitative approach to describe all information of a good understanding in implementing a waste management system in Bekasi Regency. Mapping and identifying all the waste management process variables were then arranged dynamically using the Causal Loop Diagram (CLD) techniques.* ***Results and Discussion:*** *It should be noted that the variables influence many other variables because the policies applied have much influence on other environments. In the formed CLD in this study, the Covid19 pandemic variable will directly affect 3 (three) other variables such as public consumption patterns, economic conditions, and waste volume. The limited land and high costs were the problems that will hinder the success in waste management in Bekasi Regency.* ***Conclusion:*** *The CLD model shows that the waste management process did not get much attention from the community and managers during this pandemic. The thing that is not being overseen is the increase in the volume of domestic waste because most people choose to work from home, school holidays, and many outside activities are reduced. This CLD model shows that it is necessary to immediately improve waste management so that all waste that enters the landfill can be appropriately processed.*

## INTRODUCTION

Humans carry out various activities that will produce much waste in their daily lives (1). Along with the increase of daily needs due to population growth accompanied by changes in lifestyle, cumulatively creates a consumptive society. Waste management is one of the criteria for assessing environmental sanitation to determine categorized slum areas or not, such as house and settlement buildings, roads, water supplies, drainages, wastewater treatments, and hearthplaces protection. An area is categorized as a slum settlement when the waste management indicators do not meet the technical requirements, including infrastructure and facilities, maintenances, and management (2). The problem of waste has become a hot issue that is widely discussed today, both local and global (3). Waste is an immediate effect of life that far stated that it had arisen as long as human life exists (4).

The gaps between management and volume waste produced will make the processes handling conventionally like open dumping (5). It causes by the limitation of the infrasturcture to collecting and transporting waste (6). The government realizes that the waste problem has become a national concern to have a comprehensive and integrated processing system top to bottom (7). This waste problem will now no longer most effectively be a short-time period to hassle, but it can be a long-time period, so it desires to be addressed by local government authorities policies, in order that the coping with can be extra included with most results (8). This waste will be a disaster for human welfare and environmental sustainability if it is not appropriately managed (9).

Epidemic disease outbreaks can significantly affect humans and subsequently lead to global crises become pandemics (10). The current Covid19 pandemic has progressed massively and rapidly around the world (11). Since March 11, 2020, WHO declared the Covid19 outbreak a pandemic because it has spread overgrown to several countries or continents (12). This Covid19 pandemic can effects the environment directly and indirectly (13). The Covid19 pandemic causes paralysis in various sectors in Indonesia. No exception in daily lives recommended people practice social and physical distancing (14), implement work from home in non-critical sectors, school from home (15), and increase the online orders for food or things. There will be changes in the generation and composition of waste generated from households.

The Ministry of Environment and Forestry Regulations No. P.56 of 2015 determined that waste infected by pathogenic organisms that do not automatically gift withinside the surroundings and those organisms are in enough amount and virulence to transmit infectious disease to susceptible humans. In general, this is infectious waste that is categorized as hazardous waste (16). According to the Regulation of the Republic Indonesia No. 18 of 2008 regarding Waste Management is a systematic, comprehensive, and sustainable pastime that consists of waste sorting and handling (17). Waste generated through human and animal activities because they were considered vain and undesirable can end up a catastrophe because of the quantity if it is not managed, and there may be no proper treatment (18).

One of the locations where there was a significant increase in the waste volume is Burangkeng Landfill, Bekasi Regency. In 2020, the waste volume thrown away was higher than the previous year. From 2016 to 2019, the average waste volume that enters this landfill is around 151,322,139 tons/year. Then in 2020, it was increased significantly by 40%, an estimated 211,371,250 tons.

This study aims to understand the general description through causal relationships between all components in the waste management system for providing alternative solutions and reducing the waste volume in Bekasi Regency during the Covid19 pandemic. Based on the complex and dynamic conditions faced, it is essential to look at it not narrowly and fragmented. It is intended so that the system analysis carried out can produce appropriate conclusions and recommendations. To that end, the systems analysis process emphasizes a holistic approach to problem-solving and uses models to identify and replicate alternative scenarios.

## METHODS

This research was carried out using a descriptive qualitative approach. System dynamics is a mental model that describes the parts in a complex system by stating the interrelationships between parts, feedback, information, time delay, non-linearity in the sub-systems. The benefit of a dynamics system is to simulate, explore, and test behavior that will impact the policies to became quality expected (19). Constructing a dynamic model structure was to define system-wide variables relevant to waste management in Bekasi Regency based on the defined system boundaries. The variables used include the waste volume, management technology, economic

and social factors of the surrounding community, local and central government regulations and policies, and the Covid19 pandemic.

The conceptualization of the model by generating a causal pie chart showing the causal relationship of each variable. The model contains the factors, sources of information, and the information flow network that connects the two. The shape of the dynamics system model that represents the shape of the remarks diagram was a cause-and-impact diagram or typically called a Causal Loop Diagram. This diagram suggests the path of the variable alternate waft and polarity. The waft polarity was defined as split into positive and negative. The arrow's tip was marked with the letter "*S*" which showed that if the thing that influences, modifications or will increase, then the thing it influences will alternate or grow properly. Then, the letter "*O*" showed the effect, opposite to the perception that if the thing that influences it increases, its influences decrease. The software program used was Vensim, a software program that may be used to develop, evaluate, and optimize a sustainable model (20).

The overall systems approach using the CLD model allows us to be in the best position to make decisions tested from various possibilities and changes over time. This model has several causal loops consisting of positive loops and negative loops. A positive loop suggested that the connection among the variables was immediately proportional in order that if there is a boom withinside the value of the variable, it will motive a growth withinside its effects. Conversely, a negative loop suggests an inverse courting in order that if there may be a growth withinside the fee of the variable, it will motive a lower.

## RESULTS

Through literature study, thoughts, and work experience, several things that are actual and need to be considered in the causal relationship are as follows: Number of People, Public Welfare and Health, Public Consumption, Volume of Waste in TPA, The area of the TPA, Waste Management Costs, Waste Management Technology, Economic Conditions, Local Government Budgets, and The Covid19 pandemic. Each unit has a meaningful role from the above, so if a causal relationship modeling is formed or marked "S" and "O", it can be seen in Table 1. The symbol "S" indicates that the relationship is directly proportional so that if one variable increases/ decreases, the other variables will also increase/ decrease. Meanwhile, the symbol "O" indicates that the relationship formed is inversely proportional so that if one variable increases, the other variable will decrease, and vice versa.

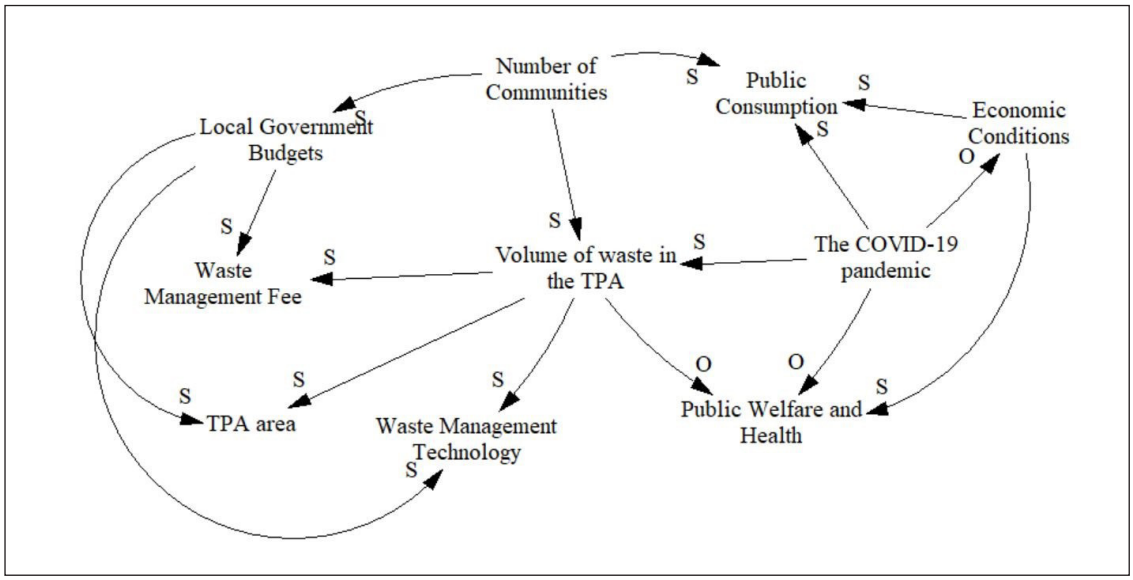


**Figure 1. CLD Model System Approach to Waste Management**

**Table 1. The Power of Cause and Effect Relationships**

| "S" Mark | "O" Mark |
|---|---|
| Number of People to:<br>1. Waste Volume<br>2. Public Consumption<br>3. Local Government Budget | Waste Volume Against:<br>1. Public Welfare and Health |
| The Covid19 Pandemic Against:<br>1. Waste Volume<br>2. Public Consumption | The Covid19 Pancemic against:<br>1. Public Welfare and Health<br>2. Economic Conditions |
| Waste Volume Against:<br>1. Waste Management Technology<br>2. Waste Management Costs<br>3. The Area of TPA | |
| Local Government Budgets for:<br>1. Waste Management Costs<br>2. The Area of TPA<br>3. Waste Management Technology | |
| Economic Conditions for:<br>1. Public Consumption<br>2. Public Welfare and Health | |

## DISCUSSION

At an international seminar held remotely (UN-Habitat Webinar) on April 16, 2020, the International Solid Waste Association (ISWA) stated that Covid19 is one of the elements in changing the waste management paradigm so far. It affects health protection globally, which requires better coordination between parties and across sectors in the household waste management system (21). The Covid19 pandemic has significantly affected the financial income of the people (22). Many workers lose their jobs because their companies are unable to pay their salaries. Simultaneously will decrease public welfare and health. The Covid19 pandemic has dramatically affected the economic condition of the community.

The pandemic has forced people to stay overtime in their homes, increasing the waste generated from households. Besides that, increases in people who confirmed positive Covid19 with asymptomatic and mild symptoms make them self quarantine in their home because the hospital may be prioritized for moderate to severe symptoms (23). With the current condition, people prefer to take away the food than dine-in to avoid crowds. Furthermore, the production of household waste is increasing for some time. Household waste is a problem that is sometimes difficult to solve due to the lack or absence of a place to dispose of it, coupled with the presence of waste from personal protective equipment like a mask or hand sanitizer bottles. Many ordinary people do not understand processing waste contaminated with Covid19 in the household environment and public places (24). The government recommends that managing waste related to Covid19 be wrapped quickly and written as infectious waste. It can do separately before putting into a source of garbage accumulation to keep away from the transmission of Covid19 (25).

It should be noted that the variables influence many other variables because the policies applied to these variables will have much influence on other environments. Our CLD modeling shows that variables Covid19 will directly affect three other variables: public consumption pattern, economic conditions, and waste volume. In the end, it will hinder success in waste management in Bekasi Regency. The high waste volume in the Bekasi landfill is also related to waste management technology that is not running optimally. Limited land and high management costs are problems for waste management in Bekasi Regency. In the implementation of waste management at the household level, several conditions inhibit efforts to reduce the use of plastic bags/styrofoam or other materials that are difficult to decompose by nature. Over time, people began to realize the dangers of using plastic and started trying to use recycled plastic. It can be seen from the efforts to separate and reuse plastic bags that have been used. However, the obstacle faced by households is that all shops or shopping centers still provide plastic for their groceries (26). Medical waste and home waste from fever clinics, remark wards, isolation wards, unique exam rooms, and clinical laboratories, particularly the nucleic acid trying out laboratories, need to be dealt with as Covid19 associated clinical waste, and a label revealed with "Covid19 infection" must be affixed (27).

The benefit of using causal loop diagrams is that it reduces the complexity of the system in the study, which is very important for the whole system's behavior and is very important for the actors of the whole system (28). Waste management must start from the smallest scope, that is, household. After household consumers consume these goods, the remainder is not used anymore, we throw away (solid waste). Organic waste is waste that comes from food waste (vegetables and fruits). Inorganic waste is waste that comes from cans, glass, rubber, and plastic. Household waste consists of solid waste (organic and inorganic) and liquid waste. According to the researchers, it is necessary even though more people have good knowledge, regular socialization of increasing public knowledge, both in disposing of waste and processing 3R waste, which becomes usability to be useful again. The approach taken can be in lectures, discussions, and presentations to directly practice the waste processing process, both composting organic waste and recycling inorganic waste. This scenario creates opportunity approaches to

deal with and put off the waste, which has caused the emergence of daily waste activities (known as the 'casual waste area'). The casual area contributes considerably to the recycling quotes of many cities in low-and middle-earning countries, consequently decreasing the extent of waste deposited in landfills, environmental pollution, developing on the equal time nearby introduced value thru the recycling marketplace, and casual employment opportunities (29).

## CONCLUSION

The CLD model shows that the interaction between variables is dynamic, and the pandemic situation further weakens vigilance in managing waste management. The increase of waste volume enterer landfill is mainly contributed by household waste. The limitations of land and conventional waste technology need more cooperation from the community to apply the 3R concept in the household.

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