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RESEARCH ARTICLE | FEBRUARY 16 2024

Community perceptions and behaviors in the management of mask waste in Denpasar City during the Covid-19 period

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AIP Conf. Proc. 2961, 030001 (2024)
https://doi.org/10.1063/5.0192864

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Community Perceptions and Behaviors in the Management of Mask Waste in Denpasar City During the Covid-19 Period

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ABSTRACT WHO has declared COVID-19 as a global pandemic, through Pergub Bali No. 10 of 2021 concerning the application of discipline and law enforcement Prokes makes the demand for PPE increase. Denpasar City has the highest population density in Bali Province, so it has the greatest opportunity as the largest production of mask waste that can harm
32 the environment. This study aims to estimate the generation of mask waste, find out the negative impact caused by the mask waste on the environment, determine public perceptions and behavior towards the management of the use of masks and the management of mask waste and model scenarios using dynamic systems. This study uses a mix method analysis method with a combination of sequential exploration (qualitative and quantitative), and perform modeling analysis using Powersim Studio 8 software. The results of the study estimate that in Denpasar City as many as 515,114 masks are used every day, through the mask life cycle assessment approach, the resulting Greenhouse Gas emissions are 10,418,226 kg CO2 Eq per year. The perception and behavior of the community towards the management of masks, the community has a fairly good attitude to use, good knowledge, and bad processing actions towards the processing of masks. Through the recommendation of community participation modeling in traditional scenarios, estimating the reduction of mask waste generation and emissions over the next 6 years by 1%,

INTRODUCTION

WHO has declared COVID-19 as a global pandemic, through Pergub Bali No. 10 of 2021 concerning the application of discipline and law enforcement Prokes makes the demand for PPE increase. Denpasar City has the highest population density in Bali Province, so it has the greatest opportunity as the largest production of mask waste that can harm the environment. The waste generated is dominated by mask waste which is often used by the community, meanwhile the Denpasar City Environment and Hygiene Service (DLHK) in the last 7 months has transported 47,250,000 masks which are taken directly to the TPA. Surgical or medical masks used by the public are
24 generally made of polypropylene (PP) plastic, besides polycarbonate, polyethylene and polyester, which are sources of fossil plastic pollution and microplastics (Aragaw, 2003). 2020), Medical masks are a type of disposable mask that are waterproof additives, and UV Stabilizers so that if medical masks are thrown away into the environment, it can cause a source of microplastics (can be degraded/decomposed into smaller ones) and fibers that are difficult to biodegrade (Fadare & Okoffo, 2020).

In general, the majority of COVID-19 studies have focused on the causes, origins, and potential impacts on water and air quality, while some have documented the possible impact of personal protective equipment waste on the
26 environment and its management strategies to address the disposal of mask waste. A number of studies have been
47 carried out to produce solutions to overcome the increase in PPE waste and minimize its long-term impact on the
12 environment. Biodegradable masks are one of the sustainable alternative strategies to reduce the use of masks that cause plastic waste through replacing the type of Polypropylene plastic with organic materials which is a good strategy
12 (Glukhikh et al., 2020; Samper et al., 2018; Siracusa and Blanco, 2020). Every city in Indonesia has the same problem

6 *The 2nd International Conference on Innovation of Science and Technology for Sustainable Development*
AIP Conf. Proc. 2961, 030001-1–030001-17; https://doi.org/10.1063/5.0192864
Published by AIP Publishing. 978-0-7354-4827-8/$30.00

in terms of waste management, so it is necessary to support efforts to control environmental pollution through public understanding and perception in the management of mask waste. SE.3/MENLHK/PSLB3/PLB.3/3/2021 concerning Management of B3 Waste and Waste from Covid-19 Handling in the community, efforts to manage B3 and waste are needed in order to prevent and break the transmission of Covid-19 as well as to control and avoid accumulation B3 waste, especially mask waste generated.

This study aims to estimate the generation of mask waste, find out the negative impact caused by the mask waste on the environment, determine public perceptions and behavior towards the management of the use of masks and the management of mask waste and model scenarios using dynamic systems.

RESEARCH METHODS

This research was conducted in Denpasar City and was carried out from April to June 2022. This research is a research using quantitative and qualitative research methods (mix method) a combination of sequential exploratory (quantitative-qualitative) (Sugiyono, 2017), by collecting data through the method questionnaire surveys, interviews and information from various sources, namely: Journals, Books, Regulations. Legislation, as well as related institutions. The sampling technique is done by convenience *sampling*to the people who live in Denpasar City. The analytical method used in this study is a quantitative descriptive analysis method in analyzing the generation of mask waste and environmental impacts, a qualitative descriptive analysis method in analyzing public perceptions and behavior in the management of mask waste and dynamic analysis by analyzing various alternative policy scenarios in order to optimize the management of mask waste. In this case, the type of mask studied is medical mask waste of PP plastic type sourced from domestic activities (people's daily activities).

The population in this study is the entire population/community residents who live in Denpasar City, amounting to 726,599 people (BPS, 2022) with the sample used in this study, namely residents with a high level of mobility, namely residents aged 20 years to 65 years as many as 515,114 people (BPS, 2022), the number of samples is determined by the Cochran method, with the desired level of precision, the desired level of confidence in the population.

$$\eta_0 = \frac{Z^2 pq}{1 + \left(\frac{Z^2 pq}{e^2 N}\right)} \tag{1}$$

This study uses a Margin of Error (e) 7.5%, a confidence interval of 95%, a population of 726,599 people (N) with a proportion (p) of 50% and a Z table value of 1.96 for a 95% confidence interval. The formula produces the required number of samples of 115 respondents.

In testing the data collection instrument, the measurement of the validity of the item is done by correlating the item score with the total item score. Item validity is indicated by the existence of a correlation or support for the total item (total score).

$$r_{XY} = \frac{N\sum XY - \sum X \sum Y}{\sqrt{\left(N\sum X^2 - \left(\sum X\right)^2\right)\left(N\sum Y^2 - \left(\sum Y\right)^2\right)}} \tag{2}$$

Where, rxy is the correlation coefficient between the variables X and Y, N is the number of respondents X is the number of item scores, Y is the total score of the questions, X2 is the number of squared scores of the items, Y2 is the total score of the item squares. The calculated r value is matched with the product moment r table at a significant level of 5%. If r count is greater than r table 5%. So the item is valid.

In testing the data collection instrument, the measurement reliability test is used to determine the consistency of the measuring instrument, whether the measuring instrument used is reliable and remains consistent if the measurement is repeated. To measure the reliability of the scale or questionnaire, Cronbach's Alpha formula can be used as follows:

$$r_{tt} = \left[\frac{k}{k-1}\right]\left[1 - \left[\frac{\Sigma\delta_b^2}{\Sigma\delta_t^2}\right]\right] \tag{3}$$

Where rtt is the instrument reliability coefficient (total test), k is the number of valid questions, 2b is the number of item variants, 2t is the total score variance. The calculation of the scale reliability test is accepted, if the results of the calculation of r count > r table 5%.

Estimated generation and long-term negative impact caused by the mask waste on the environment

At the stage in planning the handling of medical mask waste is to calculate the generation of medical mask waste in the environment. Estimates of daily mask use of the general population can be calculated by the following equation adapted from the study of Nzediegwu and Chang (2020):

$$DFM = \frac{P.\ Up.\ FMAR\ .\ FMGP}{10{,}000} \quad (4)$$

Where DFM is the use of masks every day (fruit/day), P is the number of population, Up is the percentage of urban population, FMAR is the percentage of the use of masks, FMGP is the assumption that each person uses 1 mask every day

After obtaining the volume of mask waste generation, it is continued by identifying the negative impacts that occur on the environment with the relationship of Greenhouse Gases based on a life cycle assessment, which considers the lifetime, starting with the extraction of materials, through manufacture, transportation, Estimated Greenhouse Gas footprints can be calculated by the following equation: adapted from research[1]the following : Emission load = mask type emission . rise

Where the emission of polypropylene (PP) masks is 0.059 (KgCO2), the emission of cloth masks is 0.036 (KgCO2), the emission of N95 masks is 0.017 (KgCO2). After doing these calculations, it is continued by calculating the energy consumed to produce face masks ranging between 0.000792 and 0.0342 kWh for each part. Assuming an average value of 0.01 kWh per unit[1].

Analysis of public perception and behavior towards the management of the use of masks and the management of mask waste

The technique used is a scoring technique with a "Likert scale" which is a scale used to measure a person's knowledge, attitudes, and opinions about social phenomena (Sunyoto, 2009). The results of tabulation of Likert scale data were analyzed by multiple regression analysis (Multiple Regression Anlysis). The statistical analysis was carried out using the SPSS statistical software package. Through the stages of conducting a survey reliability analysis using Croncbach's alpha, which is an easy method that can be used to ensure the internal consistency of survey items. Other aspects that must be considered in the reliability analysis are the statistical validity of the sample set size, the margin of error, and the level of confidence for the unknown population.

Descriptive analysis in this study aims to determine the distribution of the data obtained from the questionnaires that have been collected. The descriptive analysis was conducted to determine the description of the variables used in this study, namely knowledge (X1), use (X2), and processing (Y).).

The meaning of the total average value refers to the assessment criteria with the following formula:

$$P = \frac{R}{K} \quad (5)$$

Where P is the length of the class interval, R is the lowest data-height data, K is the number of classes

Calculation:

$$P = \frac{4}{5}$$
$$= 0.80$$

The assessment criteria can be seen in the class interval in Table 1 below.

TABLE 1. Criteria for Average Score and Rating Category

Classification limit (Average Score Criteria)	Rating Category
1.00 – 1.80	Very Not Good
1.81 – 2.60	Not good
2.61 – 3.40	Pretty good
3.41 – 4.20	Well
4.21 – 5.00	Very good

Source: Sugiyono (2012)

Scenario modeling analysis using dynamic systems to optimize mask waste management

There are several stages in modeling a model using System Dynamics (Roberts et.al., 1983). The steps taken in the System Dynamic model approach are as follows:

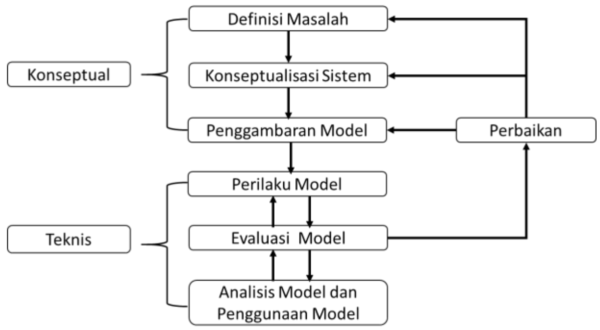


FIGURE 1. System dynamics modeling steps

The validation of the model uses two test methods, namely mean comparison (E1) and error variance (E2) whose equation can be seen in Table 2. After the model is considered valid, alternative scenarios are arranged to improve waste management services. These scenarios are simulated in a dynamic system model and the results are analyzed to select the best scenario as a policy proposal.

TABLE 2. Simulation Result Validation Formula

Mean Comparison	***Error Variance***
$E1 = \frac{\lvert \bar{S} - \bar{A} \rvert}{\bar{A}}$	$E2 = \frac{\lvert Ss - Sa \rvert}{Sa}$
Information :	Information :
3 = Average value of simulation results	Ss = Standard deviation of simulation results
= Average value of data	Sa = Standard deviation of data
The model is considered valid if E1≤5%	The model is considered valid if E2≤30%

Source: Barlas, 1989

At the model development stage In the modeling process through the stages of conceptualization, formulation, simulation, and evaluation, in each of these stages it is possible to reformulate and improve the model, by eliminating
19 or adding structures. The main purpose of this stage is to obtain a model that is in accordance with the actual system, in accordance with the objectives to be achieved, and can be understood well. There were several considerations in developing and reformulating this model, including reducing and enriching dynamic hypotheses, adding feedback structures, converting constants to variables, adding test criteria, and most importantly, when to stop.

15 Policy alternatives in the actual system relate to one or a combination of two types of model manipulation, including parameter changes (including minor changes in table functions), structural changes (changes in the form or number of equations), and Policy Recommendations and Validity Issues. The ultimate goal of the modeling process is to apply the views that exist in the model to real-world problems. What is expected from this modeling process is an effort to take the next step so that the problem of mask waste can be resolved. In providing recommendations there are two issues that need to be considered, namely how the validity of the recommendations given and how far the policy recommendations can be applied/implemented.

RESULTS AND DISCUSSIONS

Respondent Demographics

Respondents in this study consisted of 137 people, with the distribution in each sub-district shown in Table 3, with the age of respondents being in the age range of 21-59 years.

TABLE 3. Number of Respondents per District

Subdistrict	Respondent
West Denpasar	34
East Denpasar	36
South Denpasar	34
North Denpasar	33

The education level of the respondents is dominated by university graduates, both at the Diploma level to the profession and Strata 2 level, and the average income of respondents is between Rp. 2,800,000 - 10,000,000 and aged between 21-30 years as shown in Figure 2 below.

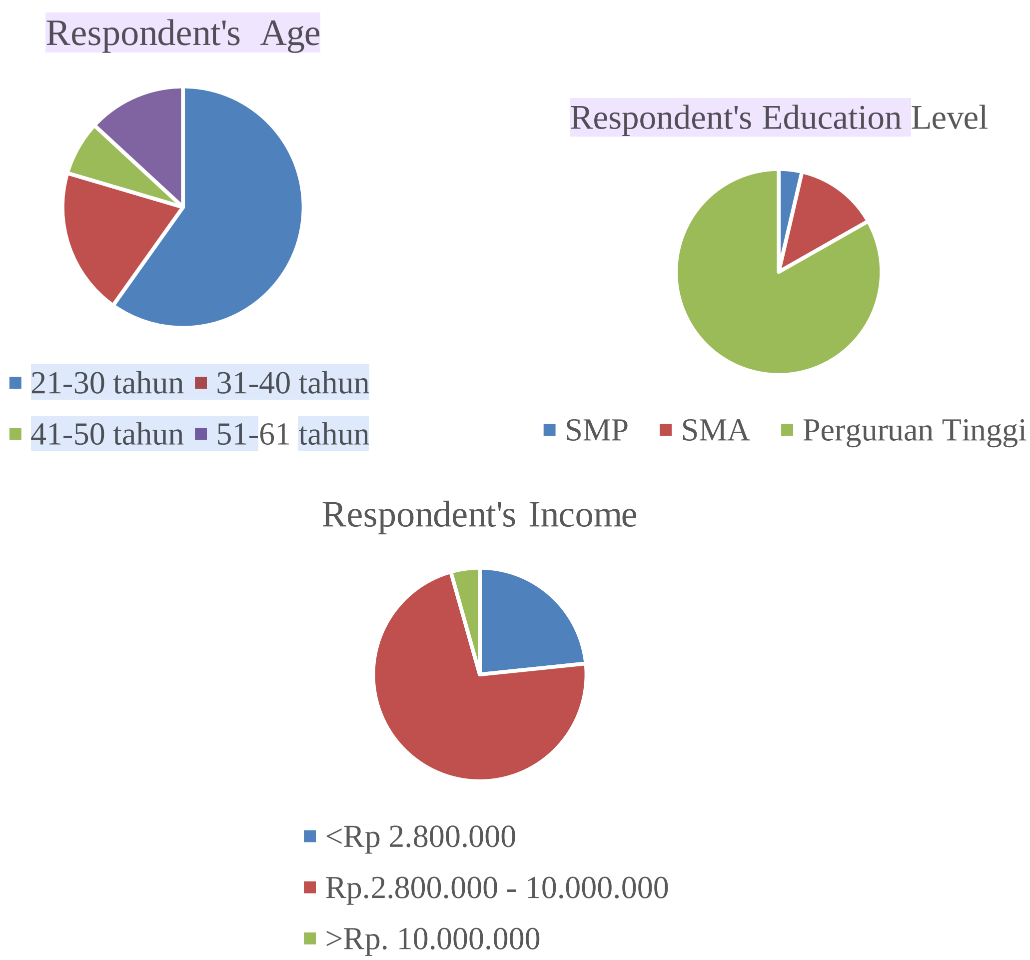


FIGURE 2. Respondent Profile Diagram

With the results of the characteristics of the respondents, it will greatly affect the quality of the answers from the questionnaire

Reliability and Validity Analysis

The validity test in this study used the SPSS application, and the results of the validity tests carried out on the instruments in this study can be seen in the following table 4.

TABLE 4. Recapitulation of Validity Test Results

Variable	Statement items	*Corrected Item-Total Correlation*
Respondent's knowledge in mask waste management(X1)	P1	0.530
	P2	0.397
	P3	0.522
	P4	0.608
	P5	0.414
Respondents' attitude in using masks(X1)	P1	0.432
	P2	0.438
	P3	0.628
Attitudes of respondents in the treatment of mask waste(X3)	P1	0.513
	P2	0.176
	P3	0.394

Based on the results of the table analysis, it can be concluded that all statement items are valid, because the corrected Item-Total Correlation number of all items exceeds 0.176. This means that all items in the research instrument are able to explain well the variables of respondents' knowledge in the management of mask waste, respondents' attitudes in using masks, and respondents' attitudes in using masks. mask waste treatment

While the value of Croncbach's alpha is 0.607 which means that the alpha is quite good, so it can be concluded that the concept measurement instrument is quite stable and consistent, this is shown in table 5.

TABLE 5. Statistical Reliability Analysis

Cronbach's Alpha	*N of items*
607	11

Community Perception in Mask Waste Management

Usage Attitude

Usage is the respondent's behavior in perceiving the management of mask waste. Based on the results of direct surveys and online surveys, it is found that people have a fairly good attitude towards the use of masks, considering the average (mean) obtained is 2.96. The indicators that are well addressed include respondents rarely using masks that have been dried and given disinfectant liquid, and people often use masks consisting of 3 layers, respondents sometimes use environmentally friendly masks, one of which is cloth masks. The attitude of respondents in the use of masks can be seen in Figure 3 below:

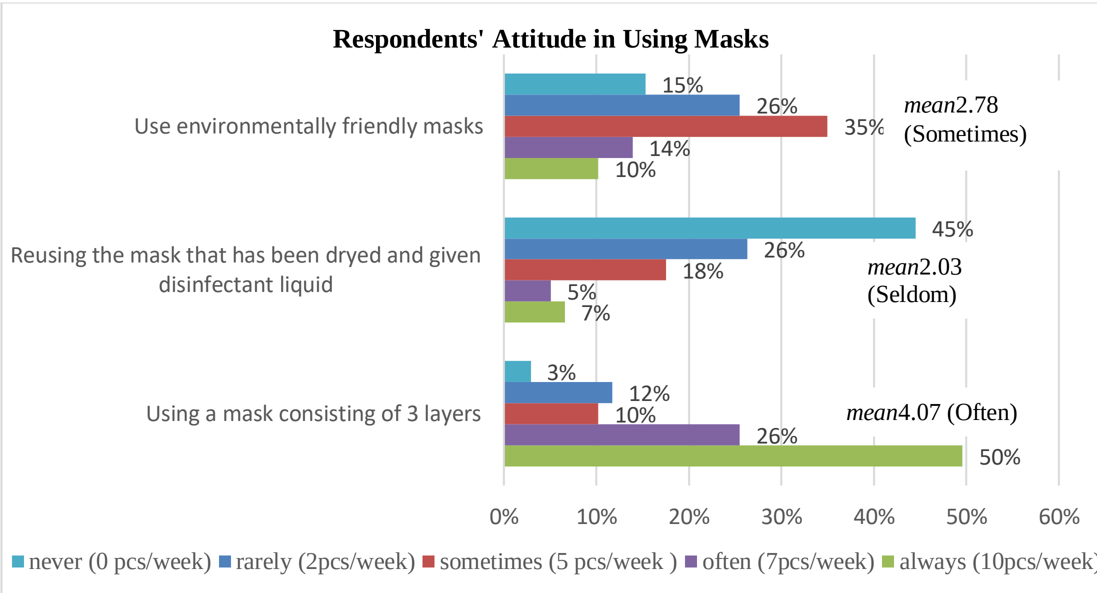


FIGURE 3. Graphics of using environmentally friendly masks

Knowledge

Knowledge is the condition of respondents who know the efforts to manage mask waste. Based on the results of direct surveys and online surveys, it was found that the community had good knowledge of the use of masks, taking into account the average (mean) obtained at 3.93. The indicators that are well known include respondents agreeing that the material used for making masks is generally made of propylene type plastic, besides that there is also polycarbonate, respondents strongly agree that WHO recommends using masks consisting of 3 layers, on the outermost layer to catch doplet from people. other. Middle layer to prevent microbes from entering or leaving the mask. While the innermost layer serves to absorb moisture, respondents agree that medical masks are a type of mask that is difficult to biodegrade which causes microplastic sources, respondents agree that mask production also contributes to CO2 emissions, which has the potential to contribute to global warming, respondents agree that efforts to reduce mask waste such as using biodegradable masks (organic masks) and processing waste masks into something useful such as processing waste masks into fiber concrete, etc. The knowledge of respondents in the management of mask waste can be seen in Figure 4.4 below: respondents agree that efforts to reduce mask waste such as using biodegradable masks (organic masks) and processing mask waste into something useful such as processing mask waste into fiber concrete, etc. The knowledge of respondents in the management of mask waste can be seen in Figure 4 below: respondents agree that efforts to reduce mask waste such as using biodegradable masks (organic masks) and processing mask waste into something useful such as processing mask waste into fiber concrete, etc. The knowledge of respondents in the management of mask waste can be seen in Figure 4 below:

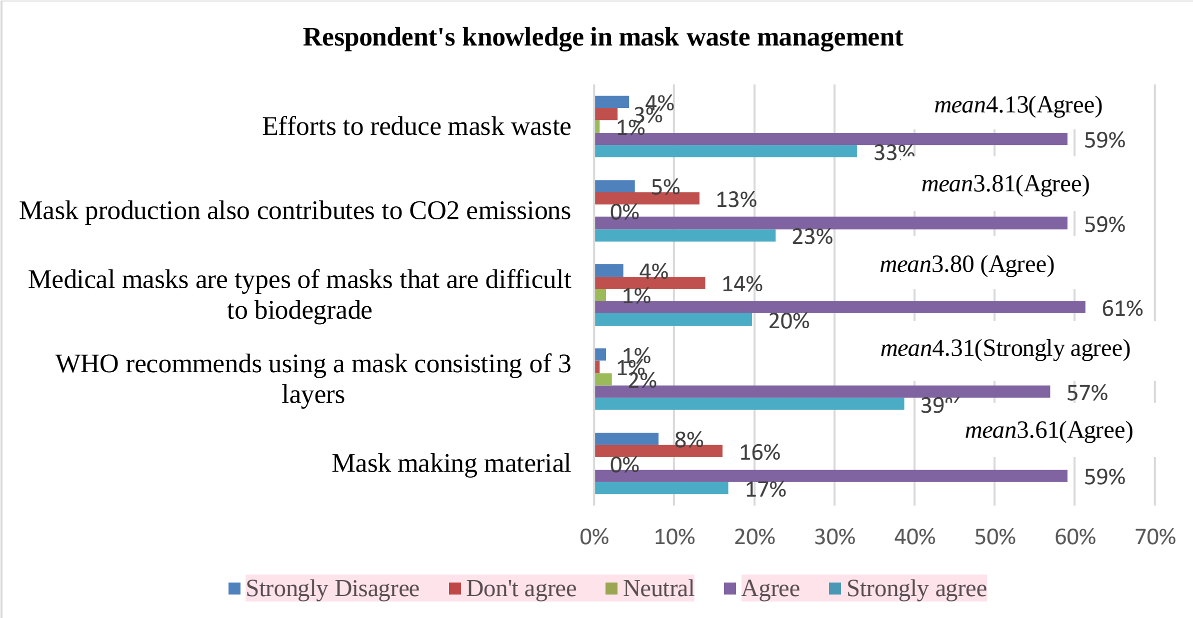


FIGURE 4. Graph of respondents' knowledge in mask waste management

Processing action

Based on the results of direct surveys and online community surveys in the management of mask waste, it was found that people had bad actions towards mask processing, considering the average (mean) obtained was 2.60. As for the processing indicators, among others, respondents often dispose of mask waste by spraying using a disinfectant and then destroying the mask by tearing or cutting it and when disposing of mask waste, make sure the position of the container is safe, so as not to cause waste to be scattered, respondents sometimes throw it directly. disposable masks without doing anything, respondents have never processed household mask waste into something useful. Respondents' actions in the treatment of mask waste can be seen in Figure 5 below:

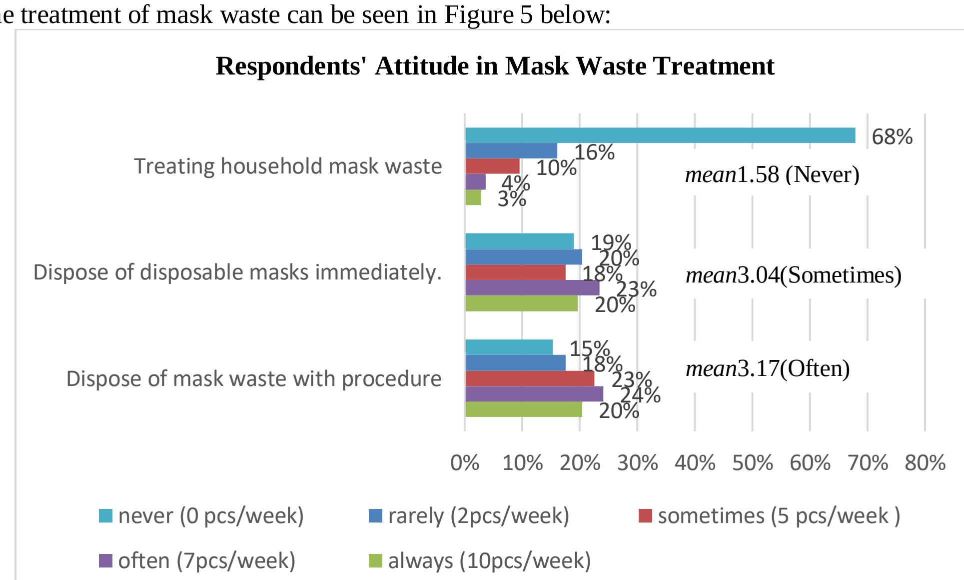


FIGURE 5. Graph of respondents' attitudes in the treatment of mask waste

Estimation of mask waste

Based on the analysis of the use of masks, it shows that the population of Denpasar City as many as 28.6% of people use masks of 1 pcs per day, 37.1% of people use masks of 2 pcs per day, 20% of people use masks of 3 pcs per day and 14.3% using more than 3 masks per day (Figure 6).

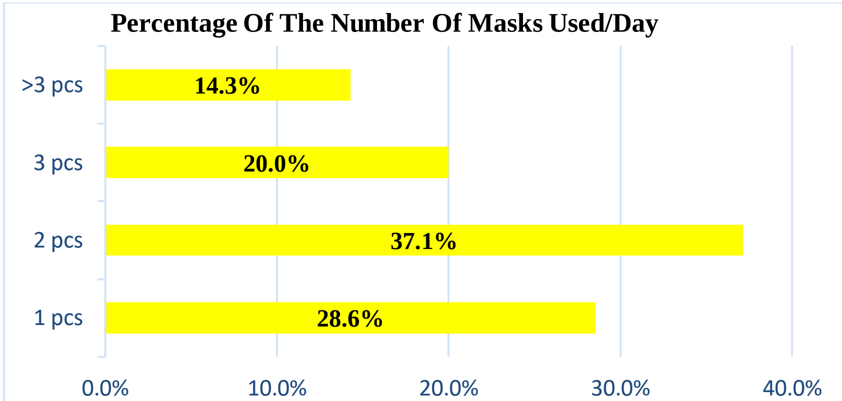


FIGURE 6. Graph of the percentage of the number of masks used per day.

This study shows the results that 37.1% of Denpasar residents wear at least two masks per day, the data shows the percentage of using two masks per day is more than the use of 1, 3 or more.

Based on the research results, the total medical masks that can be produced and disposed of every day for the area studied, and surveyed the population using the following equation

18 Total population (P) is 515,114[2], The percentage of the urban population (Up) is 70.2%, the percentage of the use of masks (FMAR) is 80% ([3], Assuming each person uses 2 masks every day.(FMGP). From the results of the analysis, it was found that the estimated generation of 578,576 pieces of daily mask use (DFM) in Denpasar City, with this estimate is estimated to be equivalent to 4964.18 Kg of medical masks (average weight of 8.58 g of masks).[4]).

20 From the results of the next analysis, the level of use of medical masks assumes that there are 4 types of masks commonly used by people in the surrounding environment, including N95 masks, medical masks (3 layers), cloth masks, and other types. The results showed that around 77.1% of people surveyed used medical masks (3 layers), 4.8% used cloth masks and 12.4% used N95 masks and 5.7% used other types of masks. The main reason for wearing a medical mask (3 ply) is the availability of this type of mask produced by manufacturers from Indonesia, so they are widely available in the market, and the price is cheaper when compared to other types of masks. Even though the price of the 3 layer medical mask is the cheapest[5]While surgical masks are still effective in reducing the spread of influenza and Covid-19 viruses, but the misuse of masks can accelerate the rate of spread of Covid-19 among individuals because the virus can persist on the surface of the mask for days. It should be noted that polypropylene and polyester are the main raw materials used in the production of surgical masks (Fadare & Okoffo, 2020), so that these materials can pollute rivers and seas as final acceptors in cases where mask waste is dumped on roads and landfills, resulting in adding more plastic and micro-plastic waste to the environment.

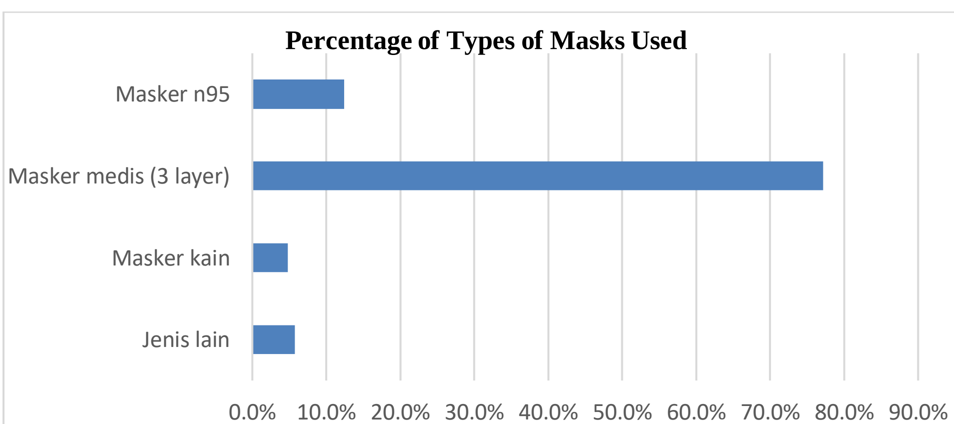


FIGURE 7. Graph of the percentage of types of masks used

Estimated Potential Environmental Impact

The behavior of using masks for the community in Denpasar City has side effects on the environment, this is related to the number and types of masks used. Several studies have evaluated the environmental impact of medical masks, some of which have examined the energy and environmental footprint of these types of masks. Based on a Life Cycle Assessment, taking into account the cycle of the use of masks, starting with the extraction of materials in the manufacturing, transportation, use, and ending with the treatment and/or disposal of waste[6]. The impact of Greenhouse Gases (GHG) for masks produced from polypropylene (PP) is equivalent to the equation 0.059 kg CO2 /pcs. The N95 type of mask has a Green Gas impact of 0.017 kg CO2 /pcs. In reusable cloth masks, the Greenhouse Gas (GHG) impact is around 0.036 kgCO2 /pcs[1]. Using these values, an estimate of the impact of Greenhouse Gases (GHG) on the masks used by the people of Denpasar City is obtained (Table 6).

TABLE 6. Greenhouse Gas Traces in Denpasar City

Mask Type	Estimated number of masks per year (pieces)	Mask emission per piece (kg Co2 Eq)	Mask emission per year (kg Co2 Eq)
cloth mask	10,056.203	0.036	362.023
Medical mask	162,910,483	0.059	9,611,719
N95 mask	26,146,127	0.017	444,484
TOTAL	199,112,813	0	10,418,226

The increasing use of masks in Denpasar also has an impact on the environment for energy consumption, especially during the production of materials. The energy consumed to manufacture medical masks ranges between 0.000792 and 0.0342 kWh for each part. Assuming an average value of 0.01 kWh per unit[6], the total energy consumption needed to produce the medical masks needed in Denpasar is around 199,112,813 GWh per year.

TABLE 7. Energy consumption and potential energy recovery in Denpasar City

Number of Masks	Number of Disposable Masks	Energy Consumption (assuming 0.01 kWh per unit)	Potential Energy (MJ recovery (0.04 MJ per unit))
199,112,813	189,056,610	1,991,128	7,562,264

Potential energy recovery is another environmental parameter that provides an energy footprint. This parameter is based on the prediction of the energy generated by the treatment of mask waste generated from the combustion of PP material, so that in this case only disposable masks are the most susceptible to incineration. The value of 0.04 Mj /pcs is used in this calculation. The energy recovery value is calculated using data related to the behavior of the studied community towards the use of masks. The results showed that the energy recovery potential for masks used for one year in Denpasar was 7,562 GJ.

The proper use and management of this type of waste can help reduce the amount of PPE that is disposed of in nature and minimize the resulting environmental impact associated with this use. Without consideration of filtering efficiency, the use of cloth masks has shown a lower environmental footprint, further reduction in transport/mobilization can be one of the steps to reduce GHG effects, because a high share of GHG emissions contained in masks comes from transportation.[7].

Dynamic Modeling System

Causal loop model or Casual Loop Diagram (CLD) is a raw model that is able to describe causal relationships and feedback to help understand the relationship between system elements and model behavior based on references, frameworks of thinking, observations and accompanied by descriptive analysis. The causal loop model of population with volume of waste can be seen in Figure 8 below.

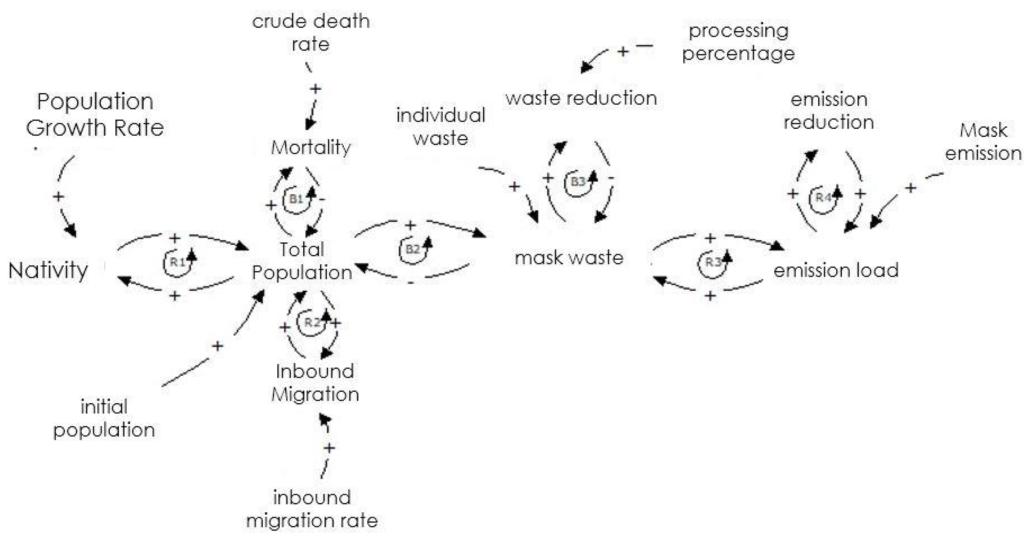


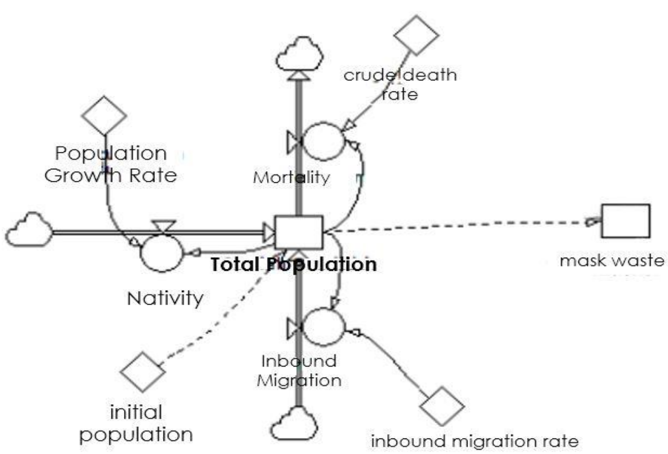
FIGURE 8. Casual Loop Diagram modeling using Powersim software.

Stock Flow Diagrams

46 Based on the flow chart below, it can be seen that the amount of waste generation is influenced by the population sub-system. The model simulation that describes the dynamic model behavior is displayed in a time graph and a time table after the model is run based on the Powersim Studio 8 software.

Before the model is run, the assumptions of the elements that make up the variables and sub-variables are as follows, Population growth rate: 0.24% per year; Crude death rate : 1.39% per year ; In-migration rate: 1.05% per year; Initial population : 515,114 people ; Waste volume per person: 6.26 kg/person per year; Percentage of waste transported to TPA : 98.5%/ per year Percentage of processed waste : 1.5% per year

5 The above assumptions were obtained based on monographic data from Denpasar City, and the results of
40 field surveys that have been carried out. The results of running the program using powersim can be seen in Figure 9.



3 **FIGURE 9.** Stock Flow Diagrams.

Model Validation

25 Model validation is carried out to examine the performance validation of the population sub-system in order to
20 determine the suitability of the model built with the actual population. The model performance validation test was also
13 carried out to find out whether the model built was academically feasible and to avoid the wrong model. The most
17 common test is to validate the model output using statistical tests, namely the statistical test of the deviation between the average simulation value and the actual (absolute mean error, AME) and the deviation test for the simulation

13 variation value to the actual (absolute variation error, AVE) with a range of values a maximum of 10%. Validation is only carried out on historical population data in Denpasar City from 2016-2020.

Before the model is run, the assumptions of the elements that make up the variables and sub-variables are as follows Population growth rate : 0.24 % per year ; Crude death rate : 1.368% per year ; In-migration rate : 1.031% per year ; Initial population : 897,300 people ;

Not all data from simulation results can be validated due to limited historical data, thus based on existing availability, the actual population development and simulation at the research site are selected as variables for
9 performance validation testing. Table 4.6 shows the results of the validated variables and the mean comparison (E1) < 5% and error variance (E2) < 30%. Thus the results of this model simulation can be said to be valid

TABLE 8. Model Validation Test Results

No	Year	Actual Population	Simulation Population
1	2016	897300	897300
2	2017	914300	973581
3	2018	930600	1056347
4	2019	947100	1146148
5	2020	962900	1243584
		mean comparison (E1)	0.001428916
		error variance (E2)	0.042809656

Scenario Sustainable mask waste treatment

Some recommendations for scenarios for treating waste masks.

1). Traditional Scenario

Before the model is run, the assumptions of the elements that make up the variables and sub-variables are as follows: Population growth rate: 1.24% per year; Crude death rate : 1.37% per year ; In-migration rate: 1.05% per year; Initial population : 515,114 people ; Waste volume per person : 6.26 kg/person per year; Mask emission : 0.297Kg CO2.Eq; Percentage of recycled waste : 1% per day; Percentage of use of cloth masks: 30% per day; The
44 results of the analysis using a dynamic system model for sustainable waste management in Denpasar City are then processed into a Stock Flow Diagram as shown in the following figure.

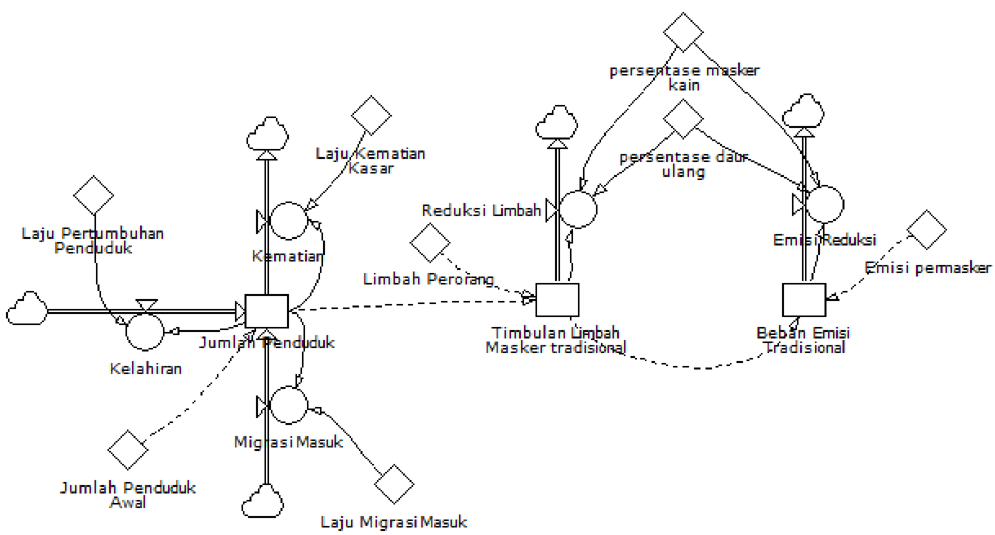


FIGURE 10. Stock Flow Diagram Traditional Scenario.

The flow chart in the image above explains that the sub-system of waste generation acts as a level/stock and obtains additional flow (inflow) from the total population and waste per person. Meanwhile, waste reduction provides an outflow. In the traditional emission load sub-system, which acts as a level/stock, additional flow is obtained from the generation of mask waste and emissions from masks. The critical point in the scenario model lies in the 30% cloth mask usage constant which was obtained based on the socialization/campaign on the use of cloth masks and the 1% recycling activity constant obtained from the mask waste processing and extermination activities using this. For this scenario to work,

2) Moderate Scenario

This scenario uses the following assumptions. Population growth rate: 1.24% per year; Crude death rate : 1.37% per year ; In-migration rate: 1.05% per year; Initial population : 515,114 people ; Waste volume per person : 6.26 kg/person per year; Mask emission : 0.297 Kg CO2.Eq; incinerator emissions; 3,336 Kg CO2.Eq; Percentage of recycled waste : 1% per day; Percentage of use of cloth masks: 30% per day; Destruction percentage : 1% per day. Here are the results of running the program for a moderate scenario:

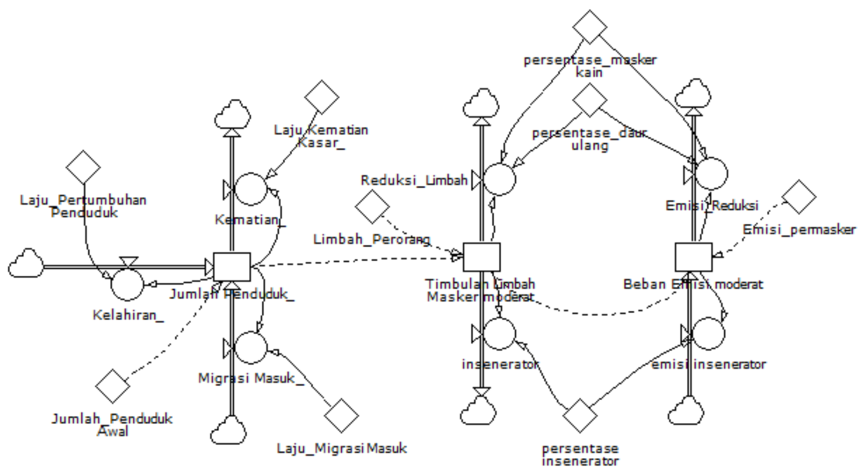


FIGURE 11. Stock Flow Diagram Moderate Scenario.

The flow chart in the image above explains that the sub-system of waste generation acts as a level/stock and obtains additional flow (inflow) from the total population and waste per person. Meanwhile, waste reduction and incinerators provide an outflow. In the moderate emission load sub-system which acts as a level/stock, additional flow is obtained from the generation of mask waste and emissions from masks. The critical point in the scenario model lies in the 30% cloth mask usage constant obtained based on the socialization/campaign on the use of cloth masks and the 1% recycling activity constant obtained from mask waste processing activities and 1% extermination activities using an incinerator.

3) Innovative Scenarios

This scenario uses the following assumptions: Population growth rate: 1.24% per year; Crude death rate : 1.37% per year ; In-migration rate: 1.05% per year; Initial population : 515,114 people ; Waste volume per person : 6.26 kg/person per year; Mask emission : 0.297 Kg CO2.Eq; incinerator emissions; 3,336 Kg CO2.Eq; Percentage of recycled waste : 10% per day; Percentage of use of cloth masks: 30% per day; Destruction percentage : 1% per day. The following are the results of running the program for the Innovative scenario:

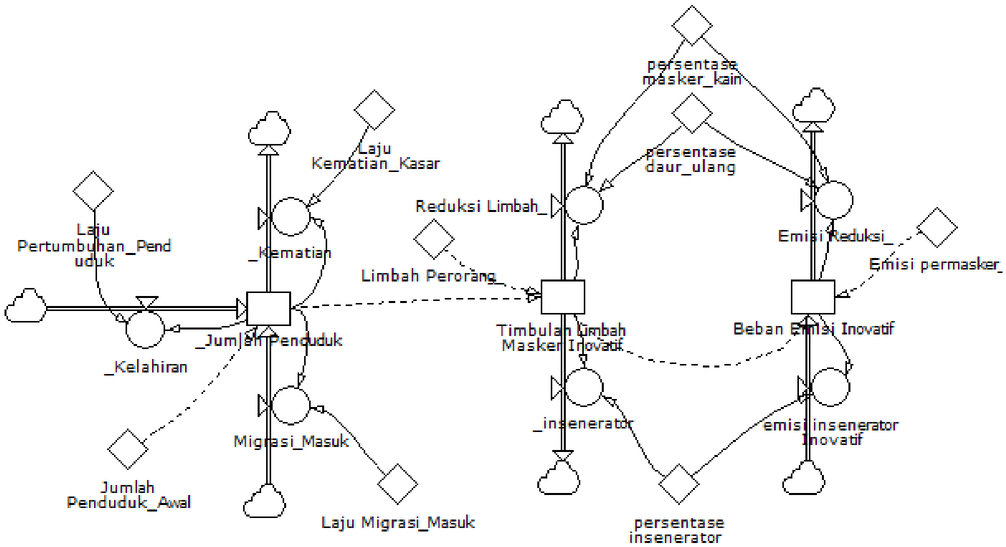


FIGURE 12. Stock Flow Diagram of Innovative Scenarios.

The flow chart in the image above explains that the sub-system of waste generation acts as a level/stock and obtains additional flow (inflow) from the total population and waste per person. Meanwhile, waste reduction and incinerators provide an outflow. In the innovative emission load sub-system, which acts as a level/stock, it obtains additional flow from the generation of mask waste and emissions from masks. The critical point in the scenario model lies in the 30% cloth mask usage constant obtained based on the socialization/campaign on the use of cloth masks and the 10% recycling activity constant obtained from mask waste processing activities and 1% extermination using an incinerator. . For this scenario to work,

The simulation results obtained from the three scenarios above, the traditional scenario assumes a condition where an area carries out waste reduction with community participation through the use of cloth masks and household-based waste treatment. The results of the analysis assume that if the scenario is carried out, there will be a reduction in the generation of mask waste in year 6 by 1% of the total waste generation in 2022. In the moderate scenario, it assumes the condition of an area to reduce waste with community participation and additional from the government through activities starting from collection to destruction. using an incinerator. The results of the analysis assume that if the scenario is carried out, there will be a reduction in the generation of mask waste in the 6th year by 6% of the total waste generation in 2022. In the innovative scenario, it assumes the condition of an area to reduce waste with the participation of the community, government and organizations in the area through waste processing activities into something that has more value. The results of the analysis assume that if the scenario is carried out, there will be a reduction in the generation of mask waste in year 6 by 18% of the total waste generation in 2022. As a comparison material, it can be seen in the graphical simulation results of the three model scenarios as follows:

9

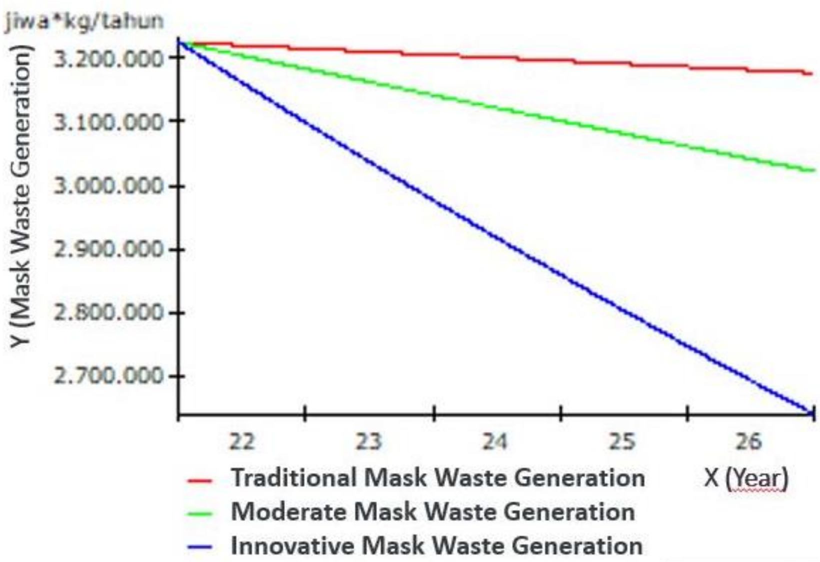


FIGURE 13. Reducing the amount of mask waste in Denpasar City Using Optimistic, Moderate and Pessimistic Scenarios

TABLE 9. Estimated amount of mask waste generation in Denpasar City using Traditional, Moderate, Innovative scenarios.

Time	TraditionalMask Waste Generation (kg)	Moderate Mask Waste Generation (kg)	Innovative Mask Waste Generation (kg)
Jan 2022	3,224,614	3,224,614	3,224,614
Jan 2023	3,214,954	3,182,964	2,098,168
Jan 2024	3,205,328	3,141,852	2,976,680
Jan 2025	3,195,722	3,101,272	2,859,956
Jan 2026	3,186,149	3,061,215	2,747,810
Jan 2027	3,176,605	3,021,676	2,640,061

In the simulation results of the emission load generated from each of the above scenarios, if using the traditional scenario, the resulting emission load shows a decrease in the 6th year by 1% of the total emissions in 2022. If using the moderate scenario, it is estimated that there will be an increase in the emission load of as much as 16% of total emissions in 2022, this is in line because the emission results from extermination activities use incinerators. If using an innovative scenario, it is estimated that there will be an increase in the emission load of 2% of the total emissions
9 in 2022. As a comparison material, it can be seen in the graphical simulation results of the three model scenarios as follows:

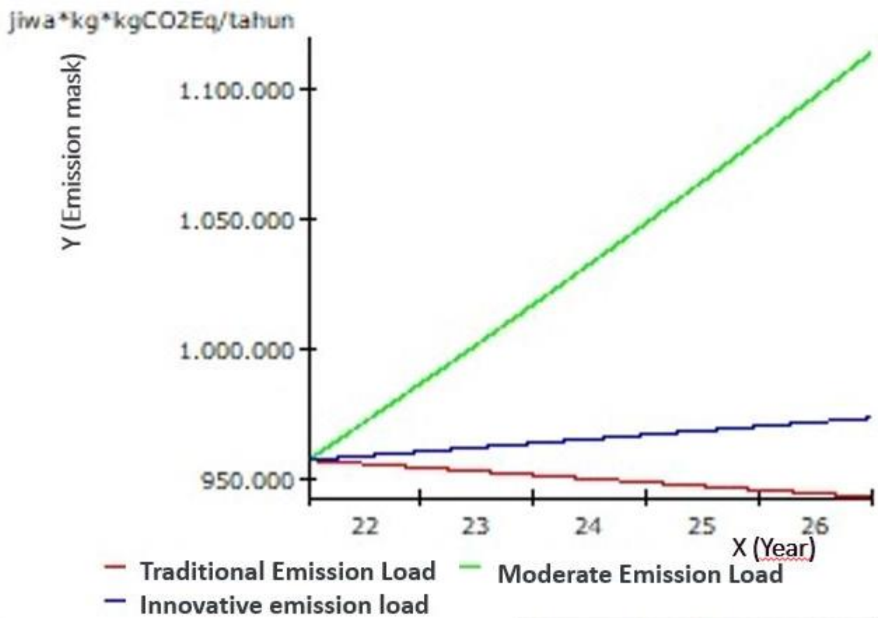


FIGURE 14. Increasing the Total Emission Load in Denpasar City Using Optimistic, Moderate and Pessimistic Scenarios

TABLE 10. Estimation of the amount of Emission Burden in Denpasar City using Traditional, Moderate, Innovative scenarios.

Time	Traditional Emission Load (KgCo2Eq)	Moderate Emission Load (KgCo2Eq)	Innovative Emission Burden (KgCo2Eq)
Jan 2022	957,710	957,710	957,710
Jan 2023	954,841	987,230	960,933
Jan 2024	951,981	1,017,661	964,167
Jan 2025	949,129	1,049,030	967,412
Jan 2026	946,286	1.081.365	970,668
Jan 2027	943,451	1,114,698	973,935

From this graph, it can be concluded that each scenario can be run if there is a complete element of cooperation between the community, the community and the government, the community and the government and community organizations, taking into account the estimation results and reduction assumptions that occur in each scenario.

CONCLUSIONS

1. From the results of the analysis, an estimated generation of 515,114 pieces of daily mask use (DFM) in Denpasar City is obtained, with this amount estimated to be equivalent to 4964.18 kg of medical masks (average mask weight 8.58 g). Total population (P) is 515,114[2], Percentage of urban population (Up) is 70.2%, Percentage of mask use (FMAR) is 80% , Assume that each person uses 2 masks every day. (FMGP).
2. Through the Life Cycle Assessment approach, based on the estimated generation of mask waste obtained, the environmental impact resulting from Greenhouse Gas emissions produced is 10,418,226 kg CO2 Eq per year, with energy consumed of1,991,128GWh per year. With the resulting potential energy of 7,562,264 GJ.
3. Based on the results of the survey, it was found that the community had a fairly good attitude towards the use of masks, considering the average (mean) obtained was 2.96. The public has good knowledge of the use of masks, considering the average (mean) obtained is 3.93. The community in the management of mask waste is obtained by the community having bad actions towards the processing of masks, with the consideration that the average (mean) obtained is 2.60.

4. In the traditional scenario with the assumption of community participation, there is a 1% reduction in the generation of mask waste and emissions in year 6 from 2022. In the moderate scenario assuming participation from the community and the government there is a reduction in the generation of mask waste in the 6th year by 6% from 2015. 2022, however, there will be an increase in emissions when using an incinerator in the 6th year by 16% of the total emissions in 2022. In the innovative scenario with the assumption of community participation, the government and community organizations there is a reduction in the generation of mask waste in the 6th year by 18% but experiencing an increase in emissions burden of 2% from 2022.

REFERENCES

1. Mejjad N, Cherif EK, Rodero A, et al. Disposal behavior of used masks during the covid-19 pandemic in the moroccan community: Potential environmental impact. *Int J Environ Res Public Health*. 2021;18(8). doi:10.3390/ijerph18084382
2. BPS. KOTA DENPASAR DALAM ANGKA 2022. In: *KOTA DENPASAR DALAM ANGKA*. BPS KOTA DENPASAR; 2022:243.
3. Nzediegwu C, Chang SX. Resources , Conservation & Recycling Improper solid waste management increases potential for COVID-19 spread in developing countries. *Resour Conserv Recycl*. 2020;161(May):104947. doi:10.1016/j.resconrec.2020.104947
4. Benson NU, Fred-Ahmadu OH, Bassey DE, Atayero AA. COVID-19 pandemic and emerging plastic-based personal protective equipment waste pollution and management in Africa. *J Environ Chem Eng*. 2021;9(3):105222. doi:10.1016/j.jece.2021.105222
5. Atmojo JT, Iswahyuni S, Rejo R, et al. Penggunaan Masker Dalam Pencegahan Dan Penanganan Covid-19: Rasionalitas, Efektivitas, Dan Isu Terkini. *Avicenna J Heal Res*. 2020;3(2):84-95. doi:10.36419/avicenna.v3i2.420
6. Fan Y Van, Jiang P. The energy and environmental footprints of COVID-19 fi ghting measures e PPE , disinfection , supply chains. 2020;211(x). doi:10.1016/j.energy.2020.118701
7. Chau C, Chandler K, Dobrijevic D, Hailes H, Lettieri P. No Title. 2020;(May). doi:10.14324/111.444/000031.v1
8. Alfonso, MB, Arias, AH, Menéndez, MC, Ronda, AC, Harte, A., Piccolo, MC, & Marcovecchio, JE (2021). Assessing threats, regulations, and strategies to abate plastic pollution in LAC beaches during the COVID-19 pandemic. Ocean and Coastal Management, 208(March). https://doi.org/10.1016/j.ocecoaman.2021.105613.
9. Aragaw, TA (2020). Surgical face masks as a potential source for microplastic pollution in the COVID-19 scenario. Marine Pollution Bulletin, 159(June), 111517. https://doi.org/10.1016/j.marpolbul.2020.111517
10. Artika, I., & Chaerul, M. (2020). Dynamic System Model for Evaluation of Waste Management Scenarios in Depok City. 8, 261–279. https://doi.org/10.14710/jwl.8.3.261-279.
11. Darmono, R. (2005). SYSTEM DYNAMICS MODELING IN CITY SPATIAL PLANNING. 2005(Snati).
12. Fadare, OO, & Okoffo, ED (2020). Covid-19 face masks: A potential source of microplastic fibers in the environment. January.
13. Hariani, & Suprajaka. (2017). DYNAMIC SYSTEM MODELING OF WASTE TREATMENT. Journal of Planesa, 8(November), 73–81.
14. Iman Tohari, PA, Suadi, S., & Subejo, S. (2020). Perceptions of Shrimp Cultivators in the Development of Sustainable Pond Businesses in the South Coast of the Special Region of Yogyakarta and Central Java. Journal of Fisheries Gadjah Mada University, 22(1), 55. https://doi.org/10.22146/jfs.36520
15. Minister of the Environment and Forestry of the Republic of Indonesia. (nd). Circular No. SE.3/MENLHK/PSLB3/PLB.3/3/2021. Minister of Environment and Forestry of the Republic of Indonesia.
16. Nugraha, AP, Hardjomidjojo, H., & Munandar, JM (2020). FACTORS AFFECTING PARTICIPATION. Ecolab, 14(1), 31–41.
17. Sangkham, S. (2020). Face mask and medical waste disposal during the novel COVID-19 pandemic in Asia. Case Studies in Chemical and Environmental Engineering, 2(September), 100052. https://doi.org/10.1016/j.cscee.2020.100052
18. Wijaya, MW, Putra, IKA, Wiryadi, PAPW, & Gegiranang, IG (2021). COVCRETE 19: RECYCLING MEDICAL MASK WASTE INTO FIBER CONCRETE MIXTURE AND PAVING BLOCK. Bali Ideathon is back.