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3RD INTERNATIONAL CONFERENCE ON GREEN ENVIRONMENTAL ENGINEERING AND TECHNOLOGY 2021

CERTIFICATE

OF APPRECIATION

THIS CERTIFICATE IS AWARDED TO

Dr. Marniati., M.Kes

FOR CONTRIBUTION AS

REVIEWER

for the 3rd International Conference on Green Environmental Engineering and Technology (IConGEET 2021) on 8 & 9 September 2021

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Demikian surat tugas ini dikeluarkan untuk dapat dimaklumi dan dilaksanakan dengan penuh tanggungjawab.

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A study on the environmental impact during distribution and disposal stages for the 3- ply face masks by using life cycle assessment

Tengku Nuraiti Tengku Izhar, Chow Suet Mun Christine and Irnis Azura Zakarya

Abstract The demand of face masks had increased tremendously due to pandemic outbreak of COVID-19, leading to the increasing production rate of face masks in industry in Malaysia. Waste pollution is also produced at the same time, resulting impacts towards the environment. The study tools used in this study is life cycle assessment (LCA) to identify the significant potential environmental impact produced during the life cycle stages for distribution and disposal by using GaBi Education Software. The impact assessment method selected in this study is CML 2001- Jan 2016 with the environmental indicator of Global Warming Potential (GWP), Acidification Potential (AP), Eutrophication Potential (EP) and Ozone Depletion Potential (ODP). GWP results in producing the highest impact in GWP to the environment during both distribution and disposal stages.

Keywords Life cycle assessment, 3- ply face masks, waste, environmental impact

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1. Introduction

On March 2020, World Health Organization (WHO) had announced the corona-virus disease (COVID-19) as the pandemic disease. [1] The virus can be transmitted easily through saliva droplets when the infected person coughs or sneezes. In order to reduce the risk from being infected, WHO had encouraged the public to wear face masks and practice social distancing.

The usage of face masks speeds up tremendously causing the production rate of the face masks to increase in order to meet the demand of public. Based on the statistics value, up to 80% of the public started to wear face masks in public area in Malaysia since April 2020. [2] As the usage increases, the waste produce also increases, causing plastic pollution to the environment due to the microparticles in the fabrics. [3] 3- ply face mask is made up of polymeric materials, taking around 450 years to degrade completely. [4]

The aims of this study are to identify the significant potential impacts produced during the life cycle stages for distribution and disposal with the input of 1000kg 3- ply face masks reflecting on real- life situation and also to analyze the end- life treatment with the uniform input of 1000kg 3- ply face masks waste to incineration and landfill.

Life cycle stages of the 3- ply face masks focused in this study is distribution and disposal stages, where the disposal stage includes incineration and landfill. Life cycle assessment (LCA) based on the standardization of ISO 14040 and ISO 14044 is used as the study tool to determine the potential impact towards the environment. The source of data is retrieved from GaBi education software, using CML 2001- Jan 2016 as the impact assessment method. GWP, AP, EP and ODP are the environmental indicator focused in the study.

Table 1: Scope of study area

Life cycle stages	Description
Distribution	• Manufacture to shop • Shop to user • Waste from user to incinerator • Waste from user to landfill • Waste to others
Disposal	• Incineration • Landfill

2. Materials and method

2.1 Material

The target material in this study is 3- ply face masks. 3- ply face mask is made up of 3 layers of fabrics, mainly non- woven bonded fabrics, having a better bacteria filtration. [5] The fabrics of the layers attributes in the stretching of the celluloses of O-H and C-H showing that the fabrics are produced from polymeric materials. [3] It also undergoes the process of spunbond and melt- blown where the fibers bond can be bond closely to each other producing the filaments that have ultra-fine sub- micron filaments.

2.2 Method

The method used to generate the results of impact assessment is CML 2001- Jan 2016 by using GaBi Education Software. The input of data is extracted from GaBi Education database based on the unit process studied. Midpoint results are used in the study focusing on the environmental indicator such as GWP, EP, AP and ODP. The results generated is then analyzed and interpreted, making conclusion and recommendations for the study.

Table 2: Waste mass distribution to its end- life treatment based on real- life situation. [6]

End- life treatment	Ratio	Amount (kg)
Landfill	0.532	532
Incineration	0.168	168
Others	0.3	300
Total	1	1000

For the emission value from each environmental indicator based1000kg waste of 3- ply face masks, the formula used is as below, derived from ratio and proportional method.

$$\text{Emission value (1000kg)} = \frac{Emission\ value\ x\ 1000kg}{Mass\ (kg)} \quad (1)$$

The emission value is the results generated from the software based on its respective mass while the mass indicates the mass calculated based on the reference ratio mass. [7]

3. Result and discussion

Fig 1 shows the process flow of the life cycle stages created using GaBi education software. Only distribution and disposal stage are focused in the study. As for the disposal stage, only incineration and landfill are involved in the study. The basis of waste involved is 1000kg, with extracting database from GaBi education software to generate out the result. The impact assessment method used in CML 2001-Jan 2016.

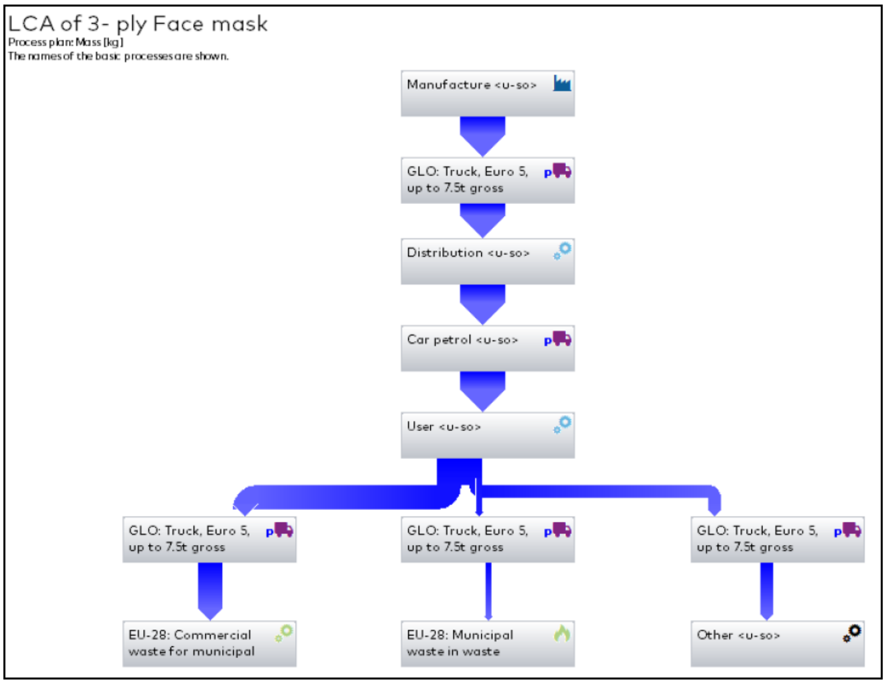


Fig 1: Process flow diagram of LCA of 3- ply face masks using GaBi Education Software

3.1 Significant potential impact produced during distribution and disposal stage of 3- ply face masks.

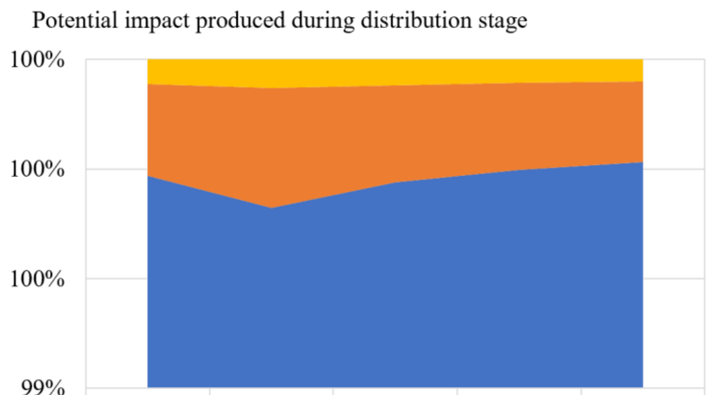
The mass of face masks is distributed to their respective location and end -up as waste in the disposal area. Each mass input for the waste respectively to the disposal area is based on the ratio reference. [6]

Table 3: Overview on the potential impact produced during distribution stage reflecting on real-life situation

Environmental Indicator	Life cycle stages		
	Distribution	Disposal	
		Incineration (168kg)	Landfill (532kg)
GWP (kg CO_2 eq)	130.57	560	158
AP (kg SO_2 eq)	0.2345	0.118	0.0629
EP (kg PO_4^{3-}eq)	0.06725	0.483	0.0131
ODP (kg CFC 11)	0	8.54E-14	6.77E-14
Total value (kg emission eq)	-	560.601	158.076
Total emission (kg emission eq)	130.8718	718.677	

Table 3 show the results that among the life cycles stages of the 3- ply face masks studied, GWP produced the highest emission among the indicator studied while ODP produced the lowest emission. During distribution stage, the emission value for GWP is 130.57kg CO_2 eq, while during the disposal stage, the GWP emission value is 718.68kg CO_2 eq.

GWP is caused by the presence of GHGs which are made up of high percentage of carbon dioxide and methane gas. [7] The low emission value of ODP is due to the absent of the compound of CFC and HCFC that will damage the ozone layer which is caused by the chlorine molecules react with ozone layer and converting them to oxygen. [8]



	Truck A (337km)	Vehicle A (20km)	Truck B (167km)	Truck C (50km)	Truck D (20km)
EP (kg (PO3-)4 eq)	0.0378	0.0166	0.00314	0.00298	0.000673
ODP (kg CFC 11)	0	0	0	0	0
AP (kg SO2 eq)	0.14	0.0692	0.0117	0.0111	0.0025
GWP (kg CO2 eq)	83.7	31.6	6.61	6.97	1.69

Fig 2 Potential impact produced during distribution stage.

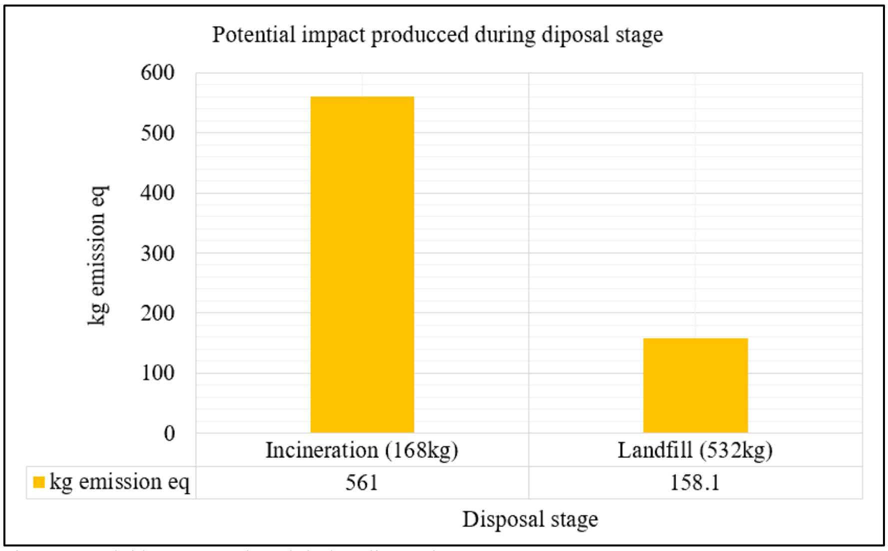


Fig 3 Potential impact produced during disposal stage.

Fig 2 above shows the emission results during the distribution stage based on different travel distance. Truck A travels the route from transport the products from manufacturer to seller. Vehicle A is from seller to users using lighter vehicle. Truck B and C are the transportation of waste to incinerator and landfill respectively while truck D presented the other method of face masks disposal method. The emission on each vehicle cannot be compared due to the different travel route distance, thus only an overview can be discussed.

The results for the emission value during disposal stage is shown in Fig 3. Although the waste ratio sent off for incineration is less than landfill, however, the emission value towards the environment is higher than landfill. The high emission produced during incineration can be clearly determine on the impact towards the environment.

3.2 Emission value from incineration and landfill based on 1000kg waste of 3- ply face masks.

1000kg waste of 3- ply face masks are sent off to the incinerator and landfill each respectively for their end- life treatment. The emission value is calculated based on the formula derived from ratio and proportion method. (1) The results shows that GWP produced the highest emission among the indicator studied during both end- life treatment. The lowest emission produced is ODP, due to the absent of compound such as CHCs and HCFC that will damage the ozone layer. [8]

Table 4: Overview on the emission between landfill and incineration based on 1000kg waste.

Environmental Indicator	Life cycle stages	
	Landfill (1000kg)	Incineration (1000kg)

GWP (kg CO_2 eq)	296.99	3333.33
AP (kg SO_2 eq)	0.1182	0.7024
EP (kg PO_4^{3-}eq)	0.0246	2.875
ODP (kg CFC 11)	1.2726E-13	5.0833E-13
Total emission (kg emission eq)	297.1328	3336.907

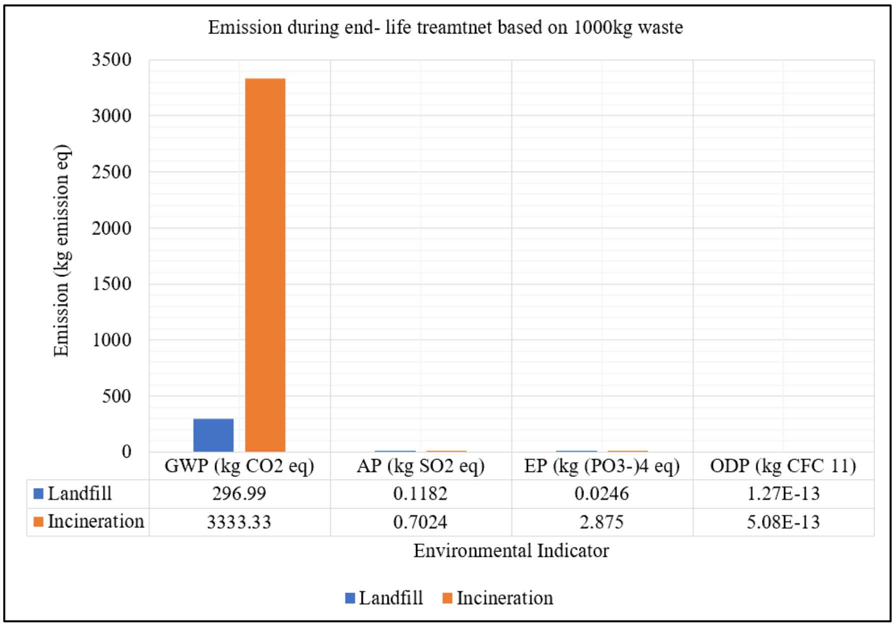


Fig 4: Emission during the end- life treatment based on 1000kg waste.

Table 4 above shows the overview on the emission between landfill and incineration based on 1000kg waste. The total emission value for incineration is much higher than landfill with the value of 3336.907kg emission eq to 297,1328kg emission eq. From figure 4, the significant emission value produced by GWP is potentially higher among the indicator studied.

The emission value from GWP is high during incineration, mainly caused by the production of carbon dioxide during the incineration of plastic. [9] Contribution of greenhouse gas (GHGs) in landfill site that leads to GWP is the degradation of waste, combustion of diesel fuel on site during the maintenance of the landfill. [10]

4. Conclusion

From the results data generated above, the significant potential impact produced during the life cycle stages of 3- ply face masks among distribution and disposal are GWP, while the least impact produced is ODP. High GWP emission value during the distribution stage is mainly caused by the burning of diesel and fossil fuel allowing the vehicles to operate.

Under the situation of having 1000kg of waste ending up in each end- life treatment of incineration and landfill, incineration results in a higher value emission data of GWP. Incineration release gases during the burning of waste resulting high emission value of GWP.

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