A review of eco-efficiency feasibility for rubber glove manufacturing in Thailand

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Graphical Abstract

Abstract

Rubber products are fundamental wares in the present-day market. Rubber glove fabricating, being inexhaustible with its one-of-a-kind characteristics, assumes an essential part of an adjustable item. Most glove manufacturers in Thailand are established in the south and Eastern area. Handling is by all accounts material and energy-serious consequently tested by cost-insufficiency and different ecological issues. This examination intended to improve the elastic glove preparing a place to be more expense productive and eco-more amiable dependent on flexible glove fabricating with a novel procedure. This approach comprised of three stages: first is utilizing material stream investigation (MFA), material stream cost bookkeeping (MFCA), and life cycle appraisal (LCA) to measuring monetary misfortune and ozone harming substance emanations, furthermore, to building up the proposition of progress choices lastly is advantage approval of the recommended improvement choices for sure executions. The examination philosophy announced here is essentially valuable in acquainting an attainability-producing model with the elastic glove handling industry and other comparative assembling ventures situated in non-industrial nations.
**Keyword**: Life cycle assessment, Glove production, Biomass fuel, Economic impact, Environmental impact

1. Introduction

As the most preferred glove material among medical services laborers, nitrile gloves are projected to arrive at a market size of US$66.8 billion by 2027, fundamentally determined by the novel Covid spreading quickly across the globe. With considers demonstrating gloves to secure against Coronavirus successfully, what the world requirements presently are clinical gloves. More than 80 million gloves are required by COVID-19 wellbeing reaction groups every month around the world [1]. The interest for elastic gloves in a few enterprises, especially in the wellbeing business, has been constantly filling in the new past because of the expanded utilization of wellbeing and clean items among customers with the COVID-19 pandemic. Nitrile without powder glove item is the significance of assembling in Thailand in regards to both business and fares [2]. Whenever considered in the field of energy measurement, glove producing is held to devour energy at a significant level and will, in general, augment the degree of energy utilization relying upon monetary development [3]. The biomass boilers can utilize renewable fuel sources such as palm kernels, wood chips, or wood pellets, thus avoiding greenhouse gas emissions from fossil fuel combustion [4]. There is us Material Flow Analysis (MFA) method with rubber glove products [5]. MFA is a widespread and standardized methodology for accounting for a system's input and output material flow [6].

Thailand's elastic glove industry means to extend its cut of the worldwide market from 15% to 20 percent in the following five years. The Thai Rubber Glove Manufacturers Association (TRGMA) is pushing for the expanded venture and generally improved intensity to meet that target. Affiliation president Veerasith Sinchareonkul said the drawn-out point was to get a 40-percent portion of the world market. The move follows a 20-percent hop worldwide interest for elastic gloves to 3.6 million during the Covid-19 pandemic. The request is required to ascend by another 10% one year from now. Veerasith asked the public authority to offer more monetary help to assist makers with the growing venture. It ought to likewise smooth out guidelines to facilitate the dispatch of new processing plants, he added. Thailand is the world's second-biggest exporter of elastic gloves, driven by 19 makers with a consolidated creation limit of 46 billion every year. Of that absolute, 90% is sent out. Clinical flexible gloves represent 88% of unlimited creation. Thailand has 19 flexible glove industrial facilities with a total creation limit of 46 billion pieces each year, 90% of which was, ordinarily, for sends out, with the realm representing around 13% of the worldwide stock, as per the Thai Rubber Glove Manufacturers Association. New interests in the business are relied upon to extend Thailand's piece of the overall industry to 20% by 2022 [7].
Worldwide interest for defensive gloves is taking off considering the Covid pandemic, driving Thailand’s elastic glove fares to flood 16% year-on-year in the initial four months of 2020. Thailand produces latex and possesses normalized creation innovation, offering a bitter edge of cost, cost, and quality. Thailand has 13 FTAs set up with 18 nations and regions, with 17 done gathering import levies on Thai elastic gloves, including ASEAN, China, Japan, South Korea, Australia, New Zealand, Chile, Peru, and Hong Kong. Just India keeps a 10% import levy on Thai elastic gloves [8].

Subsequently, this examination builds up the eco-productivity attainability by the financial and natural effect of elastic glove fabricating on the LCA and MFA, which ought to be proposed to improve the interaction by diminishing the biological product added while expanding its worth.

2. The technology of glove manufacturers

2.1 Sources of glove manufacturing (energy and materials)

The creation of elastic gloves is a work, energy-, and material-escalated measure. A lot of power and nuclear power, freshwater, kindling, and synthetic compounds are utilized at various assembling measures stages. Power is fundamentally utilized in uncompromising apparatus, siphoning water, wastewater treatment, and industrial facility lighting. In the meantime, nuclear power is utilized for elastic drying and is created by kindling consumption. Freshwater is an essential material utilization factor. Water is fundamental for washing, manufacturing plant cleaning, weakening of synthetic substances and field latex, and in any event, cooling apparatus [9][10]. Saidur and Mekhilef [11] was investigated the energy use and energy discussion in the Malaysia elastic creation by a walkthrough energy review, Energy review information, Estimating energy use, reserve funds and compensation period and

### Table 1: Thailand’s top 10 rubber glove export markets

<table>
<thead>
<tr>
<th>Market</th>
<th>Value: US$ million</th>
<th>%Change</th>
<th>Ratio (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2018</td>
<td>2019</td>
<td>2020 (Jan-Apr)</td>
</tr>
<tr>
<td>US</td>
<td>551.70</td>
<td>568.80</td>
<td>193.90</td>
</tr>
<tr>
<td>EU</td>
<td>258.90</td>
<td>249.10</td>
<td>82.90</td>
</tr>
<tr>
<td>China</td>
<td>39.40</td>
<td>49.80</td>
<td>31.00</td>
</tr>
<tr>
<td>Japan</td>
<td>74.00</td>
<td>69.40</td>
<td>22.60</td>
</tr>
<tr>
<td>Asean</td>
<td>36.00</td>
<td>38.10</td>
<td>18.30</td>
</tr>
<tr>
<td>Brazil</td>
<td>17.80</td>
<td>27.30</td>
<td>11.60</td>
</tr>
<tr>
<td>Australia</td>
<td>25.90</td>
<td>18.70</td>
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<tr>
<td>Israel</td>
<td>23.20</td>
<td>22.50</td>
<td>9.40</td>
</tr>
<tr>
<td>India</td>
<td>15.50</td>
<td>17.00</td>
<td>8.30</td>
</tr>
<tr>
<td>South Korea</td>
<td>19.70</td>
<td>17.50</td>
<td>7.90</td>
</tr>
<tr>
<td>World</td>
<td>1,188.50</td>
<td>1,203.10</td>
<td>449.20</td>
</tr>
</tbody>
</table>

Source: Commerce Ministry
Emanation Reductions; Annual energy utilized by electric engines, Energy reserve funds by utilizing high-effectiveness motors, Mathematical plans to gauge energy investment funds using HEMs, Motor energy reserve funds utilizing VSD, Estimation of evaporator energy investment funds, Compressed air energy investment funds, Chillers energy investment funds, Mathematical details of the recompense time frame and Estimation of outflow decrease.

Elastic merchandise is created with numerous articles, for the most part, little and medium-sized undertakings, and huge sort producers. Creation plants for types or general adaptable items contain creation lines of 800–1200 m long and usually are fanned out in different structures. The essential handling ventures for elastic items are rumination, blending (plants, interior blenders, cooling factories), further preparing (pre-warming, preparing in extruders, handling on schedules) vulcanization. Energy is required for all the elastic items taking steps, and it addresses a tremendous expense for the utilization of a portion of the gear, like blowers. Among the adaptable thing fabricating measures, the processing interaction, expulsion cycle, and moving interaction have a moderately higher electric force utilization, over half of the all-out utilization.

In correlation, the vulcanizing cycle goes through 80% pretty much of the all-out utilization [12]. As of late, there has been a developing worry about energy use and its unfavorable effect on the climate. Since the most recent couple of years, most non-industrial nations have moved from agribusiness towards industrialization and urbanization because of economic development. While promising a reasonable extension of the GDP, the modern area’s advancement has seriously influenced its capacity to keep up fuel supply or holds. The presentation of the idea of objective utilization of energy intends to decrease energy use. It focuses on the ideal utilization of every approach to accomplish more proficient utilization of the last point in industry to decide the measure of energy utilized and energy misfortune. Various sorts of gear and gadgets would use power at different degrees of proficiency, contingent upon their attributes restricted financial assets [13]. A strategy used to distinguish and evaluate how energy is being utilized and squandered in a plant is an energy review. Various investigations have been distributed on energy review and energy examination results for different businesses [14];[15]. Energy use exhibitions and energy efficiencies have likewise been examined through different reviews in various nations. Nonetheless, current writing doesn't show any investigation that has distinguished and evaluated appraisals of the energy use breakdown in Asian elastic creating businesses. This technique is exhibited utilizing contextual analyses of real energy appraisals. Nonetheless, there are two huge limits: (i) the ends drawn from this examination ought to be estimated against the measurable vulnerability of the outcomes and (ii) the second and the most basic impediment is in the framework space, where the technique endeavors to decide investment funds from singular subsystems utilizing entire plant energy use. The trigeneration technique is introduced in Ref. As an elective method of improved energy use in cogeneration frameworks. The decline sees investment funds of the fuel took care of to the turbogenerator hardware. Thermodynamic strategies for energy and
exergy) investigations have been utilized to show energy use in industry, and it has been presumed that poor thermodynamic execution is essentially the consequence of exergy misfortunes in ignition and warmth move measures \[16\].

As per Fig. 1, 10-30% of the info heat is squandered through the pipe gas, and this is the most elevated wellsprings of warmth misfortune in the kettle framework. Since the vast majority of the warmth is being squandered through the high-temperature vent gas, the recuperation of heat from high-temperature fumes can bring about critical energy reserve funds. Saddling the high-temperature vent gas’s waste warmth could be a considerable energy reserve funds potential for an evaporator framework. Nonetheless, the evaporator productivity can be improved by limiting this misfortune by upgrading the overabundance air proportion utilizing a VSD (variable speed drive). A VSD is being used on the fan engine to change the overabundance of air proportion. Fig. 2 shows heater effectiveness with the pipe gas temperature decrease \[17\].

Biomass is the most appealing elective energy asset since it is inexhaustible, spotless, modest, and promptly accessible. There are a few biomass types like wood, energy crops, farming deposits, mechanical squanders, metropolitan solid waste, and so on, and there are a few different ways to change biomass over to energy. Also, biomass is the solitary dependable asset that can be changed over into all energy usage structures. Densification of biomass is the fundamental method to give better properties as a pellet structure. Numerous investigations about biomass pellet in late year, like pellet from wood and wood builds, pellet from horticultural deposits, pellet from modern waste, and pellet from civil strong debris and muck \[18\].

The palm oil industry creates enormous measures of strong squanders. The strong squanders, otherwise called oil palm biomass, incorporates the storage compartment (OPT) and fronds (OPF) from the manor, and void organic product pack (EFB), mesocarp fiber (MF), and palm piece shell (PKS) from the preparing factories (see Fig. 3) \[19\]. Tables 2 and 3 have represented the lignocellulosic substance of oil palm biomass and Cellulose, hemicellulose, lignin, and debris arrangements of oil palm biomass, separately.

![Fig. 1: Proficiency of an evaporator with the vent gas temperature decrease \[17\].](image)
**Fig. 2:** Energy utilized by measure heat in elastic ventures \[17\].

**Table 2:** Lignocellulosic substance of biomass from oil palm \[20\].

<table>
<thead>
<tr>
<th>Biomass type</th>
<th>Moisture content (%)</th>
<th>Volatile mater (%)</th>
<th>Ash (%)</th>
<th>Fixed carbon (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Palm kernel shell (PKS)</td>
<td>11.00</td>
<td>67.20</td>
<td>2.10</td>
<td>19.70</td>
</tr>
<tr>
<td></td>
<td>5.40</td>
<td>71.10</td>
<td>4.70</td>
<td>18.80</td>
</tr>
<tr>
<td>Empty fruit bunch (EFB)</td>
<td>6.36</td>
<td>78.20</td>
<td>4.53</td>
<td>16.46</td>
</tr>
<tr>
<td></td>
<td>8.78</td>
<td>79.65</td>
<td>3.00</td>
<td>8.60</td>
</tr>
<tr>
<td>Mesocarp fiber (MF)</td>
<td>73.03</td>
<td></td>
<td>10.83</td>
<td>16.13</td>
</tr>
</tbody>
</table>

**Table 3:** The compositions of oil palm biomass \[19\].

<table>
<thead>
<tr>
<th>Biomass type</th>
<th>Cellulose</th>
<th>Hemicellulose</th>
<th>Lignin</th>
<th>Ash</th>
</tr>
</thead>
<tbody>
<tr>
<td>Palm kernel shell (PKS)</td>
<td>28.8-27.2</td>
<td>21.6-22.7</td>
<td>44.0-50.7</td>
<td>8.6-16.3</td>
</tr>
<tr>
<td>Empty fruit bunch (EFB)</td>
<td>34.0-40.4</td>
<td>17.2-22.4</td>
<td>23.1-29.6</td>
<td>5.0-6.5</td>
</tr>
<tr>
<td>Mesocarp fiber (MF)</td>
<td>23.0-28.8</td>
<td>25.3-30.5</td>
<td>25.5-28.97</td>
<td>2.6-5.8</td>
</tr>
</tbody>
</table>
Figure 3: Biomass fuels for TOH (a) Empty fruit bunches (EFB), (b) palm fiber, (c) wood ship, and (d) Palm kernel shell (PKS)
2.2 Different manufacturing methods (describe a different kind of methods)

The general square stream chart of the NBR glove producing measure is addressed in Fig. 3. During this cycle, previous cleaning (reuse from the past clump of gloves creation) is completed, trailed by coagulant plunging for cement improvement. At that point, NBR elastic plunging and gelling to shape a film of latex, followed by filtering and beading, drying and vulcanization to expand the mechanical properties of NBR gloves, cooling, chlorination, at that point post-draining and drying, stripping and review for the creation quality, and finally bundling for dispersion to the end shoppers happen.

2.2.1 NBR powder-free glove dipping process which is polymer-coated.

The principal stage comprises three cycles which are a corrosive wash, antacid wash, and water flushing. At first, the previous should be cleaned after the past group of glove creation. To start with, the formers are plunged into the corrosive arrangement tank to change striate over to steric sarcastic, at that point killed by water washing. After the formers passed, however, the water washing tank will be moved to the antacid arrangement tank to eliminate stearic corrosive from previous by a transport chain. The stream is then moved to the water washing tank, which is the last method before it is finished. After the water washing tank, the cleaned formers are shipped off the subsequent stage, nine distinct sorts of cycles, to be specific, coagulant plunging, engineered elastic plunging, latex film drying, pre-draining, beading, polymer plunging, vulcanization, post-filtering, and drying measures, are associated with the in-measure stage. The item is then shipped off the third stage, web-based pressing interaction by the transport chain.

2.2.2 NBR powder-free glove dipping process which is online chlorination.

The primary stage, previous cleaning measure similitude with polymer covered interaction. After the water washing tank, the cleaned formers are shipped off the subsequent stage, ten unique kinds of cycles, to be specific, coagulant plunging, manufactured elastic plunging, latex film drying, pre-filtering, beading, vulcanization, cooling, chlorination, post-draining, and drying measures, are associated with the in-measure stage. The item is then shipped off the pressing interaction.
3. Life cycle assessment (sustainability recycle)

Life cycle beliefing is one of the fundamental approaches to decrease discharges to the climate by lessening asset use and upgrading financial execution through the existence cycle \([21]\). The existence cycle viewpoint guarantees that the exercises are ecologically stable, have the upper hand, diminish expenses, and plan a special item. Decided Life Cycle Assessment (LCA) is an idea just as an apparatus to determine the measure of weight to the climate because of human movement. The European Commission (EC) inferred that LCA gives the best system for surveying the possible natural effects. It provides a structure for investigating and assessing the existence cycle items framework. The exercises' evaluations are assessed from extraction until removal, known as from the support to the grave or entryway to door, for example, during preparation. Material use, energy use, and waste delivered to the climate are investigated quantitatively and subjectively. They were shown the upside of utilizing LCA standards encouraging chiefs to pick a progression of exercises that will have the smallest impact on the climate. Life Cycle Assessment is being used as an instrument to help the eco-proficiency idea and offer a quantitative benefit of the effect brought about by the cycles through the Life Cycle Impact Assessment (LCIA). LCA's potential as an instrument can uphold the eco-productivity approach. LCA is at present controlled in ISO 14040. ISO 14040 is about the specialized prerequisites, which portray the standards and structure, and ISO 14044 is about requirements and rules. Life cycle impact assessment (LCIA) is utilized as an instrument by recognizing quantitatively the energy and materials utilized and squanders delivered to the climate \([5]\). Maulina et al. had improved Eco-efficiency in crumb rubber processing in Indonesia through life cycle assessment (LCA) \([22]\). The scrap elastic processing plants utilize a considerable
volume of water and energy to be more proficient in their materials and energy use and prompt ecological issues. The examination's principal goals are to direct a daily existence cycle stock for scrap elastic preparing, break down the natural effect from the existence cycle handling exercises, carry out environmental enhancements through LCA, and recommend the impacts from the current practice's morsel elastic handling towards eco-effectiveness.

Because of a contextual investigation of a Sri Lankan elastic crepe plant with a novel system comprised of three stages: first is the measurement of industrial facility's asset use, monetary misfortune, and ozone-depleting substance outflows utilizing MFA, MFCA, and LCA, second is creating proposition of feasible improvement alternatives and the settle this point advantage approval of the recommended improvement choices for specific executions. For instance, Jawjit et al [9] evaluated the GHG emanations identified with RSS creation, block elastic, and CL in Thailand. This investigation featured that compost and energy use were the primary wellsprings of GHG discharges in the Thai characteristic adaptable industry. It could lessen such emanations by changing from engineered compost to creature excrement, moving from petroleum derivatives to an environmentally friendly power, and energy and manure proficiency improvement. In the meantime, Jawjit et al [10] explored CL creation's ecological exhibition in Thailand with LCA utilization. They proposed, in fact, and reasonable, cleaner innovation alternatives for improving the productivity in burning-through energy (i.e., power and petroleum derivative), alkali, and diammonium phosphate. GHG outflows in crepe elastic handling have likewise been evaluated, focusing on the significance of utilizing sustainable power [23].

Producing the engineered gloves may cause unfriendly ecological effects, including a dangerous atmospheric deviation, carbon impression, fermentation, photochemical ozone development, eutrophication, human poisonousness, and water impression. A natural administration apparatus is applied to assess its ecological effects, and life cycle streamlining is executed to limit energy utilization and discharge of ozone harming substances by proposing five elective interaction improvement situations. Utilizing power created from biodiesel shows the most immaterial natural effects contrasted with different options for creating engineered gloves [5].

4. Material flow analysis (MFA)

MFA is a precise appraisal of the streams and loads of material inside a framework, characterized in reality. MFA envision every one of the material inflows and surges inside the assembling framework and gain an information yield balance. There is use STAN 2.5 programming was utilized for MFA computations. STAN 2.5 is programming that conveys an easy-to-use illustrations-based interface to direct numerous MFA computations, including building an MFA model and keeping up the info yield balance.

Material stream cost bookkeeping (MFCA) is an apparatus intended to elevate the eco-productivity in associations by diminishing material use and improving financial and natural
As per ISO 14051: 2011, MFCA considers four classes of cost data as the information at every amount place (QC; i.e., unit measure): 1. Material expense, 2. Framework cost, 3. Energy cost; and 4. Squander the executives' cost [25].

Further, it characterizes yield cost data bound with the material, framework, and energy costs into two fragments (i.e., positive and negative item costs) by increasing them by the percent of crude material misfortune by weight at each QC. Nonetheless, squander the board cost is exclusively distributed to the unsafe item cost related to squander. Aside from everyday materials, MFCA involves two different sorts of materials: axillary and working materials [26]. Helper materials are the materials needed to create the eventual outcome and consistently end in the result itself. Working materials are vital for making the result yet invariably end up as non-item yields (NPOs), i.e., wastewater and emanations.

5. Economic impact

The rubber glove industry assumes a fundamental part in many non-industrial nations' economies, especially in Asia. Among the diverse NR types, crepe elastic stands firm on a colossal situation, as it is utilized to deliver drug and careful elastic things and articles in contact with food varieties.

As of now, crepe elastic assembling has been tested by low efficiency, rising creation costs, and ecological issues. Dunuwila et al., study expected to survey the plausibility of receiving economic assembling rehearses in crepe elastic creation in Sri Lanka. They discovered 1 MT of adaptable information, the hidden financial misfortunes and GWP sway in the flow fabricating measure were distinguished as LKR 19,585, and 279.3 kg CO$_2$e with the estimations of 7% and 13% for Relative Standard Deviation, individually as progress choice proposed decrease choices of water, synthetic compounds, and power proportions. It uncovered that embracing these decrease alternatives could lessen 32,064 kg of water and 30.1 kWh of power, bringing about 5.3% of cost investment funds and a 4.3% of GWP sway decrease. Different ramifications related to progress choices and their limits are likewise talked about [27].
Fig. 5: The whole efficient chain of importance outlining the procedures and apparatuses coordinated in the examination [5].
As per Amadeo [28], monetary capital is the cash or other subsidizing structure that forms an organization's riches. It additionally alludes to an organization's believability for its business venture. Ordinarily, the organization will utilize monetary funding to put resources into their fixed resources like hardware, building, and materials. They likewise will do some innovative work to acquire benefit [29].

In light of the investigation, they tracked down that Top Glove organization has utilized biomass, which is sustainable power, to work at their processing plants. Notwithstanding, they work six processing plants because of the significant expense of innovation. In this manner, Top Glove should acquire sufficient monetary cash-flow to empower whole industrial facilities to appreciate a similar environmentally friendly power during assembling. As a matter of first importance, high economic capital empowers Top Glove to utilize trend-setting innovation, for example, heat transformer machines. This machine can decrease heat utilization by recuperating heat from hot wastewater and hot air missions. Furthermore, monetary capital additionally empowers Top Glove to supplant all old forced air systems and fridges by buying 5-Star Energy Rated Machines to improve energy productivity. Simultaneously, less utilization of fridges and forced air systems will diminish the worldwide temperature and help forestall an unnatural weather change.

The reason for subsidizing monetary capital in Top Glove is to utilize green power by supplanting petroleum products during assembling since Top Glove is expected to diminish carbon dioxide emanations and lessen environmental change brought about by consuming non-renewable energy sources. Hence, Top Glove needs generous monetary money to do this project and apply environmentally friendly power in each manufacturing plant. Studies have shown that green power can be more solid than customary energy administrations for ecologically friendly power energy administrations. Nonetheless, encountering huge scope disappointment is more outlandish by efficient power energy frameworks. For instance, wind and sun-based forces are less inclined to fizzle since they are circulated and measured. Along these lines, geological issues, for example, extreme climate or problems with one piece of hardware, won't result in an excessive amount of damage to the help in the encompassing zone [30].

Conversely, non-renewable energy sources can fundamentally add to air and water contamination, which can be the reason for serious medical problems like malignancy, breathing issues, coronary failures, and different sicknesses. Having efficient power fuel sources as a substitute for petroleum derivatives can help decline destructive outflows and tidy up air and water quality. Efficient power energy ultimately will gainfully affect improving general wellbeing and brings down 37 by and high medical care costs. According to [31], sustainable power sources will carry advantages to people's government assistance and diminish environmental change, which will affect the climate. By utilizing green wellsprings of energy, Top Gloves can add to deliver practically no hurtful discharges. In any case, non-inexhaustible types of energy discharge emanations restrict warmth and augmentation to the
globe's average temperatures, prompting a dangerous atmospheric deviation. This consistently delivering discharges from non-sustainable sources will bring about more hurtful environmental changes to human wellbeing and the climate. One of the particular factors that Top Gloves should use is the expense.

The expense of current non-sustainable power assets is in a steady transition state, prompting vulnerability and disarray worldwide. Be that as it may, environmentally friendly power energy encourages more value steadiness. The expense of keeping up and running that source is reliable and regularly low contrasted with petroleum products [32]. Moreover, an environmentally friendly power fuel source is more dependable for extreme climate conditions that may somehow cause disastrous repercussions. For example, sun-powered energy and wind energy are both put away, so they generally have energy stores to be utilized, notwithstanding any dangerous climate conditions. Non-environmentally friendly power sources can cause serious medical problems as they keep on dirtying the air, water, and soil. These toxins can hurt youngsters as a social and harmless to the ecosystem business. Top Gloves receive these environmentally friendly power fuel sources would not emanate a similar number of foreign substances, and truth be told, a considerable lot of them would transmit no poisons by any means. The contamination would prompt better general wellbeing among the residents of the world. A few spots have started to view environmentally friendly power sources all the more appropriate because it is indispensably significant.

Subsequently, Top Gloves comprehend the extensive advantages that environmentally friendly power fuel sources have to bring to the business table, especially the climate when all is said in done. There is one planet to live on, and keeping that planet sound is a principal piece of keeping us strong, also. Green power is only one of the numerous exceptionally gainful approaches to improve and support the climate. We need more monetary funding to embrace this green power as it will assist Top Glove with producing benefits in the long haul since we know the significance of green strength that will carry advantages to our life. Subsequently, it is excellent for Top Glove to put this environmentally friendly power in each chain of an auxiliary production line.

6. Environmental impact

The glove fabricating industry in the worldwide market accomplished a five-billion-dollar income in 2016. As per the overall organic market measurement data, this undertaking hope to grow an extra 8.6 % to nine billion dollars in 2024. This industry has gotten strong interest development as it gives the best hand assurance to laborers in different areas like food and refreshment, producing, crude materials preparing, and others.

In any case, the assembling of gloves causes a few natural issues, including global warming (GWP), carbon footprint (CF) [33], acidification (AP), photochemical ozone formation (POFP), eutrophication (EP), human toxicity (HTP), and water footprint (WF). Thus,
identification, assessment, and understanding of these natural issues should decrease unsafe waste from the unit activities, measures, crude materials, and items. As per ISO 14040, LCA is an arising ecological administration instrument.

It is generally applied to help those items or administration areas stay serious and assess biological weights (34). It depends on a support to-grave way to deal with dissect the natural effects of items or administrations from the crude materials to the creation of completed products and towards conclusive removal, reuse, or reused in their life cycle (35).

Table 4: Environmental characterization factor adopt from [35]

<table>
<thead>
<tr>
<th></th>
<th>GWP (g CO₂ eq.)</th>
<th>AP (g SO₂ eq.)</th>
<th>POFP (g C₂H₄ eq.)</th>
<th>EP (g NO₃ eq.)</th>
<th>HTP (m³ air)</th>
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</thead>
<tbody>
<tr>
<td>CO</td>
<td>2</td>
<td>0</td>
<td>0.03</td>
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<td>830</td>
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<tr>
<td>NOₓ</td>
<td>0</td>
<td>0.7</td>
<td>0.028</td>
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<td>CO₂</td>
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</table>

Table 5: The result of LCA inventory for base case sicario in glove production [35]

<table>
<thead>
<tr>
<th></th>
<th>Electric generation</th>
<th>Natural gas generation</th>
<th>Acid synthesis</th>
<th>Alkali synthesis</th>
<th>Coagulant synthesis</th>
<th>Synthetic rubber synthesis</th>
<th>Chlorine synthesis</th>
<th>Ceramic former</th>
<th>Cleaning process</th>
<th>In-process</th>
<th>Packaging</th>
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<tr>
<td>CO</td>
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The natural effect from the existence cycle handling exercises is investigated by an entryway to-door study where information stock begins from an acknowledgment of cup irregularity from the manor and skim latex as a side-effect of latex concentration preparing. The effect on the climate of scrap elastic handling is determined utilizing the Eco-Indicator 99 strategy. Petroleum products are extremely prevailing in sway classifications and have the highest rate esteem, trailed by respiratory in-organics and environmental change (22).

![Eco-Efficiency of crumb rubber processing](image)

**Fig 6:** Eco-Efficiency of crumb rubber processing based on Impact Categories (22).

7. Conclusion

Rubber glove product is the fundamental business visionaries of Thailand. Notwithstanding, the elastic glove measure is caused naturally. The eco-productivity idea has arisen as a significant apparatus toward the objective of a manageable turn of events. Moreover, eco-productivity can be measured through markers dependent on the proportion of economy and climate. Life cycle appraisal and material stream examination are viewed as two viable instruments and techniques in eco-efficiency assessment. The outcomes showed that elastic glove items' eco-productivity pointers could be isolated into two measurements: financial and natural execution. The monetary markers of flexible glove items are the amount of the thing and the net deal. The environmental pointers of elastic glove items are material utilization, energy utilization, water utilization, wastewater creation, strong waste creation, ozone-depleting substance outflow. The use of eco-proficiency evaluation would help find more conservative and viable approaches to improve the creation cycle and upgrade recyclability or diminish energy and material force. These eco-effectiveness pointers in this paper will also be utilized to evaluate the eco-productivity execution of elastic glove items in Thailand in the subsequent stage of our task.
8. References


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