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Plastic versus Glass: a view of the life cycle of the two controversial materials

Plástico versus vidrio: una visión del ciclo de vida de los dos materiales controvertidos

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Resumen– Desde los últimos años, las prácticas de reutilización y reparación de productos para alargar su vida útil y reducir la generación de residuos ganan interacción. Así como impulsar fuertemente el reciclaje potenciando al máximo la industrialización de materiales para convertir los residuos en nuevos recursos. Por lo tanto, actualmente se discute sobre dos materiales controvertidos (vidrio y plástico). En 2020 se produjeron 385 millones de toneladas de plástico a nivel mundial, en comparación con 143 millones de toneladas de vidrio. En 2020 el consumo per cápita de vidrio fue de 32 kg al año, en comparación con el plástico de 105 kg año. Sin embargo, el manuscrito tiene como objetivo discutir el uso de plástico versus vidrio para aprender sobre cada material, sus beneficios y desventajas para hacer una perspectiva crítica. La metodología es investigativa recopilando estadísticas de artículos de investigación en el período del 2017 a 2022. Los resultados muestran que la elección entre vidrio o plástico depende de factores muy particulares como la aplicación específica en la que se requiere y las preferencias del fabricante o usuario final. Además, es importante destacar que, en comparación con los plásticos, el vidrio tiene menos impactos negativos en el cambio climático, ya que tiene una menor huella de carbono. Sin embargo, se requiere un enfoque integral para minimizar los efectos del vidrio en el cambio climático debido a su alto consumo de energía, incluidas prácticas de producción eficientes. Se recomienda que cada país defina estadísticas de mercado para la recuperación, reciclaje e industrialización de vidrio, plástico y otros artículos como cartón, papel y latas de aluminio para promover la recuperación de residuos y prevenir la contaminación ambiental a nivel mundial.

Palabras claves: Basura, economía circular, leyes, plástico, polímero, políticas, vidrio.

Abstract– Since the last few years, the practices of reuse and repair products to extend their useful life and reduce waste generation gained interaction. As well as strongly promoting recycling, maximizing the materials industrialization to convert waste into new resources. Therefore, two controversial materials are currently discussed (Glass and Plastic). In 2020, 385 million tons of Plastic were produced globally, compared to 143 million tons of Glass. In 2020, the per capita consumption of Glass was 32 kg yearly, compared to Plastic at 105 kg yearly. However, the manuscript aims to discuss the use of Plastic versus Glass to learn about each material, its benefits, and disadvantages to make a perspective criticism. The methodology is investigative collecting from investigation articles statistics from 2017 to 2022. The results show that the choice between Glass or Plastic depends on very particular factors, such as the specific application in which it is required and the manufacturer's or end user's preferences. Moreover, it is important to highlight that, compared to Plastics, Glass has fewer negative impacts on climate change since it has a lower carbon footprint. However, a comprehensive approach is required to minimize the Glass effects on climate change due to its high energy consumption, including efficient production practices. It is recommended that each country define market statistics for the recovery, recycling, and industrialization of Glass, Plastic, and other items such as cardboard, paper, and aluminum cans to promote waste recovery and prevent surrounding pollution globally.

Keywords: Circular Economy, Glass, Laws, Plastic, Policies, Polymer, Waste.

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1. INTRODUCTION

Since the 1980s, there has been a strong tendency to change the habit models, disposal, and resource use, and the term a circular world emerged, referring to a system in which resources are used efficiently, products are designed to be reused or recycled, and the waste generation is minimized. Instead of the linear model of "take, make, and dispose", in a circular world, the aim is to keep materials in use for as long as possible, closing the life cycles of products and reducing dependence on natural resources [1].

From these concepts arose parameters such as reducing the resources seeking to minimize the extraction of raw materials, thus reducing the environmental impact associated with their extraction and promoting the conservation of natural resources. In addition, reuse and repair products and components to extend their useful life and reduce waste generation. As well as strongly promoting recycling and recovery, maximizing the materials industrialization to convert waste into new resources, thus preventing it from ending up in landfills or being released into the environment [2], [3]. Therefore, two controversial materials are currently being discussed, which compete in similar products, Glass and Plastic.

In 2020, approximately 385 million metric tons of Plastic were produced globally, compared to 143 million tons of manufactured Glass. The per capita consumption of Glass varies in each country, but according to the Glass Packaging Institute, on average, around 32 kg of Glass is consumed per person per year. In comparison, according to the Plastic Atlas report in 2020, Plastic per capita consumption was about 105 kg per person yearly [4], [5].

The global Glass industry generates annual profits of about USD 75 billion. The US, France, Japan, China, India, and Germany are the main glass-exporting countries. The most common products in the Glass industry are fiberglass, flat glass, glass containers, and specialty products such as lenses, fiber optics, mirrors, glassware, and television tubes. In 2020, a production of 610,520 million glass bottles and containers was registered, and it is expected to reach 883,520 million units in 2027. In comparison to plastic bottles, by 2020, around 815,000 million single-use plastic bottles were manufactured. Furthermore, the plastic bottle and container market were estimated at USD 104 billion in 2020 and is expected to reach a value of USD 152 billion by 2026 [6], [7].

According to The International Energy Agency, the glass container and flat sheet industry emit more than 60 megatons of CO2 annually. Although glass containers can be reused 12 to 20 times, Glass is often treated as a single-use container [8]. To 2019 data, The European Union and The United Kingdom have a glass recycling rate between 74% and 76%, respectively, while the percentage in the United States was 31.3%. Besides, the global plastic recycling rate can vary across countries and regions. However, the plastic recycling rate is generally low compared to total production. According to The International Association of Plastic Distribution for 2019 in Europe, the average recycling rate is 41% for plastic containers, while in the United States was 8.4% [9], [10].

It is important to highlight those various factors, such as the available recycling infrastructure, waste management policies, education, and citizen awareness, can influence the recycling rate of any material. Nevertheless, there is a growing awareness of the negative impacts of single-use plastics, such as plastic bags, food packaging, and disposable utensils. As a result, there is a trend toward reducing these products and promoting more sustainable alternatives, such as reusable bags, biodegradable packaging, and durable products.

Therefore, concerning citizen perception, when Glass is left in the natural environment over time, it is less likely to cause pollution than Plastic. Plastics break down into microplastics that can seep into the soil and water. Glass is not toxic, but it is sensitive to breakage and cuts by the personnel who treat, separate, and transport it. Another important factor to consider: if the Glass or Plastic ends up abandoned in the environment, the Plastic will have a time of 800 to 1,200 years to disintegrate, depending on the product. And, over time, it will break down into smaller pieces without changing its chemical composition. Although it takes much longer than Plastic to decompose at around 4,000 years, Glass does so mainly by erosion [11], [12].

On the other hand, for Glass manufacture, mainly sand, sodium, and silica are required, and they constitute 59% of the earth's crust, and since they are natural compounds, there is no concern about their possible filtration or environmental degradation. However, sand, silica, and sodium extraction can cause significant ecological damage, from soil deterioration to biodiversity loss. Thus, sand is the second most used resource in the world after water, and globally about 50,000 million tons of industrial compound of sand and gravel are used each year [13], [14].

Uses for the sand range from soil restoration to microchip manufacturing. Still, according to 2019 research from the United Nations, the sand is currently being used faster than it can be replenished, which will start in a short time to cause a unique problem [15].

Glass is an inert material that does not have an impact, nor does it transfer flavor to the food or drinks it contains. It can be reused as often as desired without any problem or losing much of its quality. Plastic is much more porous; in some cases, it contains chemical elements that can pass into food or drink when recycled with simple methods, and when it is recycled, depending on the material, it requires migration tests to verify that it can be used again in contact with food [14], [16].

Nevertheless, considering another factor, it long does material travel from when it is collected to when it is recycled? Sometimes it thinks that when it puts an object in the recycling container, another recycling is obtained without much effort, but the reality is different. Sometimes these materials travel a long distance to be recycled. Until recent years, 70% of the Plastic recycled

worldwide ended up in China. Since 2019, this Asian country has prohibited certain waste imports, including Plastic, due to the environmental problems that they entail, by basing their recycling systems on the waste imported from other countries for the reduced price without collecting their trash. It means, it is not sustainable for long trips to manage recycling [17]–[19].

In contrast, plastics are very versatile and can be molded into various shapes and sizes. It allows great design flexibility and adaptability to each application's needs and specific requirements. In addition, by molecular density, plastics are generally lighter than other materials, such as metal or glass. Plastics make it easy to handle, transport, and use in products where weight is an important factor, such as packaging, electronics, and automobiles [20].

For example, adopting polyethylene terephthalate (PET) bottles can lead to a weight reduction of up to 90% compared to Glass, allowing for a more economical transportation process. Today, plastic bottles made of PET are widely replacing heavy and fragile glass bottles, offering reusable containers for mineral water and other beverages. According to the British Plastics Federation, more than 70% of soft drinks on the world market are packed in plastic bottles, and only 30% of that is packed in various other packaging materials, such as glass bottles, metal cans, and pressed paper [21], [22].

Undoubtedly, Glass and Plastic still play an important role in many industries. Its durability and lack of toxicity make it ideal for packaging food and other substances that require conservation. However, it is incorrect to assume that Glass is sustainable simply because it is more recyclable. If the entire life cycle of Glass is considered, its production can be just as harmful to the environment as Plastic. Under these perspectives, this manuscript aims to discuss the use of Plastic versus Glass to learn about each material, its benefits, and disadvantages to make a perspective criticism.

2. MATERIALS AND METHODS

Based on the data collected from various sources, the methodology is investigative. For this analysis, data was collected systematized mainly from investigation articles. However, the method is used for determining the actions taken to reduce the use of plastics and glass, the period for determination is from 2017 to 2022 to verify the information that is currently available.

From the Google Academic database information collected from research articles. This database was selected because there is considerable uncertainty about the subject, especially in developing countries, such as Latin America, where few studies on plastic or glass pollution have been conducted. A key feature of Google Academic is its ease of use, agility in academic searches, and availability of free services with high visibility for linked documents.

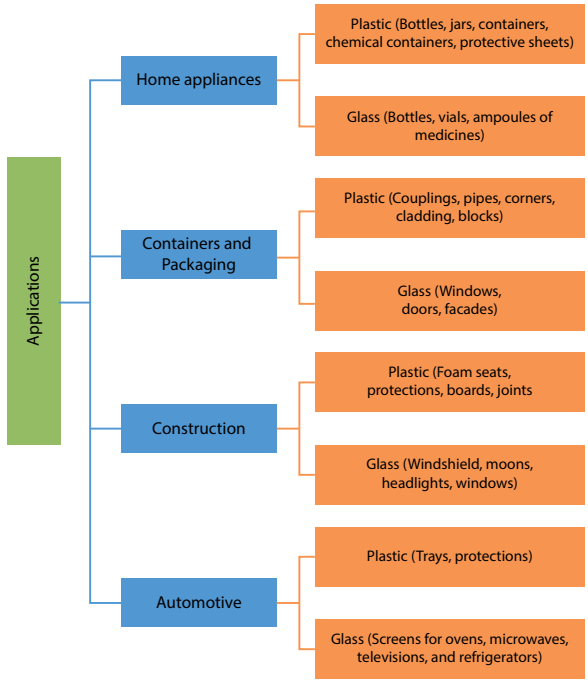
During the first round of searches, it uses to find data with keywords; around 63 documents related to this subject were found in the Google Academic database. A wide variety of documents were included in this collection, including research articles, reports, web pages, and theses.

As a result, the keywords were: "Glass and plastic pollution", "Circular Economy Actions in the Plastic and Glass Sectors", and "Policies for reducing plastics and glass". Therefore, only 31 academic documents referenced in the manuscript were selected.

3. RESULTS

In a general and comparative way between Glass and Plastic, there are several tenders, often similar, and certain separate cases with the two materials. Then, Figure 1 determines each main application of these materials.

Fig. 1. GLASS AND PLASTIC APPLICATIONS



Sources: [23]–[27].

From Figure 1, just some applications were explained where they coincide or support each other to form an element, but there are more uses; for example, in the decoration case, artists and designers use Glass to create artworks, sculptures, and decorative elements. Blown or fused Glass and other craft techniques shape Glass and develop pieces. Due to its transparency, chemical resistance, and ease of sterilization, Glass is used to manufacture laboratory instruments, such as test tubes, flasks, pipettes, and burettes [28].

On the other hand, Plastic also has several uses due to its various types and low cost; it is important to consider that the exact properties vary significantly depending on its composition, molecular structure, and processing. Each Plastic type has its specific properties, making it suitable

for many different industrial and commercial applications, including many more than Glass [29], [30].

In contrast, although it is a very versatile material, Plastic is currently demonized environmentally, which is why there is a growing awareness of single-use plastics negative impacts, such as plastic bags, food containers, and disposable utensils. As a result, there is a trend toward reducing these products and promoting more sustainable alternatives (reusable bags and biodegradable products). In addition to an increase in plastics recycling to reduce their environmental impact, implementing initiatives to improve waste industrialization infrastructure, increase the recycling rate and promote the circular economy of Plastic.

Additionally, as part of the comparison below, in TABLE I., several comparative concepts are summarized that illustrate the criteria of each element based on various instances of analysis.

4. DISCUSSION

As shown in TABLE I, several characteristics define each material; However, the raw materials are obtained from non-renewable resources, Glass is made with materials that are more easily extracted on the planet for its production.

But when it comes to the production of each item is different, for example, much more than making a Plastic one. To shape the Glass, it is necessary to heat it to very high temperatures between 1,200 - 1,500°C, which requires large amounts of energy. It is the material with the highest energy expenditure in its production, even more than aluminum [11], [34].

According to studies of the Life cycle environmental impacts of carbonated soft drinks, a bottle of Glass would have to use a glass bottle three times to reduce the carbon footprint of a Plastic one. For example, if you compare a glass bottle with a plastic one, the weight is about 1200% more in Glass under similar volume conditions. However, Plastic is generated more than Glass. Many plastics can generate dioxins, persistent substances in the environment, which can travel long distances and end up in the food chain [35].

On the other hand, regarding product distribution, one cancan be someone other than an expert to verify that Glass is heavier than Plastic. Any product packaged in Glass will need more energy to transport than if packaged in Plastic. In addition, Glass is much more fragile, it can break much more easily, so sometimes you may need to use other materials to protect it during transport. In this case, plastic wins by far. Its transportation is much more efficient and requires less energy.

Finally, when seeking to close the cycle, the materials industrialization must be exposed; Glass has a great advantage, it is 100% recyclable and can be recycled as many times as you want, losing only a small amount of quality, so it closes the recycling circle with recycled Glass you can make bottles or jars that are used for food. There is only one limitation, the color. Colored Glass can no longer be transparent. In addition, recycling uses 40% less energy than producing new Glass. It still requires more energy for plastic production or recycling [36].

In contrast, although most Plastic can be recycled, it is often not practical or economically viable. Its recycling is limited; depending on the type, it can be recycled 2 to 5 times. And every time it is recycled, it needs to improve its quality, especially regarding resistance. Finally, being porous and carrying additives in certain cases, migration tests must be generated to be in contact with food. In addition, worldwide, there is no campaign to recover the vast majority produced and marketed, causing a negative perception [37], [38].

Nevertheless, as indicated in Figure 1, Plastic is used in the packaging industry for bottle manufacture, containers, bags, protective films, pharmaceuticals, and cosmetics. In the construction industry, various applications include pipes, cable jackets, thermal and acoustic insulation, doors, building panels, waterproof membranes, and roofing materials. The electronics industry manufactures mobile phone cases, computers, televisions, household appliances, cables, and connectors. Plastics are used to manufacture synthetic fibers such as polyester, nylon, and spandex, which are used in producing fabrics and clothing with quick-drying properties. In addition, there are also medical applications with rigorous safety standards and compatibility with chemicals for products and patients. But, one can go on listing an infinite number of applications for Plastic because polymer products offer a variety of colors, shapes, and textures that are resistant and economical [39]–[41].

Nonetheless, because Plastic is found more frequently and, above all, it is observed in pollution debris on beaches, sidewalks, and islands, the truth is that, due to its cost, easy manufacturing versatility with several processes, it has created its use in a wide variety of applications in various industries, businesses, and sectors generating an irrational use, without order or control [42]. Figure 2 shows some considerations to keep in mind when comparing Glass and Plastic:

On the other hand, the advantages and disadvantages of each material may vary depending on the specific application and individual needs. Choosing the most suitable material must be based on carefully analyzing each case's technical, environmental, and economic requirements. It is so where circular criteria enter as sustainable design considering its complete life cycle, using materials with low toxicity, easily recyclable, and thinking about its reuse.

Moreover, it is important to note that these trends in the use and disposal of Plastic and Glass can vary in different regions and are influenced by factors such as government policies, consumer awareness, and industry practices. However, it can be seen from the data collected that there are areas where Glass and Plastic compete, such as liquid bottles, light containers, and containers; however, in most sectors, the two materials are complementary.

TABLE I.
COMPARISON CRITERIA

No.	Criterion	Glass	Plastic
1	Job	According to the Manufacturing Employment Statistics report published by the International Labor Organization in 2020, the number of workers employed in glass manufacturing globally was 1.3 million.	From the same International Labor Organization report in 2020, the number of workers employed in the plastic product manufacturing sector globally was approximately 5.8 million.
2	Recyclability	It can be infinitely recycled with little loss of quality, reducing the need to extract and process new raw materials. However, Glass is highly sensitive when moving, separating, and recycling due to its fragility, which can be vulnerable to cuts by the person who handles and transport it.	Depending on the product and its source from where it was collected, it may return to being the same element, which, if it is for contact with food, will depend on migration tests that support its reuse. Also, if it is a PET bottle, sheet, or polyethylene packaging, its impact is less because it is highly recyclable.
3	Recycling cycle	It must be separated from other materials and sorted by color before re-melting. It is often time-consuming and costly to sort Glass by color at recycling facilities requiring much care.	Materials or products must separate to generate similar elements; otherwise, secondary products are produced that can unify materials.
4	Energy consumption	The Glass manufacturing process requires high temperatures (1500°C) and consumes large amounts of energy; for one kilogram of Glass, between 5 and 9 kilowatt-hours (kWh) of electricity is needed.	Plastic manufacture does not require such high temperatures; an energy consumption between 4 to 6 kilowatt-hours (kWh) per kilogram of Plastic is approximated.
5	Barrier and conservation properties	Glass is a non-porous material resistant to chemicals, making it suitable for containing food and drinks since it does not affect their taste or smell. In addition, it is transparent and allows you to see the content.	Plastic can offer similar barrier properties, such as preserving vacuum-packed foods, and it is also mostly manufactured in transparent shades.
6	Firmness and durability	Glass is more resistant to scratches and degradation from sun exposure than many plastics. In addition, it does not easily deform or degrade over time due to its hardness. However, Glass is more fragile and can break in an accident; it causes safety problems due to possible cuts in skin sections.	Depending on its thickness (grammage), Plastic is moderately resistant, but it deforms when dropped and hit hard due to less brittleness, which can cause shape problems but does not cause skin damage such as cuts. Plastics are generally flexible and can deform without breaking, allowing their use in applications requiring the ability to conform to different shapes.
7	Compressive and tensile strength	The compressive strength is in the range of 100 to 150 MPa. However, its tensile strength is 30 to 70 MPa. It is important to note that different types of Glass have specific resistance properties. For example, tempered Glass may have a compressive strength of 200 to 250 MPa and a tensile strength of 70 MPa.	The Plastic strength varies widely depending on the specific type; some examples of compressive strength are 20-40 MPa High-Density Polyethylene (HDPE), 10-20 MPa Low-Density Polyethylene (LDPE), Polypropylene (PP) of 30-50 MPa, Polyethylene terephthalate (PET) of 50-80 MPa, and Polystyrene (PS) of 40-60 MPa.
8	Weight and transport	Glass is heavier than Plastics, which can increase costs and environmental footprint during transport since more energy is required to move it. Referentially, a 500 ml glass bottle can weigh 300 - 400 grams.	Lighter Plastic can reduce fuel consumption in transport and therefore generate fewer emissions. In general, 500 ml Plastic bottles have an average weight of 20 - 30 grams.
9	Volume	A cubic centimeter of Glass weighs 2.2 to 2.8 grams. Approximately five standard-size glass bottles could be made with one kilogram of Glass.	A cubic centimeter of Plastic weighs 0.9 to 1.5 grams. Approximately 50 standard-size plastic bottles could be made with one kilogram of Plastic.
10	Environmental footprint	The exact amount of CO2 equivalent (CO2e) emissions per kilogram of Glass varies depending on the type and manufacturing process; it is estimated that glass production generates around 0.8-1.6 kilograms of CO2e per kilogram produced. These emissions are mainly due to energy consumption during the melting of materials and manufacturing. However, when purchasing products for similar applications, glass bottles have a larger environmental footprint than plastic bottles and other packaging materials, including beverage cartons and aluminum cans.	The exact amount of CO2 equivalent emissions per kilogram of Plastic also varies depending on the type and specific manufacturing process. Plastic is produced from petroleum-derived materials, such as ethylene and propylene, obtained through refining processes. Estimates of the carbon footprint of Plastic production 1.5-3.3 kilograms of CO2e per kilogram.
11	Original material	Glass is obtained from silica, usually sand, quartz, calcium, and sodium. However, there is a new global problem; the lack of sand is a growing problem in glass production, especially in some regions that show degradation of coastal ecosystems, eroding beaches, and altering watercourses.	Petroleum is required to generate Plastic, and although ample reserves are still available, the complexity of extracting this material is more problematic than silica, sand, and sodium, depending on its location, depth, and critical extraction systems.
12	Reservations	Information on sand and silica reserves is less commonly reported and monitored than accounts of resources such as oil, natural gas, or minerals, so no amount was found specific to what to report.	As of September 2022, world-proven oil reserves were estimated at approximately 1.6 trillion barrels.
13	Ductility	Glass has an amorphous structure and a long-range lack of order in its molecular structure. It makes the Glass susceptible to crack propagation when subjected to mechanical stress, leading to fracture.	Plastics offer electrical insulation, impact resistance, and ease of molding to fit the shapes and sizes of electronic components. Some Plastics can be ductile, stretch and deform considerably before breaking. It allows them to withstand tensile and deformation loads without fracturing easily.
14	Impact resistance	Some Glass, such as the laminate used in automobile windshields, is designed to have high impact resistance and can absorb energy and resist fracture. However, blown Glass from bottles and containers is highly brittle on impact.	Some Plastics can absorb impact energy without breaking, making them suitable for applications requiring impact resistance, such as in packaging and manufacturing protective products.
15	Density	Glass has a relatively high density, which varies depending on the type; however, it is generally in the 2.2 to 2.8 g/cm^3 range.	Plastics have a relatively low density compared to other materials, making them lightweight. The density of the Plastic varies depending on the type, for example, Low-Density Polyethylene 0.91 - 0.93 g/cm^3. High-density Polyethylene 0.94 - 0.97 g/cm^3. Polypropylene 0.90 - 0.91 g/cm^3. Polystyrene 1.04 - 1.07 g/cm^3. Polyethylene terephthalate 1.35 - 1.40 g/cm^3.
16	Melting point	Glass has a high melting point, which varies depending on the composition of the Glass, but is generally above 1,200°C and can be as high as 1,500°C depending on the smelting furnace.	In plastics processing, Low-Density Polyethylene is generally carried out in a temperature range of 120-150°C. High-density polyethylene at temperatures of 120-180°C. Polypropylene at temperatures of approximately 160-200°C. And Polystyrene polymerizes at temperatures of 70-100°C.
17	Environmental Sustainability	According to the public's perception, it is better than Plastic because it is a natural and mostly recyclable material that does not release harmful substances into the environment during its decomposition.	It is also a natural material from a natural resource (petroleum). However, when produced, it can be mixed with additives, and its decomposition over time is faster than Glass.

Sources: [23]–[28], [31]–[33] .

Fig. 2. ADVANTAGES OF GLASS AND PLASTIC

Glass advantages	**Transparency and Aesthetic Appearance: Glass offers high transparency and gloss, making it ideal for applications where aesthetics are important.**
	High-Temperature Resistance: Glass can withstand higher temperatures without warping or melting compared to plastics.
	Corrosion resistance: Glass is resistant to most chemicals and does not rust easily.
	Recyclability: Glass is recyclable and can be industrialized repeatedly without losing quality.
Plastic advantages	**Lightness: Plastics are generally lighter than Glass, making them easier to handle and transport.**
	Versatility and Flexibility: Plastics can be molded into various shapes and sizes, allowing for greater design versatility.
	Impact Resistance: Plastics can be more resistant to impact and breakage than Glass, making them suitable for applications requiring higher impact resistance.
	Thermal and acoustic insulation: Some plastics offer better thermal and acoustic insulation properties than Glass.

Sources: [43]–[46].

There is no definitive answer regarding which material is better, between Glass and Plastic, as it depends on various factors and specific tenders. Both materials have different advantages and disadvantages, but from the data presented, Glass is generally considered more sustainable and suitable regarding environmental impact and food safety. However, Plastics use is more convenient in certain cases due to its lightness and versatility. Thus, this manuscript is only an applications vision of Glass and Plastic; it is not determined which is more polluting or better because more data should be available and similar products should be compared to differentiate specifically, for which there are still gaps to cover, such as the social aspects that have generated the overuse of Plastic and its bad disposal that create a negative perspective.

5. CONCLUSIONS AND RECOMMENDATIONS

The choice between Glass or Plastic depends on very particular factors such as the specific application in which it is required, the required properties, cost, sustainability, and preferences of the manufacturer or end user.

Compared to Plastics, Glass has fewer negative impacts on climate change since it does not contain toxic chemicals and has a lower carbon footprint. However, a comprehensive approach is required to minimize the Glass effects on climate change due to its high energy consumption, including adopting more efficient production practices, using renewable energy sources, and promoting reduction, reuse, and glass recycling to maximize its environmental benefits.

It is important to consider the complete life cycle of materials, from the extraction of raw materials, production, distribution, disposal, and recyclability, to assess the specific context and make the most appropriate decision between the two materials.

It is essential to encourage reducing, reusing, and recycling any material to minimize its negative environmental impact. In many cases, Glass and Plastic are used in similar products such as beverage bottles, but there are also different applications depending on their particular features and benefits.

It is recommended that each country define market statistics for the recovery, recycling, and industrialization of Glass, Plastic, and other items such as cardboard, paper, and aluminum cans to promote waste recovery and prevent surrounding pollution globally. Future lines will be able to determine the current recycling trends of Glass and Plastic as study materials of this manuscript.

6. PERMISSIONS

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