

How to reduce the harmful impact of cigarettes on environment

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ABSTRACT

The fundamental aim of this research is to inform the reader about the importance of implementing sustainable practices at a business and social level, focusing on reducing the impact of cigarettes on the environment. After going through all the data, the idea is to make the readers think critically about why and how they can contribute to reducing cigarette littering and the consequent pollution. The research contains the analysis on different proposals, if they can be applied, and how to educate society to decrease cigarette waste.

This study represents a review of the literature documenting the impact of cigarettes' chemicals on the environment, and how consumers behave (if recycling or throwing cigarettes away).

The expected research results would be encountering a wide range of alternatives and feasible solutions to replace the actual composition of conventional cigarettes, and strategies to educate the smokers' population about the importance of reutilizing the leftovers from cigarettes. In this way, changing actual practices and reducing pollution would contribute to a more sustainable world, from which all, businesses and consumers, would benefit.

I chose this topic because I consider it as a latent issue in many countries, and I strongly believe that educating about this problem can protect people who are exposed to these chemicals in their daily life, either if they consume tobacco products or if they drink contaminated water, deal with smoke-filled air, etc. Protecting natural life is also crucial, as polluted oceans influence greatly not only our present but also our future as humankind.

1. Introduction

It is a worldwide known fact that tobacco use causes serious health problems. But what about the impact on our planet? This question came to my mind when walking a crowded street in Budapest, Hungary, and observed workers cleaning it. For me, it was a cultural shock realizing how socially accepted is the smoking habit here, with the consequent harmful habit of littering. In 2018, the smoking rate in Hungary was 30.60% of the total population aged over 15 years old (Macrotrends, 2021).

The vast majority of cigarette butts are plastic of single-use containing hundreds of toxic chemicals once smoked. Littered cigarette filters can persist in the environment for many years and release these chemicals to air, land, and water, harming plant growth and wildlife.

Each year, over 6 trillion cigarettes are produced around the world, resulting in 1.2 million tons of toxic waste dumped into the environment (Kaszubska, 2020). This makes cigarette butts to be among the most frequently littered items.

The plant tobacco contains mainly nicotine, cellulose, ammonia, and protein. “For tobacco to be suitable for human consumption, the tobacco leaves are dried and cured after picking them at the plant and separating them from their stems” (Shahbandeh, 2021). After processing the dried leaves, they manufacture various tobacco goods including cigarettes, cigars, chewing tobacco, pipe tobacco and shisha tobacco. The stimulant nicotine makes it a predominantly consumed product.

For the tobacco to grow a mild and sunny climate is needed, that is why production is primarily concentrated in regions with those characteristics suitable for its cultivation. China, India and Brazil were rated among the leading producers worldwide, followed by the United States. Producing around 2.61 million metric tons of tobacco converted China in the biggest tobacco producer worldwide in 2019 (Shahbandeh, 2021) (see Appendix C, Figure 8).

Tobacco is not a particularly green crop. Because it is very sensitive to disease, it requires many pesticides; in the United States alone, tobacco farmers use 27 million pounds on a yearly basis (Rastogi, 2009). Although it is not a big number compared to the total, it indicates that growing tobacco results in the use of more pesticide per acre than raising most other crops.

Tobacco contributes to deforestation, because “the most common method of drying out tobacco leaves, called flue-curing, requires an external heat source. In the developing world, where 85 percent of the world’s tobacco is grown, that is usually a wood-burning fire” (Rastogi, 2009).

Over 4000 chemicals are present in a cigarette, from which seventy-two are known to be cancer-causing carcinogens. The main toxic agents include carbon monoxide, aromatic hydrocarbons, hydrogen cyanide, phenol, nitrogen oxides, formaldehyde, acetaldehyde, acetone, benzene, ammonia, and pyridines. The filter of a cigarette is made of cellulose acetate fibers, with poor biodegradability as they can take up to 10 years to decompose under normal environmental conditions. Therefore, when cigarette butts are thrown in the environment, they represent a critical problem in terms of toxic waste for urban and aquatic life. Aquatic animals regularly consume CBs (cigarette butts hereinafter) confusing it for food and they have been found in the stomachs of fish, birds, sea turtles, and other creatures, leading to serious digestive issues. (Mohajerani et al, 2020).

The reason behind choosing this topic is that I consider it is a latent issue in many countries, and I strongly believe that educating about this problem can protect people who are exposed to these chemicals in their daily life, either if they consume tobacco products or if they drink contaminated water, deal with smoke-filled air, visual contamination, etc. Protecting natural life is also crucial, as polluted with tons of cigarette waste oceans influence greatly not only our present, but also our future as humankind. By investigating further about the components of these products and possible biodegradable alternatives, a clearer path towards reducing the impact on environment can be found, digging into different perspectives: from the consumer side, the manufacturers and producers, and the governments.

The objective of this study is to contribute with sustainable ideas and feasible solutions from each stakeholder, reduce contamination and propose an organic production of tobacco derivatives.

2. Data Collection Methods

This study contains both primary and secondary collected data. On one hand, it represents a review of the literature documenting the impact of cigarettes' chemicals on the environment, how consumers behave (if recycling or throwing cigarettes away), and possible recycling options. Document searches include data from the scientific literature, academic journals, chemical experimental studies, statistics, etc. This review is constrained by limited data on tobacco manufacturing impacts.

On the other hand, the study relies on an online survey and a brief online interview with Gabriel López Libardi, an ex-employee of a big tobacco company in Argentina. Although the latter did not show much specific quantitative data, it helped to understand better the topic by bringing insights from someone who worked at a tobacco plant. The interviewee approached me after completing the survey and offered his knowledge from his experience in 2011. A particular set of predetermined questions were asked, making the interview structured. The interview was held in Spanish and translated into English.

A survey form was filled in mainly by students, but also by individuals belonging to different social media groups where the survey was distributed, mainly on Facebook. An online Google form was used, after considering it the most effective in these pandemic times. It was shared in different groups for three days. It consisted of ten questions in total, out of which three were about personal information such as age, country of origin and actual residence place; two were general simple-choice questions to know how many are consuming tobacco and if yes, how often; one about littering; other three related to the companies' perspective, asking if they do know a recycling place, then if they believe organic filters can be produced, and an open question asking why do they think unsustainably-produced cigarettes are still nowadays being sold in enormous quantities. Lastly, there was a multiple-choice question asking to choose among seven possible solutions, with the option to add more in case of having another idea.

A hundred and twenty-five people filled out the survey. The participants are mostly students of Budapest Business School. Almost half of the participants are aged between 20 and 25 years old, consisting of 44% of the surveyed (see Appendix B, Figure 6). Using the weighted average method, the average age is 26.44 years. The participants are both males and females, and coming from thirty different countries (see Appendix B, Figure 7). Twenty-nine percent were from Argentina and twenty percent from Hungary. Despite the participants are residents in 46 different cities in 18 countries, most of them live in Hungary (67.58%), and 43.86% in Budapest. All of the participants' answers were handled anonymously to make sure that their answers were given honestly.

Moreover, the research analyses a case study of a recycling company founded in the United States named TerraCycle, whose process is detailed and utilized as a possible guide for establishing similar recycling centers in Hungary. In addition, the nonprofit organization "Keep America Beautiful" is considered into the research, counting with millions of volunteers and dozens of researches made since 1968, providing as well helpful guidance to copy their initiatives in other countries around the globe.

3. Findings

Companies perspective

Production

In the tobacco planting process, there is no rotation with other crops. An amount of 11.4 million metric tons of wood are required annually for tobacco curing (WHO, 2017). Furthermore, this creates a loss of biodiversity, describing it as an environmentally damaging activity. In low and middle-income countries, tobacco cultivation and curing are one of the most destructive agricultural practices.

Tobacco companies admit that manufacturing is the most environmentally damaging step of tobacco production, but these firms are reluctant to provide data, hindering to perform a deep calculation about such environmental impact. The China National Tobacco Company, for instance, has no publicly available environmental reports (WHO, 2017), whereas China produces nearly 44% of the global tobacco.

One possible solution to validate the statements of the industry increased efficiency and sustainability would be to hire independent environmental auditing of tobacco companies overseen and paid for by the government.

The tobacco industry is known for shifting its operations away from countries in order to avoid facing the consequences of its activities, including environmental harms. Tobacco manufacturing is extremely water-intensive. Water is used in areas where tobacco-manufacturing facilities are located, making inks and dyes for packaging, and tobacco pulp processing. This may generate a severe stress on local water reserves in case these of dry areas.

Many tobacco manufacturing plants are now located in countries with few environmental regulations or a solid law system with an active judicial power able to act when necessary against unsustainable practices. The tobacco industry tends to move plants or factories when social conditions and environmental regulations have become too strict for them to be willing to bear, proactively shirking their responsibilities instead of absorbing the price of complying with higher labor standards or reduced environmental harms. The only way to avoid this is to harmonize global standards for reporting and regulation, so that the tobacco companies have nowhere to run.

According to the Toxic Release Inventory Database, over 456 000 kg of toxic chemicals were released in 2008 from tobacco manufacturing plants, including ammonia, nicotine, hydrochloric acid, methanol, and nitrates, which affects drastically the environmental well-being. (WHO, 2017).

In the survey, the first reason for keep producing massively without adapting to the demands for being socially and environmentally responsible was related with cost-efficiency; with more than 60% of the participants writing down answers mentioning this issue. Below we can find the open question itself with the most answered sentence.

Why do you think unsustainably produced cigarettes are still being sold in enormous quantities?

- **Because it is cheaper and easier (60.52%)**

The results showed an extended awareness about the economic interests behind the producers, demonstrating a general public opinion that companies prefer to save cost rather than enhance sustainable practices throughout the entire process.

Filters are supposed to reduce the harshness of inhaled smoke, being usually made from non biodegradable cellulose acetate. However, some recent studies assure that filters are not avoiding health issues at all, as they are also hazardous and part of the marketing strategy of the big companies (Hiscock, 2021).

International tobacco companies can play an important role in changing behaviors and encouraging consumers to dispose of their cigarette butts responsibly through information campaigns and the distribution of portable ashtrays. They must reduce greenhouse gas emissions, not only in factories, but also across the whole supply chain. Statistics reflect that these companies conform a multimillionaire business, and they count with the financial means to invest in research. For instance, Marlboro was by far the most valuable tobacco brand in the world in 2020, with a brand value of almost 33 billion U.S. dollars. L&M, which ranked second, had a brand value of just over 6 billion U.S. dollars that year (see Annex C, Figure 9 and 10). The company, headquartered in New York, sells its products in over 180 countries. (Statista, 2021).

Companies should also reduce the environmental footprint of the smoke-free products' manufacturing process, promoting crop diversification among tobacco farmers. The IQOS are an option without combustion, less air pollution. This is because IQOS heats tobacco instead of burning it, generating no fire, no ash and no smoke. According to Gabriel López, they are "the future".

One biotech company, Stanelco, developed a filter made of carbohydrate polymer found in foods like potato and rice; this could make filters biodegradable and ready for composting. "Even with starch-based composition, these filters may take two months to biodegrade, and they would still release toxic filtrates into the environment when they do so" (Novotny, 2009). We should regard this with caution, as biodegradable filters would still contaminate the environment with harmful chemicals if discarded improperly. Moreover, it is likely that the tobacco industry will use biodegradable filters as both a Corporate Social Responsibility and a marketing opportunity. The reputation rehabilitation and common social belief that filtered cigarettes are less harmful are consequences of this. "Tobacco companies are already marketing their filter innovations to retailers in a way that connotes health benefits, biodegradable filters are likely to be no exception and the filter fraud will be enabled to adapt and persist once more" (Hiscock, 2021).

The survey showed that only 50.4% of participants believed it is possible to produce organic filters, 45.6% voted for "Maybe" and 4% voted "No". This proves how misinformed is the overall population regarding scientific upgrades on the environmental framework, especially when big financial interests are at hand. Gabriel López states in the interview, "the organization is going to adapt, as profitably as possible, to what the market forces it, not what society thinks".

Recycling

A number of studies have been realized on recycling cigarette butts with encouraging results, and several methods have been studied, including recycling of cigarette butts in asphalt concrete and fired clay bricks, as a carbon source, sound-absorbing material, corrosion inhibitor, biofilm carrier, and many more.

RMIT University researchers found that “incorporating 1% cigarette butt content would reduce the energy required to firebricks by 10%” (RMIT University, 2020). Butts can also be added into asphalt concrete. They specified steps for the implementation of recycling CBs in fired-clay bricks:

1. For the collection of CBs, it is important to develop a close relationship with CB collection companies to facilitate the delivery of CBs to manufacturing sites. These CBs are normally collected from modern bins or receptacles.
2. Once the CBs are collected, they use a sterilization method to clean the CBs from bacteria, generating a strong odor. When using mothballs containing naphthalene, they should be put into the bags containing CBs to inactivate any bacteria that may be present. The collector or the workers can be responsible to do this. They should be careful to not breathe in fumes when the bags are opened. The CBs will then be stored on-site.
3. When ready, they incorporate CBs into the brick clay mix through a specific method. Once the CBs have been incorporated, the remaining steps that are common within the brick manufacturing process can be followed.
4. They always have to ensure that relevant OH&S standards are followed, the correct PPE is worn, and the fumes are not breathed.

As mentioned before, CBs consist of cellulose acetate, which it is demonstrated by the study of De Fenzo and others that it can be recovered through extraction and purification processes. Considering that cellulose acetate is the main component and it is soluble in acetone or ethyl acetate, they propose a methodology to purify this polymer-based on several solid-liquid extraction steps using solvents with different polarity. The recycling of CBs and turning this waste into a resource can be a solution to cigarette butt pollution. They reached the conclusion that we can obtain a transparent film from acetate cellulose recovered by cigarette butts using a green extraction method. (De Fenzo et al, 2020).

In the research performed by Rahman and others, CBs have been pre-processed and mixed with bitumen classes C320, C170, and PMB A10E as a fiber modifier. They performed comprehensive laboratory investigations, including a penetration test, softening point test, and viscosity test, along with a binder drain-off test to evaluate the performance of the modified samples. “The results of the CB-modified samples were compared with the sample with cellulose fiber and fresh bitumen (0% fiber). The results show that the physical and rheological properties of bitumen incorporating CBs improve significantly, and CBs could be used instead of virgin cellulose fiber as a fiber modifier” (Rahman, 2020).

TerraCycle Case Study

The startup was founded in 2001 by Tom Szaky in the USA. Now it is present in 21 countries, with over 80 million people engaged in different programs. TerraCycle is a company that is able to recycle the butts, turning the plastic into industrial-grade products like plastic pallets. “Vancouver, where people litter a million cigarette butts a day, was the first city to pioneer this partnership with TerraCycle, installing 110 cigarette butt recycling bins in its downtown area in 2013” (Orso, 2018). Participating is completely free. The program for tobacco recycling accepts this waste: all parts of extinguished cigarettes, cigarette filters, cigar stubs, outer plastic packaging, inner foil packaging, rolling paper and

ash. They do not accept the cardboard packaging of a cigarette box. Instead, this can be recycled through a municipal recycling program. (TerraCycle, 2021).

The rectangular receptacle used is called a TerraCycle "zero waste" box. It can hold hundreds of cigarette butts before they are shipped to New Jersey, where they will be processed and recycled into such things as ashtrays, fence posts, industrial supplies, and park benches. "The receptacles themselves must be weather-resistant and flame-resistant and something must draw smokers' attention to them, whether a bright color or a sign." (Orso, 2018).

"TerraCycle's global vice president of research and development, Ernel "Ernie" Simpson, was part of the team that spent a year developing the recycling process for cigarette butts and said the company is the only one in the world recycling them that way" (Orso, 2018). Simpson said that the process took years to perfect.

The process consists of these steps:

1. Once collected, they separate the cigarettes and packaging by composition and melt into hard plastic that can be remolded
2. Organic compounds such as tobacco and paper are composted and used to create specific types of fertilizer, while inorganic components such as the filters are cleaned and shredded.
3. Then, it is transformed again into tiny granules of plastic that TerraCycle sells to other companies that use them to build new items, everything from picnic tables to decking materials.

Consumers' perspective

After studying different ways how producers can improve the material in a more eco-friendly approach, and how the recycling centers can reuse cigarette butts for a wide range of products, it is essential to include a deeper understanding of the consumers' behavior. The survey yielded the following results: 24% are social smokers (when partying), 16% are regular smokers and 62% of participants stated they are no smokers (see Appendix B, Figure 5). This matches if we consider the statistics for smoking rate in Hungary, where the main part of surveyed is living in, which is 30.6%. The "increased risk of smoking predominantly affects the 25-34 age group among men (41%) and the 45-54 age group among women (31%)" (Cselkó, 2018). From those who affirmed they do smoke, the following graph shows how often they do it:

Figure 1- Frequency of Smoking Among Surveyed Smokers (2021)



We can observe that more than half of the smokers in the survey affirmed they smoke once a week or less, which coincides with the answers from the question “Are you a smoker?” where 24% said they are social smokers. During the past twenty years, there has been a gradual decrease in tobacco smoking rate in both Hungary and Argentina (Macrotrends, 2021), but at a global level it was more slightly (The Tobacco Atlas, 2016). Knowing the consumption trends helps to forecast the environmental consequences of littering these products.

In the survey, apart from saving-cost strategies, the participants wrote down the following answers to the open question:

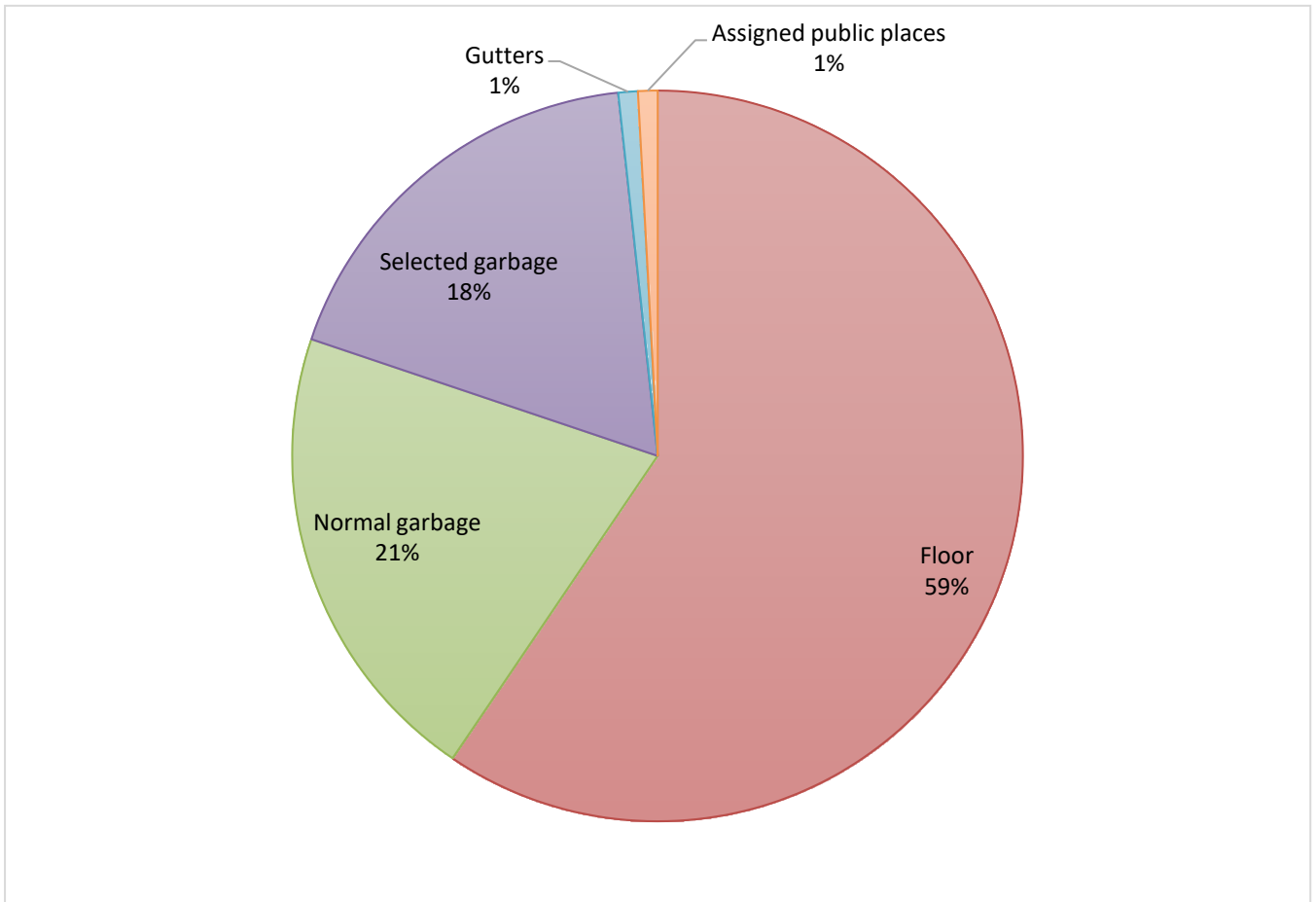
- Why do you think unsustainably produced cigarettes are still being sold in enormous quantities?**
- **Resistance of consumers to change (25.44%)**
 - **No idea (14.91%)**

This supports the idea that a profound analysis of consumer behavior is essential to implement changes in bad habits. In addition, almost 15% answered that they do not have any idea, which also means that there is a lack of education and general knowledge about this issue, combined with a lack of visibility.

According to the 2009 National Visible Litter Survey and Litter Cost Study made by the organization Keep America Beautiful, the littering rate in the US is 65%. Smokers are more likely to litter if the environment contains any type of litter. They also found that “For every additional ash receptacle, the littering rate for cigarette butts decreases by 9%” (KEEP AMERICA BEAUTIFUL, 2020).

In the figure below, we can observe how much percentage of the surveyed believes each of these options as the most common destination for post-consumption cigarette waste.

Figure 2-Destination of Cigarettes in The Street (2021)



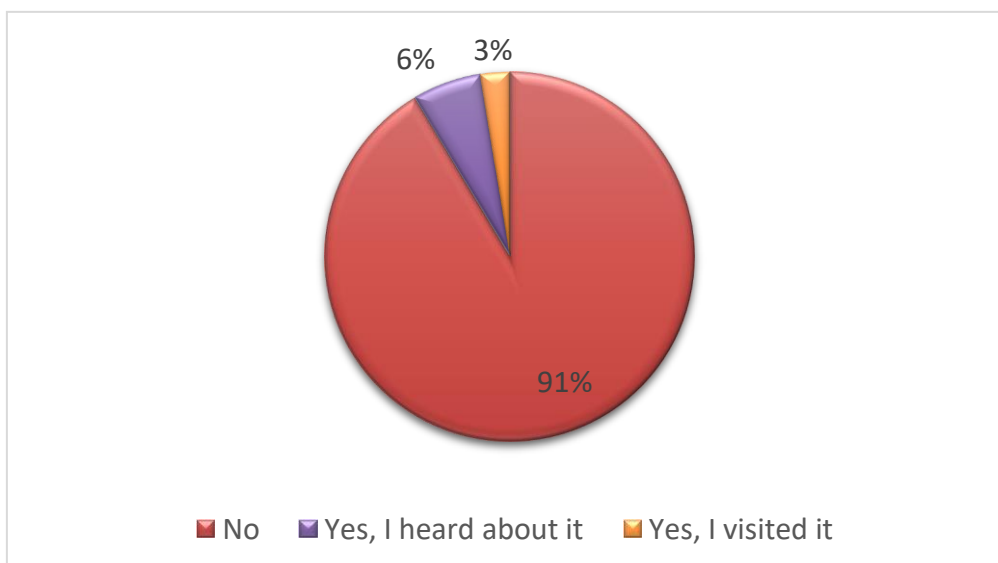
These results support the proposal of facilitating exclusive receptacles for cigarettes in each street, as many consumers (59% shown in the survey) tend to litter directly to the floor, and one cause could be the absence of trash bins at a certain distance that ensures their visibility.

Butt littering is for the most part an ignored behavior among smokers; it may even be a part of the smoking ritual. Added to this is the now widespread regulation of indoor smoking, which causes smokers to retreat to the street and sidewalk where there may be no butt receptacles.

A growing public concern about pollution could boost a change. Increased publicity about ‘green’ behavior may affect the littering behavior of smokers.

The amount of available places to treat cigarette waste affects consumer behavior, as there are very few around the world. There was not data about such place in Hungary. The graph belows the percentage of people who heard or went to tobacco recycling sites.

Figure 3- Percentage of Surveyed People That Know About Tobacco Products Recycling Places (2021)



Another reason behind the very low recycling rate among consumers is precisely the lack of recycling sites for tobacco products. Only 3% stated they know one and visited it, another 6% just heard about it and 91% do not know any place as such. This gives room for the government to encourage the formation and maintenance, maybe with financial aid and incentives, of centers that collect, process and transforms the waste into numerous items, as described in the case of TerraCycle.

Government intervention

To raise awareness of the butt litter problem, governments shall increase the regulatory activity at the state and local level. Increasing fines, fees, and other economic disincentives contribute for a reduced consumption and therefore, pollution.

Some countries like the United Kingdom, Australia, and Brazil had reduced significantly their smoking rates, great part due to the implementation of the most advanced tobacco control laws. Unfortunately, their efforts are almost entirely offset by the increasing consumption in many countries with weaker tobacco control regulations. (The Tobacco Atlas, 2016). Hence, cigarette consumption is predicted to increase in many low- and medium-HDI countries due to dynamic economic development and continued population growth.

Despite the rhetorical commitment of some in the tobacco industry toward a smoke-free world, all major tobacco companies continue to aggressively advertise cigarettes and vigorously fight tobacco control efforts around the world. A ban on the sale of single-use plastic cigarette filters would be resisted vehemently by the tobacco industry as it challenges the deception it has perpetuated in marketing manufactured cigarettes. According to Hiscock, the industry mounts large-scale lobbying activities to divert attention from its health-damaging products and from the pollution caused by butts. “Unlike manufacturers of some other polluting post-consumption waste products, such as refrigerators containing fluorocarbons, it has never been held accountable for the cost of the waste it generates” (Hiscock, 2021).

In the United Kingdom, they are taking already some measures to address this issue. The Environment Minister Rebecca Pow said “cigarette butts are a blight on our communities, littering our streets or ending

up washed down the drain and polluting our rivers and oceans. We must all take action to protect our environment. We are committed to making sure that the tobacco industry plays its part. That is why we are exploring how cigarette companies can be held fully accountable for the unsightly scourge of litter created by their products.” (Mirage News, 2021).

Government officials are taking action to reduce litter. In 2015, the city council of Philadelphia approved a plan “requiring corner stores and restaurants to place trash and recycling bins within 10 feet of their entrances in an effort to reduce litter. The bill is modeled on the Walt Disney Co.’s determination that if trashcans are more than 25-30 steps apart, people will litter. Violators will face fines of up to \$100” (Keep America Beautiful, 2020). In recent years, Hungary introduced significant measures to curb smoking: it is restricted in enclosed and in certain open public areas, the number of tobacco points of sale had been drastically reduced and the legally binding increase of excise tax has resulted in rising prices. (Cselkó, 2018).

It may even be possible to ban the sale of filtered cigarettes altogether based on their adverse environmental impact. This option may be attractive in coastal regions where beaches accumulate butt waste and where is prohibited to smoke indoors. It is needed additional research on the various policy options, including behavioral research on the impact of banning the sale of filtered cigarettes altogether. Enforcing tobacco companies to change the content is still under review.

The current industry approach (as with its historical approach to the direct health consequences of smoking) is basically to ‘blame the victim’. In this context, the smoker is the litterer and thus it is his or her responsibility to take care of the butt disposal.

The study performed by Mohajerani and others considered the combined risks from hundreds of highly toxic chemicals and possible pathogens in cigarette butts. They proposed to prohibit the littering of this waste anywhere in cities and the environment, and to fine heavily the offenders. This strategy should be supported by appropriate education, guidelines, and advertising. “Our cities, parks, waterways, beaches, and oceans have been contaminated for many years, with millions of tons of unsightly and toxic cigarette butts. Effective and strong laws and guidelines by governments for solving this global pollution problem are overdue and urgently need to be established. This action should be supported by an adequate number of receptacles installed at critical locations in cities and public places by local governments for the collection of CBs for recycling. The sincere, effective, and urgent support and cooperation of smokers, governments, educators, and waste management industries are essential for ending the littering of cigarette butts in the environment” (Mohajerani, 2020).

To date, most litigation against the tobacco industry has focused on the health costs that others (individuals, insurance companies, states) end up paying because of cigarette consumption. Similarly, the industry must be held responsible for environmental impacts associated with the sales of their product. There were some cases where some communities pursued a litigation against manufacturers of products that damage the environment. These cases are typically based on two theories: negligence and nuisance. The first one allows someone who is injured by another’s unreasonable conduct to recover money damages. “The primary element of a successful negligence case is proof of the defendant’s wrongful conduct, or failure to take reasonable steps to prevent the harm. Nuisance is a tort theory that protects someone’s right to use and enjoyment of his or her real property” (Novotny, 2009).

“In 1997 the World Bank, in partnership with the World Health Organization, began a global study on the economics of tobacco control. They concluded that tax increases are the single most effective intervention to reduce demand for tobacco (tax increases that raise the real price of cigarettes by 10% would reduce smoking by about 4% in high-income countries and by about 8% in lower-income countries). Tax comprises about two thirds of retail price of cigarettes in most high-income countries but is less than half of the total price on average in lower income countries” (Jha, 2000). This is supported by the comment of Gabriel López saying, “Profit, at a unitary level, is very low. It is a market for volume, not margin. There is a lot of tax burden, and without a doubt, the more "developed" the country economically, the lower the profit.”

Governments and local authorities should not borne the clean-up and disposal of tobacco use, but either producers or users of tobacco products. “To solve this, the environmental “precautionary principle” should be employed, meaning the use of preventative measures to avoid harm to the environment and human or animal health in the first place” (WHO, 2017).

4. Discussion & Conclusion

These key research findings indicate that that the most effective ways to address cigarette butt littering include increasing the availability of ash receptacles and portable ashtrays, decreasing the amount of existing litter through clean-up activities, and educating the public with motivational messages that target individual responsibility and obligation. Since indoor smoking bans have pushed smokers outdoors, they need better infrastructure to collect the waste and keep butts off the street. Smokers should avoid littering and should dispose of their cigarette butts responsibly. Cigarette filters are from a non-biodegradable plastic, so consumers should recycle whenever they can. Recycling cigarette boxes can be done through different programs, that is why consumers should contact a recycling company that accepts tobacco products. Receptacles are perfect for standardizing cigarette recycling in small or large-scale outdoor environments.

Governments must take the following actions:

-Cooperate through environmental regulation. Strengthen regulation of tobacco agriculture to prevent deforestation and land degradation. Enact laws that make tobacco manufacturers financially responsible for cleaning up and safely disposing of tobacco product waste, with programmes and other activities. Innovate, improve and enforce new and existing environmental regulations and agreements that may apply to tobacco manufacturing, transport, consumption and post-consumption waste.

-Create recycling programs in each country. Pilot new programs and initiatives like zero plastic waste cities and green zones.

-Decrease the amount of existing litter through clean-up activities.

-Educate the public about individual responsibility and obligation. Reach, inform, and engage all people, from diverse backgrounds and from all age groups. In order to further reduce the rate of smoking and consequent littering, particular attention should be paid in the coming years to support and disseminate health promotion programs, specifically aimed at groups with increased risk of

smoking, that combat habituation, as well as educate smokers about the harmful effects of smoking and cessation methods.

- Support more frequent litter research and analysis of big data sets.

Tobacco producers can do the following:

-Replace existing filters with biodegradable and non-toxic ones.

-Invest in innovation and next-level solutions for reducing litter, including litter prediction models, other AI techniques to prevent litter including remote sensing and image classification, litter tracking maps, and public interfaces for these solutions.

Businesses in general can contribute in this way:

-Change the environment to reduce littering. Make proper disposal convenient and accessible. Provide sufficient trash, ash, and recycling receptacles inside and outside your establishment.

-Ensure consistent and ongoing cleanup, as littered environments attract more litter.

-Make the most of motivational messaging. Encourage customers to properly dispose of litter through direct engagement or on-package messaging.

In the survey, several solutions were proposed, from which participants could choose which are the most effective in their opinion. More than 61% agreed with changing the product itself into a more eco-friendly one, and almost 58% agreed that education is key. First two options were added by the participants, that is the reason why they only received one vote each (see Figure 4 below).

Figure 4-Support of Surveyed Towards Different Solutions to the Negative Environmental Impact of Tobacco Products (2021)

Encourage and help smokers to change their lifestyle	0.8%
Promote anti-smoking campaigns to decrease smoking overall	0.8%
Impose import quotas towards these products	7.2%
Make campaigns against unsustainable practices by the big companies	31.2%
Increase its price by increasing taxes so demand lowers	32%
Provide a budget to install special trash bins in every street for cigarettes	38.4%
Promote the recycling and reutilization of cigarettes in, for instance, bricks	48%
Educate the population about this issue	57.6%
Develop a more eco-friendly solution, from cultivation to manufacturing and distribution	61.6%

We can observe how accountable the companies producing tobacco and the government should be, according to the surveyed public.

In conclusion, tobacco producers should be responsible for liability, economic costs, and providing information on environmental impacts of tobacco use. Other stakeholders, including governments, citizens' groups, green businesses, distributors, and academic researchers, shall engage in complementary activities to help reduce, prevent, and mitigate environmentally harmful and unsustainable practices in tobacco growing, manufacture, transport, consumption, and post-consumption waste disposal.

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Appendix A- Interview transcripts

1) What are the components of the filters, and what are traditional cigarettes wrapped in.

Well, there are many, and I do not remember all. I remember in the induction process, they explain in detail the components and operation of the filter (you can imagine that this is confidential information, it is not available online).

I remember that they are made of carbon, but the most important thing is how thin the "fibers" are, generating the ability to retain a large part of the toxic components generated by combustion. It is worth clarifying that a large part, if not most, of the "harmful" of smoking is a consequence of combustion, since carbon dioxide (CO) is released and when entering the body it affects oxygenation. This is key. In these pictures, it is shown better:



Paper is a big problem, because it burns, there is "combustion", which is a big part of the problem in terms of health.

The paper has "delays" of burning, they are like "rings" (you can see them if you look at a cigarette closely), which makes the paper not burn so quickly and the cigarette lasts longer. I think something like 7 minutes per cigarette was stipulated.

It is worth clarifying that, as I understand it, and it is quite logical, there are no "additives" or "chemicals" that "make the cigarette more addictive", it is not necessary. Nicotine by itself is very addictive.

What I do remember is a very interesting process to "expand the volume" of the tobacco strands, and to fill the cigarette with less tobacco. The volume expanded but with much less density. Very interesting.

2) Sales: in which country the most quantity is sold, and in which one is the most profit generated.

It is very difficult to answer this, since I did not have access to another country other than Argentina. I can tell you that Masalin Particulars (Marlboro, Philip Morris, Next, among others), when I left,

produced an average of 110 million cigarettes a day, and had a 70% market share, so you can estimate the daily production average in Argentina in 2011. Today, without a doubt, the volume has fallen.

Profit, at a unitary level, is very low. It is a market for volume, not margin. There is a lot of tax burden, and without a doubt, the more "developed" the country economically, the lower the profit. Except for exceptions like some European countries, where you could still smoke in closed public places, or Indonesia, where you can "advertise" almost anywhere, as I recall.

3) Do the companies allocate a percentage of their income to scientific research on how to produce in a more sustainable way?

The IQOS are the future. The cigarette is "heated", there is no combustion. It is another story. There is certainly a tendency to use smokeless tobacco. Do you know snooze in the Nordic countries? (It is ultra-addictive, and you don't have to smoke it. It is like a tea bag with flavored tobacco inside, you put it between your lip and gum, and have to chew it.

4) Is there a change in the culture of the organization with regard to caring for the environment and social responsibility? Are there numbers that can demonstrate it?

No, in my opinion, they do not care. They will adjust if the market asks for it, and they will do what generates the most profits. Everything else is verse. I remember when I went to work I asked if the legal department was very big. No, the big one is the corporate affairs department. If it comes to justice, they have failed, it must be negotiated before.

Therefore, the organization is going to adapt, as profitably as possible, to what the market forces it, not what society thinks.

5) In your opinion, what are the consumption trends in the last 5 years?

Well, a bit what I have commented, the key is to reduce combustion, smoke. The smell, the hangover from the smoke, etc.

A few years ago, they smoked less, but for many years. Now you see a more aggressive trend, you start smoking when you are young, you smoke a lot, and you try to quit smoking after the age of 30, let us say.

In conclusion, the cigarette is poison. However, my best work and professional experience, the "best professionals" that I met, the best and highest standards of work, I saw them in a tobacco factory. Very contradictory, or not?

Appendix B- Survey results

Figure 5- Percentage of Smokers, Social Smokers and Non-smokers among surveyed (2021)

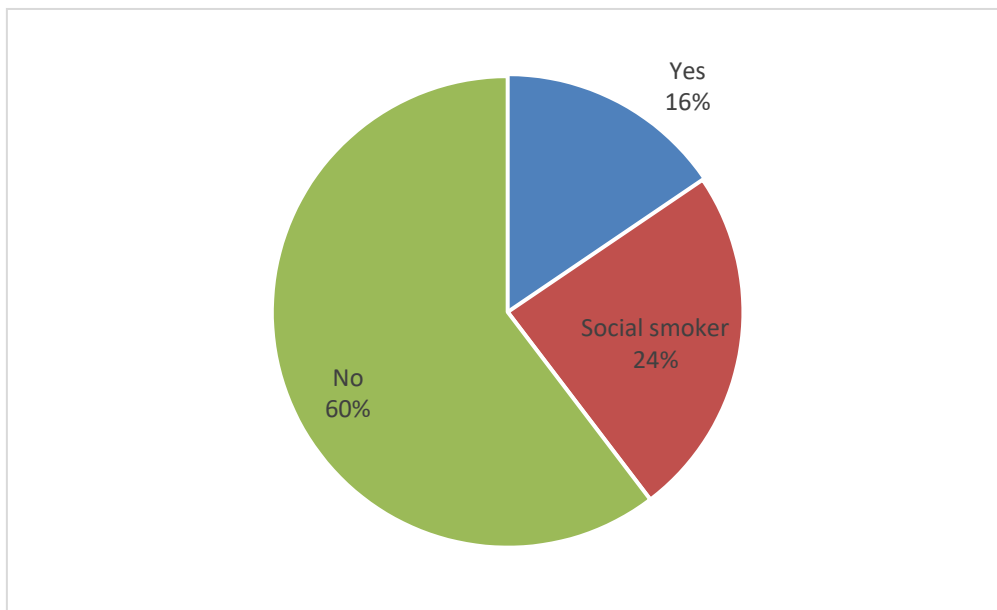


Figure 6- Age Of Surveyed in Years (2021)

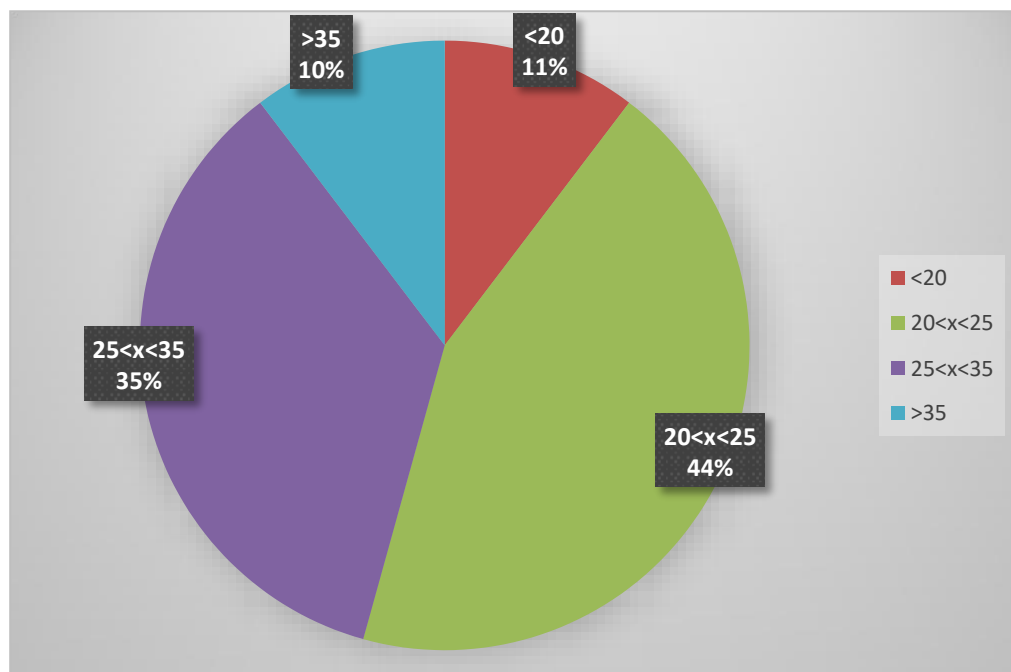
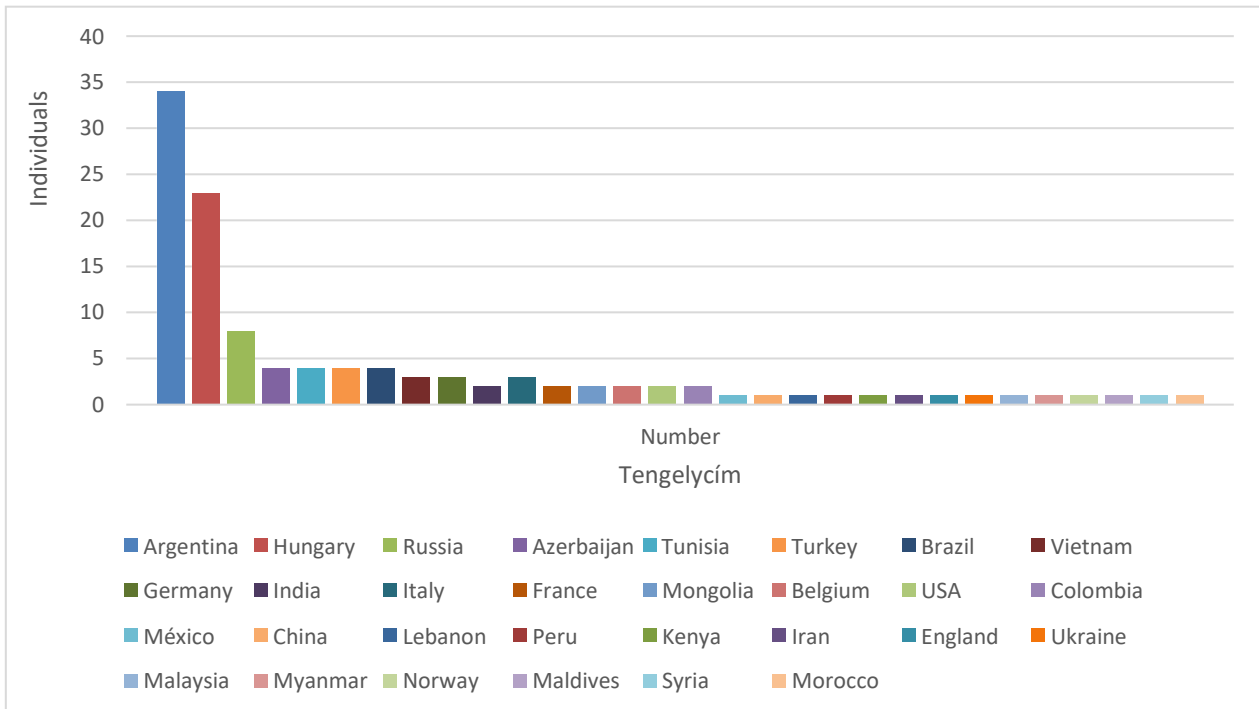
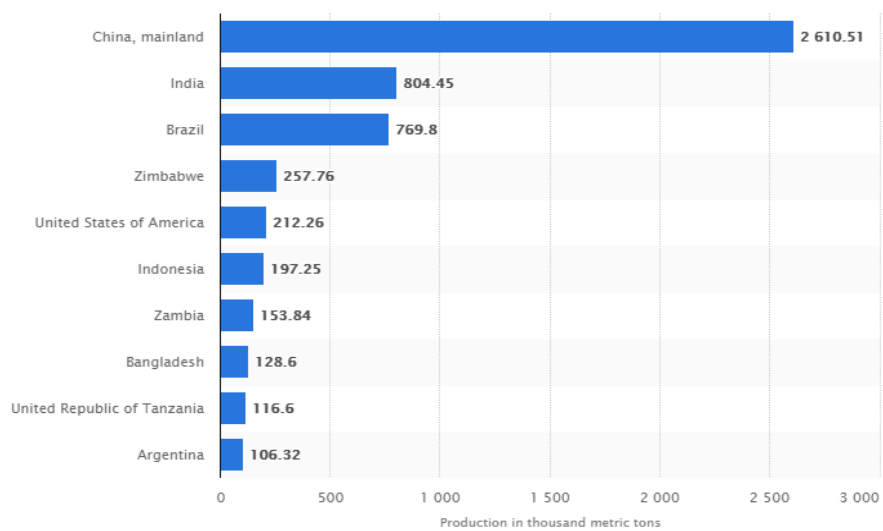


Figure 7-Participants Country Of Origin (individuals)



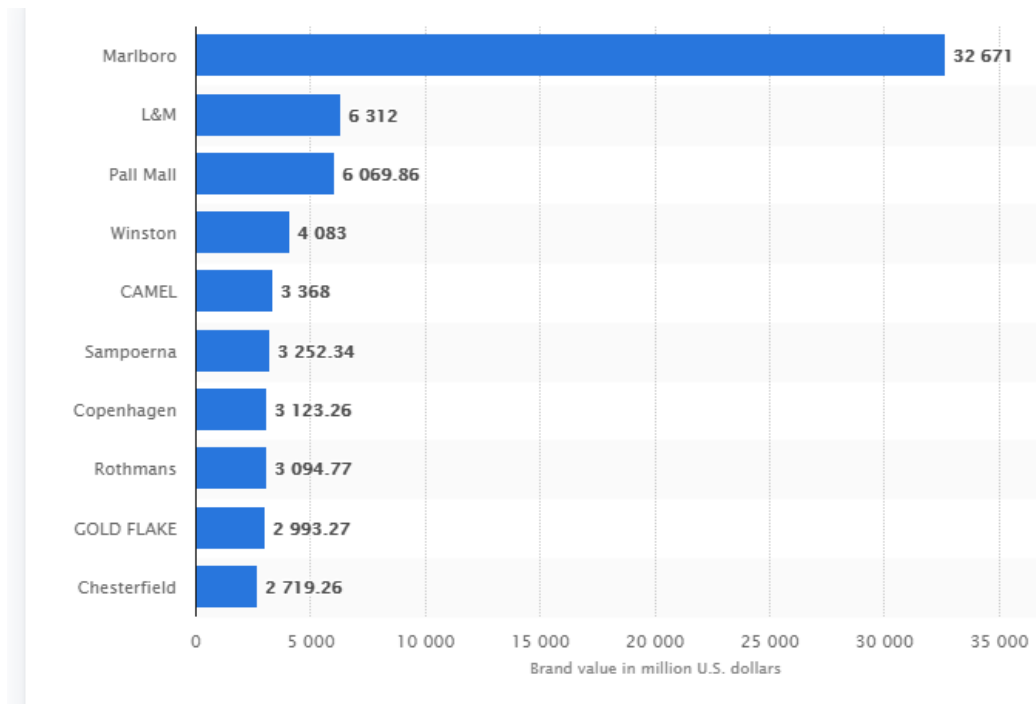
Appendix C- Other tables and figures

Figure 8- Leading Tobacco Producing Countries Worldwide in 2019



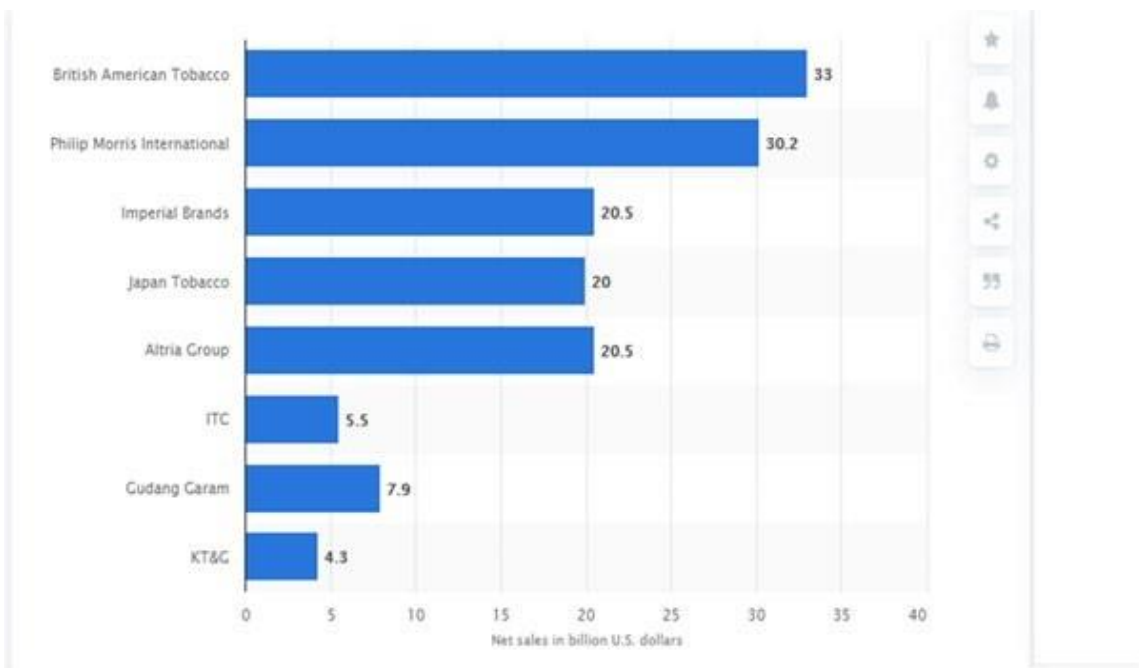
Source: Shahbandeh, 2021.

Figure 9-Most Valuable Tobacco Brands Worldwide in 2020



Source: Statista, 2021

Figure 10- Leading Tobacco Companies Worldwide in 2019, Based on Net Sales (in billion US dollars)



Source: Statista, 2021.