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ORIGINAL ARTICLE

Improving plastic management by means of people awareness

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ABSTRACT

In past decades the usage of plastic has seen a tremendous increment. This raise is mainly caused by industrial development and by the spread of this material in every aspect of people life, from food package to aerospace application. For sure plastic has a key role in society and it is not possible to erase, nevertheless its overuse has a serious impact on the environment as well know. In particular, just a few percentage of the total amount of plastic is recycled, the rest has to be landfilled or burnt causing serious pollution side effect. This poor circularity in plastic value chain is mainly caused by difficulties in sorting processes and expensiveness of recycling. By the way a great part of plastic applications could be avoided without implying a reduction in life quality for the people. In addition, a better education in plastic objects shopping and plastic waste management could decrease the difficulties in sorting and recycling. One of the crucial reason why these applications and incorrect behaviour are still present is that the information on alternatives are not present or very hard to be found. In the present paper a novel platform to enhance a more plastic-free life is presented. First a detailed description of the problem is stated, then the process to achieve the proposed solution is described. Finally the platform prototype is analysed in details among its functionalities.

Keywords:-Plastic consumption reduction; plastic free life; quantification of people behaviour; ImpActo app.

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INTRODUCTION

Plastics play a key role in our daily life and are a fundamental part of the world economy.

Global plastics production is constantly increasing since 1950. In 2017, European plastics production amounts to 19% of the global production (Plastic Industry 2018).

Plastics are used in a wide range of industries: packaging 39.7 %, building and construction 18.8%, mobility and transport 10.1%, electronics 6.2%, agriculture 3.4 %, sport and entertainment 16.4% (Plastic Industry, 2017; Plastic Europe 2018).

From ensuring food safety and reducing food waste to building ships and satellites: this versatile material is easy to produce at a low cost. However, the whole plastic-system is failing in capturing the economic benefits of a more sustainable 'circular' approach while harming the environment.

In order to mitigate this problem, the European parliament has overwhelmingly voted in favour of banning single-use plastic products, which will include plastic drinking straws, stirrers, cotton buds, cutlery, plates and sticks for balloons from 2021 (European Commission, 2018). Legislative restrictions aside, plastic recycling plays a key role in this ecosystem in order to reduce the amount of waste to bury or bring to landfills. Plastic recycling involves a great number of stakeholders identified in Fig. 1 (ref: plastic journey). In fact, plastic is produced starting from natural materials (e.g. cellulose, coal, natural gas, salt and crude oil), giving life to many different plastic families with various properties.

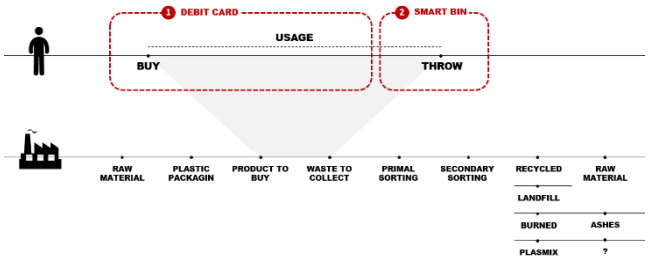

Fig. 1: Production chain of plastic material

Each plastic family is suitable for a specific use but once missing the main purpose, it goes from a valuable consumer good to a worthless, dangerous for the environment, waste to trash. As shown in Fig. 2 (ref: funnel) 50% of the total urban waste is plastic (EUROSTAT 2018), which must be processed in order to recycle only the 8% of it (Cossu et al., 2017).

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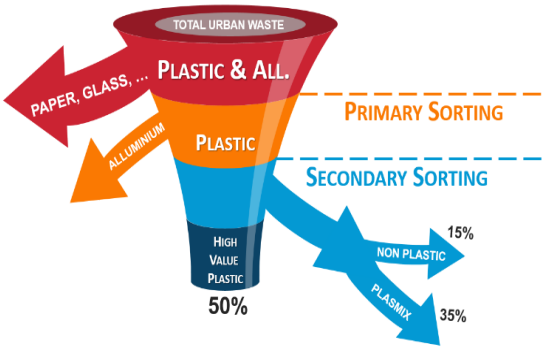

Fig. 2: State of art of plastic waste management

According to waste hierarchy, plastic waste can be faced through different actions: 1) prevention, 2) re-use, 3) re-cycling, 4) recovery and 5) landfill.

In agreement with Circular Economy Policies and Sustainable Development Goals (SDGs) of Agenda 2030, energy recovery and landfilling cannot be considered valid options.

Nowadays target is to make the path of plastic circular.

The aim of the present study is to propose a valid solution to face plastic waste as a social-economic and environmental problems. The solutions taken in consideration are the following: different chemical-mechanical technologies, according to recycling strategy, to make plastic edible and to reuse it for art, according to reuse. Finally, the promotion and support of plastic-free lifestyle app, according to the prevention of plastic consumption.

For all these ideas pros and cons are evaluated (detailed evaluation is presented in the theoretical background section) and plastic free life-style model is carried out as the most suitable and effective solution addressing plastic waste problems. The novelty of the proposed solution is the combination of social-technical-economic and environmental perspectives in order to support and boost the human-nature reconciliation.

THEORETICAL BACKGROUND

In the past decades plastic recycling has gained more and more importance due to the increase in air pollution and disposal issues. Two different types of plastic exist, thermoplastics and thermosets. The majority part of urban plastic waste is packaging, and it is mainly composed by thermoplastics, that are almost recyclable. The plastic needs to be divided in seven sub-categories to be fully recycled. Those categories are commercially numerated and in order they are PET (polyethylene terephthalate), HDPE (high density polyethylene), PVC (polyvinyl chloride), LDPE (low density polyethylene), PP (polypropylene), PS (polystyrene), OTHERS. When the polymers are sorted several methods exists to recycle them, both mechanical and chemical. As regard the first methodology, the process consists in cleaning, hashing and drying the plastic refuses. Then the obtained flakes are recast and extruded to create new raw material. As regard the chemical recycling, several processes exist, e.g. catalysis, gasification, methanolysis and so on. The common aim is to break the polymer in simple molecules to be used as raw material or fuel (Glaser 2018). Even though these processes allow to recycle plastic, just a few percentages of it undergo to such processes mainly because the contamination sources inside the waste (EU, 2019). This contamination is caused mainly by errors in waste management and difficulties in sorting small and twisted pieces.

In 2018, in Europe, 27.1 Mt of plastic waste was collected and managed as following: 42% energy recovery, 31% recycled and 27% landfilled. Nearly 40% of recycled plastic was sent outside EU for treatment, in particular one of the main destination was China. Since January 2018, Chinese authorities imposed bans on low quality waste imports, including plastic waste post-consumer. Thus, plastic waste had to find a new treatment.

The idea to make circular the recycling of plastic waste addressed the policies of Circular Economy (CE) and Sustainable Development Goals of Agenda 2030, but the main issue was that the existing recycling processes address only some types of polymers. In detail, PET, HDPE and plastic films, after sorting and treatment, usually find a mature outlet market with a good valuation. Whereas, other polymers, contribute to create a mixed plastic fraction, called PLAS MIX, which is hardly exploitable and it is usually incinerated or landfilled. Anyway, existing waste to energy plants are saturated by other types of waste and the capacity of European landfills is limited and regulations restrict their use. For these reasons, in this paper other plastic waste treatment solutions were evaluated. The considered and screened solutions are recycling, reuse and prevention.

Considering recycling processes, chemical recycling technology resulted unfeasible for the high amount of wastewater and waste produced, around 70% of treated plastic waste (Cossu et al., 2017). Mechanical technology was economic unprofitable (Ardulino et al, 2018), while biological paths are still at the laboratory scale (Mazzoli et al, 2018).

Recycling is critical to effective end-of-life plastic management. Increasing recycling rates are results of a greater public awareness and of the increased effectiveness of recycling operations. Operational efficiency will be supported by ongoing investment in research and development. Industry and policymakers can also help stimulate recycling activity by requiring or incentivizing the use of recycled resin versus virgin plastics (Partners for innovation, 2019)

Since recycling resulted difficult to apply, the second evaluated solution was the step before recycling: sorting. Sorting operation was evaluated by means of SMART BIN technology. Sorting correctly based on the above-mentioned families of plastic and here, in the very

beginning of the process, as human errors can occur, is where a smart-bin would make the biggest difference.

Nowadays there are several smart-bins solutions, for example Bin-e (bine.world) is able to sort and compress waste to recycle, but it must be bought by a company in order to reach its internal sustainability goals. Other solutions, less advanced than Bin-e, are only able to send information about how much waste there is inside the bin, which is good for optimizing the garbage collection, but is not pulling people to recycle. Therefore, a great number of solutions are focusing on the technology side, but very few are taking in consideration the whole plastic recycling picture, made by a technical solution designed with the right business model to sustain it economically and financially (Rigamonti et al, 2014)

Since smart bin resulted technical feasible, but economical unprofitable, the reuse of plastic waste for art and for new products realization was considered. The idea was to use recycled PLAS MIX pellets to create a new product as pile, clothes (Montello; Polartec Gary Smith) statue (ENI Ecomondo, 2017) and products (Revet).

Since the reuse of plastic waste resulted economic unprofitable and technically hard, the final and developed solution is the promotion and support of a more free-plastic lifestyle to boost the human and nature reconciliation changing human behavior over time. In detail, the idea is an online marketplace which contains lifestyle composed by plastic free and recycled plastic products, tailored to customer needs and classified on their environmental impact and sustainability. This sort of lifestyles are defined for everyday life, as for example “mountain and sea trips”, and for different moment of the day like “breakfast”, “lunch”, “dinner”, “make up”, “sports”, etc.

The goal is to redesign everyday life in such a way as to provide our user with an easy alternative to a full plastic life and to make him aware of the impact of his purchases.

METHOD AND DATA

The state of art for plastic waste in Italy is undergoing deep changes in the recent years. Public institutions are introducing laws and fines in order to incentive a proper behaviour, for example banning single-use plastic products. Plastic waste problem is a wide and huge issue affecting social, economic, environmental and technical perspectives. The challenge is to reduce plastic waste, tackling the problem of living everyday with less plastic (making plastic waste circular).

The applied methodology consisted in 1) problem definition, 2) formulation and evaluation of the available ideas 3) critical thinking 4) definition of the solution 5) solution validation and 6) solution prototyping

The problem definition is the following: plastic waste has to be reduced in order to allow human-nature reconciliation boosting circular economy. Plastic waste cannot be reduced during recycling and sorting steps, because they are difficult to improve for technically and economic issues respectively. Thus, the idea is to prevent the plastic waste at the origins, improving the social awareness.

Critical thinking was applied to screen ideas and define boundary conditions and contents, in order to shape the solution. Critical thinking is carried out with a rational and unbiased team analysis. The solution is validated by means of personal and on-line surveys. The prototype is a online marketplace based on technical, social economic and environmental key factors designed following UX best practices.

The vision consists in the HUMAN-NATURE RECONCILIATION and it is carried out enhancing and boosting the social awareness. The proposed solution is an online marketplace which contains a set of daily life activities with plastic free and recycled plastic products, tailored to customer needs and classified on their environmental impact and sustainability. In order to rank products, an algorithm (see Table 1) has been developed. The algorithm has two main outputs: 1) kg of avoided plastic consumption and kg of avoided CO_2 and 2) the sustainability of a set of daily life activities with plastic free and recycled plastic products which is able to consider different features of the product and to use them as classification’s criterions. The kg of avoided plastic consumption is calculated as difference between the amount of plastic of conventional products and alternatives ones, while the kg of avoided CO_2 is calculated as kg of avoided plastic per 1.6 kg CO_2/kg avoided plastic, a multiplicator factor, certified by Green database of plastic forum.

The second part of the algorithm is developed in collaboration with Politecnico of Torino and it considers three main categories: certification, recyclability and plastic structure. The categories are chosen on the bases of the following laws: UNI EN ISO 1043-1:2002 for plastics-symbols and abbreviations based on special characteristics and structure of polymers, CEN/CER 14311: 2002 for packaging-marketing and material identification system, UNI EN ISO 11469-2001: for plastics generic identification and marking of plastics products, in presence of polymers is reported +, while in presence of additives -, but this law is not applied for packaging weighing less than 25 g and/or surface 200 mm^2 and finally UNI EN ISO 14021-2002 for label and environmental declaration of type II.

Certification, which weights 30%, is composed by two international parameters, “Ecolabel” an “Environmental Product Declaration” (EPDF) and an Italian one, “Plastic Second Life” (PVS).

Recyclability, which weights 40%, considers Mobius cycle and the percentage of recyclable plastic in the products and in their packaging.

Table 1: Algorithm parameter's weights and structure.

Category	Parameter	Score category	Score parameter	Range	Measure unit
Certification	Ecolabel	30%	0.42	[0-1]	[-]
	PVS		0.16		[-]
	EPDF		0.42		[-]
Recyclability	Bioplastic	40%	0.6	[0-1]	[-]
	Mobius cycle		0.4	[0-1]	[-]
Plastic structure	Plastic homogeneity : percentage of recyclable plastic in total plastic	30%	0.30	[0-1]	[-]
	General homogeneity		0.30	[0-1]	[-]
	PET/ total plastic		0.25	[0-1]	[-]
	PET colour		0.15	[euro/t]	[euro]

Plastic structure, which weights 30%, is based on four parameters: percentage of plastic in the multi-material packaging, percentage of recyclable plastic (PET, HDPE, LDPE, P8) in the multi plastic packaging and products, percentage of colourless PET in the plastic and the economic value of PET colourless.

The algorithm is based on a multi-criteria analysis reported in Table 1.

All these factors are chosen according to the parameters considered by recyclable plant and EU commission to define standardisation of plastic packaging (Rigamonti et al., 2014)

The name of the platform is ImpActo and the prototype is already developed. The customer is everyone who wants to live a free plastic life as much as it is possible. The customer's age belongs in range between 25-35 years old and they are online customers with a strong social media life. The customer is validated by means of survey and evaluation of the followers of plastic free influencers and life-style.

The unique value proposition of ImpActo is the realization of an online market place, able to quantify the impact of each product and to provide an economic and environmental reward to those who decide to live a less or a plastic free life. The analysis of the market competitor distinguishes by one side the presence of online market of enormous size with very little attention to the sustainability perspective and on the other side blog and Instagram pages which deliver a lot of information but require a long time to be followed and that risk to target a public too restricted. The main pillar of ImpActo are: 1) the algorithm, proposed as a patent, through which customer can measure his environmental print and impact and the redesign and proposal of sustainable and plastic free lifestyles, 2) economical and emotional rewards and 3) expert/ plastic life styler set creation

From a business perspective ImpActo relies on Amazon, which provides the referral program and ecological packaging service available on request, and on other potential partners that can insert their products in our platform.

The market penetration is performed in European market, because EU has established grants and laws for plastic packaging standardisation and reduction of plastic consumption and production.

The long term objective is to sell eco-friendly and plastic-free products with our own brand, using Amazon platform.

RESULTS

Every day, social networks and news on TV underline and denounce how negative is plastic for our ecosystem if it is not well managed. A lot of spot and fragmented information of plastic alternative and plastic free products are available. People, who desire living plastic free life have to invest a lot of time and efforts for the search of these products. Thus the main problems related to plastic free life are following sum up: 1) spot and fragments alternatives, 2) requirement of huge amount of time 3) strong efforts. The visions, which moves towards the solution is the following: HUMAN-NATURE RECONCILIATION and it is carried out enhancing and boosting the social awareness, helping people changing their behaviour of plastic consumption. The proposed solution is an online marketplace named ImpActo, which contains a set of daily life activities with plastic free and recycled plastic products, tailored to customer needs and classified on their environmental impact and sustainability.

Currently ImpActo contains 4 sets of daily life activities with plastic free and recycled plastic products: 1) office, 2) pic-nic., 3) early morning and 4) light kitchen

For each set, an avarage of 6-8 products are considered and the kg of avoided plastic and CO_2 are reported in Table 3. Moreover, the increment or decrements of invested money are calculated according to the singular set of daily life activity.

Table 2: quantification of money saved and kg of avoided plastic and CO_2

Category	Products			
	Reusable Mug	euro saved /year	kg plastic saved/ year	kg CO2 saved/ year
Office	Paper cup	252	20	31
	Palette in bamboo			
	Pen			
	Bottle Al			
	Dispencer			
Pic-nic	Fork paper	-29,99	0,3	0.4
	Knife paper			
	Glass of paper			
	Plates of bioplastic			
	Water bottle AL			
	Table			
Early morning	Tootbrush in Bamboo	-27,63	28	45
	Cotton fioc			
	Hair brush			
	Hair comb			
	Soap			
Light kitchen	Reusable bags for fruits and vegetables	1,34	6,15	9,85
	Paper for preserving food			
	Food containers			

Hiring these 4 sets of of daily life activities with plastic free and recycled plastic products, plastic and CO2 are avoided, but the categories of pic-nic and early morning require a little economic effert.

The second part f the algoritm is aimed to quantify the sustainability of the 4 sets of daily life activities with plastic free and recycled plastic products in a range 0-1 (see Table 3).

Table 3: quantification of sustainability of 4 sets of daily life activities with plastic free and recycled plastic products

Sets of daily life activities	Product	Score
Office	Reusable Mug	0,06
	Paper cup	0,09
	Palette di bamboo	0,22
	Rechargeable pen	0,35
	Water bottle in Al	0,17
	Dispenser	0,46
	Total score of set office	1,34
	Average score of set office	0,22
Pic-nic	Re-usable straw in bamboo	0,52
	Travel glass	0,23
	Glass flute	0,15
	Mark glass	0,44
	Fork in bamboo	0,53
	Iron ice-cube container	0,25
	Glass with straw	0,29
	Total score of set pic-nic	2,41
	Average score of set pic-nic	0,34
Early morning	Tootbrush in bamboo	0,58
	Cotton fioc	0,57
	Hair brush in bamboo	0,46
	Hiar comb in bamboo	0,53
	Soap in lavande 100% natural	0,53
	Total score of set early morning	2,65
	Average score of set early morning	0,53
Light kitchen	Reusable bags for fruits and vegetables	0,49
	Paper for preserving food	0,50
	Food container	0,48
	Total score of set light kitchen	1,47
	Average score of set light kitchen	0,49

The highest average score for sustainability of the set of everyday life activities is achieved by Early morning with 0,53 and light kitchen with 0,49.

The impact of innovation and management of ImpActo can be calculated by means the proposed algorithm. Considering Eurostat database (Eurostat, 2017) 113,30 kg of plastic/ inhabitant are produced in a year, the avoided kg of plastic and CO_2 per inhabitants in 1 year with the adoption of all the 4 set of everyday activities are respectively: 48,06 kg and 85,85 kg. The estimated total reduction of plastic consumption in 1 year is 60%w/w. ImpActo is a unique online market place able to gather in an order way information about plastic, considering where, when and how purchase product

plastic free and plastic recycled products evaluating the customer action value.

The customer of ImpActo is validated through a survey and the results is: 57,7% of the customers are women with an average age between 25-35 years old and they are students (39%).

The customer is who wants to live a free plastic life as much as it is possible. The customer tailored shops online more than one a week (57%) with a strong social media life. Based on Global web index database, 67% of customers consider plastic free packaging before booking a product online and 53% of customers try to reduce their plastic impact. Furthermore, 42% of customers believe in the importance of sustainability in their own day-to day shopping and 28% of customers suffer of lack of information of plastic and packaging's origins. Finally, 61% of customers is more oriented to sustainability than brands.

In a long term perspective, ImpActo provides the following benefits

1) to solve the sense of frustration that the customer faces looking for recycled plastic products or free plastic packaging ones.
2) to reduce and minimize recycled plastic or the time spent searching free plastic packaging products.
3) to provide an e-commerce with selected plastic free and plastic recycled products with price and technical-environmental characteristics
4) to calculate the impact of customer's purchases

The gains of the customer are:

1) money reward: the eco-friendly purchase is rewarded with discounts, cash back, and virtual wallet to use in other applications.
2) motivational reward: the eco-friendly purchase is performed with gamification, from plastic zero to plastic hero
3) co-creator reward: After numerous purchases on the platform the customer can be nominated as influencer/expert and can improve the service by adding new lifestyles and product features.

Rewards can be both money and motivation.

ImpActo is provided by Playstore and Appstore. ImpActo provide three main information: 1) certification of people good impact action, 2) organized and well-structured plastic alternative information and 3) easier search and purchase of plastic free or recycled products.

DISCUSSION AND CONCLUSIONS

Plastic consumption has seen a huge increment during last decades, despite the pollution caused by its disposal has been partially neglected. In this paper a novel platform helping people to find easily alternatives to plastic usage is presented. First the problems related to an excessive exploitation of plastic objects have been highlighted, then the proposed solution is deeply described. The platform consists in an online marketplace in which people can easier find and buy products to reduce their plastic impact. Moreover, news and information to help people having a more environmental-friendly behaviour are presented. In order to get people aware of the effect of their actions, a novel algorithm has been developed. Thanks to the information obtained from the actions done on the platform, every user is able to practically see how much his new behaviour has had a positive effect on the environment. The combination of these various aspects has caught the attention and interest of many people and this trend is still growing. ImpActo has the possibility to simplify and better people life and concurrently save tons of plastic waste from sea, air and ground. Nevertheless, many other efforts must be done to enhance the platform and its functionalities to achieve a better result. ImpActo gives the possibility to enhance the awareness of customer and change his behaviour moving towards more sustainable actions. The sustainability of actions is quantified through an algorithm and the customer is stimulated to do continuous sustainable actions also thanks to emotional and money rewards. Moreover, ImpActo represents also the attempt of bringing scientific research into the everyday user experience, giving value to users choices. Future works will explore the possible different needs of customers and will optimize the afore discussed algorithm. Future perspective for the research consists in evaluation of additional parameters will be implemented in order to achieve more accuracy and reliability in impact estimation, such as transportation factors or manufacturing emissions. The final purpose is to obtain a scientifically correct instrument able to get people aware about the impact of his choices.

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