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HOUSEHOLDS TEXTILE WASTE MANAGEMENT IN THE CONTEXT OF A CIRCULAR ECONOMY IN ROMANIA

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Abstract

The large amount of textile waste resulted annually both in the EU and Romania, the worrying growth of textile waste from households in many parts of the EU and the significant differences regarding the treatment of textile waste in Romania compared to the EU are the main reasons we proposed to carry out in this study. The aim of this paper was to find out what happens to the textile waste from Romanian households if the population is aware of the textiles' environmental impact and the appropriate recycling methods. For this reason, an online consumer survey was conducted from January 2020 to February 2020 and covered 282 respondents. The study's results showed that only a small part of the clothing products no longer used end up in the garbage, still, there is a danger that this quantity will increase in the future, as most citizens have no knowledge about the existence of recycling centres or these centres do not exist in the localities where they live. There is also the possibility that very few consumers would use these recycling centres. Even if a relatively high number of respondents are aware that textile products can be recycled, only a small part of them use this method. The study reconfirms the fact that Romanians still have to purchase secondhand clothes and shows which are the main forms of marketing preferred by them. It also shows that there is a potential growth of the market for products obtained from the recovery, recycling, and re-use of textiles.

Keywords: clothing waste, environment, households, treatment of waste

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1. Introduction

Textiles are a necessity in our life, both for manufacturing clothing items and due to the extension of their use fields – automotive industry, construction, computers, agriculture etc. The textile and clothing industry is among the most essential consumer goods industries, accounting for more than 37% of total European industrial activity, the 171.000 Textile and Clothing companies having over 1.7 million workers. (EURATEX, 2018). According to the same source, in 2018 the Textile and Clothing industry in EU-28 had a turnover of €178 billion and investments of €4.9 billion. Textile industry is not just one of the most important consumer goods industries but it also has a detrimental impact on the environment.

Throughout the entire life cycle of textile products, from obtaining fibres to storing waste, they generate multiple sources of pollution. For example, in the first stage, that of obtaining the natural liberian fibres from agricultural raw materials, a large quantity of water is consumed and there is a pollution of both the air and the wastewater. High-level pollution exert the pesticides removed from cotton, flax and hemp, but also other chemicals (lactic acid, alcohols, peptides, waxes) resulting during the melting process. Water use can be up to 29 m^3 per kg of cotton and cultivation of cotton use about 11% of the world's pesticides (Palm, 2011). Cotton depends on pesticides more than any other crop, using 1/3 of a pound of pesticides per shirt (Heuer and Becker-Leifhold, 2018). In the processes of wool processing

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(degreasing, carbonizing, carding, washing, bleaching, dyeing, etc.) more than 800 chemicals are used, such as: acid and alkaline substances, oils, detergents, dyes, SO_2, H_2O_2, etc., all negatively affecting water quality (Kulkaria, 2007). The negative effects on the water are manifested by the change of pH and colour, by the presence of dissolved solids or in suspension, of phenolites, chlorides, oils and fats, sodium sulphate, etc.

The second most commonly used textile fibre (after cotton) is polyester. The largest problem is that it requires huge amounts of energy for production, about 40% more energy than the production of cotton fibres (Kalliala and Nousiainen, 1999) and a large quantity of nitrous oxide, a greenhouse gas that is 300 times as powerful as CO_2, resulting from the production process. Estimates of the global warming potential of textile productions are 16.9 kg CO_2-equivalents per kg of 50% cotton and 50% polyester, 15 kg CO_2-equivalents per kg of 50% cotton and 50% polyester and 25 kg CO_2-equivalents per kg of textiles (Palm, 2011).

In addition, the textile industry uses a variety of dyes, chemicals, and other materials for different forms of finishes applied to textile products in order to obtain different characteristics, properties or to provide the required qualities to the fabrics. This results in the production of wastewater. Its pollution load increases not only from the removal of impurities from the raw materials themselves but also from the residual chemical reagents used for processing (Correia et al., 1994). If they are not properly treated before to discharging, the waste water from wet processing contains hazardous chemicals, including mutagens carcinogens, and teratogens, that cause serious environmental damage by contaminating exhaust gases, waste water, and the fabrics themselves (Gregory, 2007).

The environmental impacts of garments are not only associated with material production. The consumer use and post-consumer use phases of a garment life cycle appeared to have important environmental impacts as well. The main factors driving the environmental impacts of the consumer use phase are number of uses, laundering frequency, washing methods, drying methods and end-of-life fate (Daystar et al., 2019).

Economic prosperity and seasonal changes in fashion determined textile manufacturers to develop increased quantities of low durability clothing (Babel and Mehta, 2019). As the production of textiles increases, so does waste production from both the manufacturing and household sectors. That waste can mainly be classified into three groups: production waste, pre-consumer waste, and post-consumer waste.

Production waste is composed of fibre, yarn, cloth scraps, flock, sweeping, fabric cut-offs, fabric roll ends and selvage generated by fibre producers, weavers, knitting companies and apparel manufacturers - realized with design mistakes, fabric faults, or the wrong colours being produced for sale and consumption. Post-consumer waste consists of any types of household articles or garments made from fabricated textiles that the owner does not require any more and has decided to discard when they are worn out, damaged, outgrown, or out of fashion (Yalcin-Enis et al., 2019). The volume of post-consumer waste is very large and is comparable with the rate of fiber consumption (Wang, 2010).

The total quantity of textile waste in the EU, in the last years, has registered a downward trend, reaching 2.190.000 tonnes in 2016, compared to 2.420.000 in 2008, as can be seen in Fig. 1.

The statistical data shows that in 2016, in Romania, the total of textile waste produced by all NACE activities and households reached 30.360 tonnes, which represents 1.38% of all textile waste in the EU (EUROSTAT, 2020). At the same time, it can be observed that the level of textile waste in Romania has increased annually, being 57.99% higher in 2016, compared to 2008. The evolution in time of these wastes, according to data provided by EUROSTAT, 2020, is shown in Fig. 2.

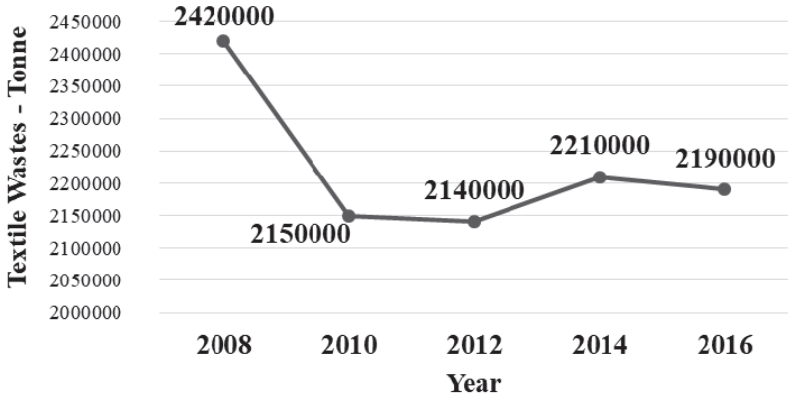

Fig. 1. Evolution of the textile wastes in EU (hazardous and non-hazardous)

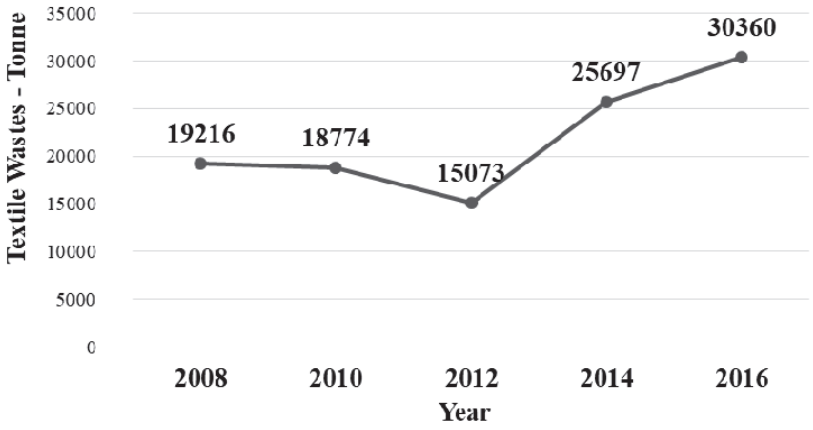

Fig. 2. Evolution of the textile wastes in Romania (hazardous and non-hazardous)

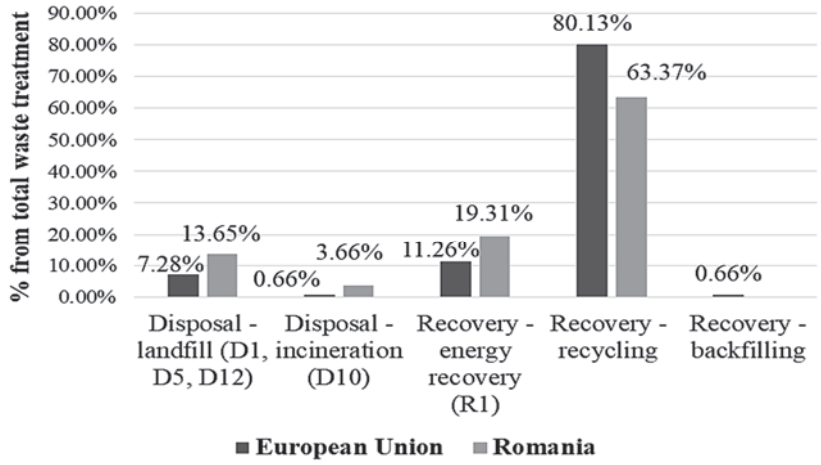

Fig. 3. Treatment of textile waste and waste management operations – in 2016.
Calculated by the authors according to the EUROSTAT, 2020

Currently a part of the textile waste resulting from the production processes is used for producing yarns, non-woven textiles, and wool upholstery for furniture and cars, insulating materials, geotextiles or for the creation of some clothing products collections made wholly or partially from a different kind of textile waste. This has led to a significant decrease in the waste from the industry of textiles manufacturing, wearing apparel, leather and related products, from 2.130.000 tonnes in 2006 to 620.000 tonnes in 2016, in the EU (EUROSTAT, 2020). The same downward trend is registered in most EU countries.

In terms of textile waste from households, the statistical data show that they have increased worryingly in the last years reaching 860.000 tonnes in 2016 - total EU. Significant increases compared to 2006 are recorded in Germany from 47.996 tonnes to 141.667 tonnes in 2016, in Spain from 4.775 tonnes to 34.616 tonnes, in France from 2.000 tonnes to 165.803 tonnes - their volume becoming comparable with the rate of fibre consumption (EUROSTAT, 2020).

According to the EC waste directive (EC Directive, 2008) the landfill (or other means of disposal) is the least preferable treatment of waste option and waste prevention is the most preferable option. Disposal of solid waste is the less-favoured waste management method, in which the last destination of waste is a landfill site, because the wastes containing synthetic fibres do not decompose. Those made from wool, even if they are decomposable, produce methane and carbon dioxide gases, contributing to global warming. The methane emissions are more harmful than carbon dioxide emissions during the disposal of textile waste in landfills (Sotayo et al., 2015).

Numerous studies show that reuse and recycling have more environmental benefits than landfill and incineration. For example, according to Dutch aWEARness's calculations, textiles recycling can offer energy, water and carbon dioxide savings of 64%, 95% and 73% respectively, in comparison to standard non-recycled textiles. This also reduces the consumption of raw materials by 61% because waste is eliminated (EC Eco-innovation, 2014). Another study, by comparing them, shows that the textile recycling has a much higher potential of GHG emissions and energy savings than their incineration. (Zamani et al., 2015). According to the quality of the final product, this category can be also subcategorized into down cycling and upcycling. In the recycling

process, the quality of the final recycled product is equal to that of the base or original product. Upcycling means to take a lower quality or waste product and use its materials to make a product of higher value and down cycling refers to recycling a material into a lower value product (Yalcin-Enis et al., 2019).

Of the total textile waste, in Romania, 76.28% get to be treated in different forms and 68.94% in the EU. Even if disposal - landfill is the least preferable option for treatment of waste, both at EU level and especially in Romania, this way of managing textile waste still records significant percentages - 7.28% in the EU and 13.65% in Romania. At the opposite end, both in the EU and in Romania, is textile recycling - with 80.13% of the total textile waste in the EU and 63.37% in Romania. At EU level, in 2016, only 0.66% of textile waste is recovery - backfilling and for Romania the statistical data does not indicate the existence of such a form of recovery, as can be seen in Fig. 3.

The large amount of textile waste produced annually in both the EU and Romania, the worrying growth of textile waste from households in many parts of the EU and the significant differences regarding the treatment of textile waste in Romania compared to the EU are the main reasons we proposed to make the study presented in this paper.

2. Material and methods

Methods of the scientific research that have been employed in the paper are:

- summarizing of literature which presents the textiles' environmental impact and the textile waste management;
- mathematical calculations and comparative analysis of statistical indexes regarding the textile waste, treatment of textile waste and waste management operations in EU and in Romania;
- a questionnaire applied online.

An online consumer survey was conducted from January 2020 through February 2020. For its creation, Google forms (Google Inc.) were used.

The survey covered 282 respondents and has been divided in three parts. The first part was focused on conventional demographic variables (living areas, school level) and the second part contained 4 questions in order to find the degree of information of the population regarding the problem of textile waste. The last part included 6 questions to see what happens to textile waste from households but also the availability of citizens to buy second-hand clothes and products made from recycled materials.

Respondents were randomly selected according to the highest level of education completed and their place of residence. 224 of respondents are living in urban areas and 58 in rural ones. Regarding the highest level of education completed, 225 respondents have got a university degree, 47 graduated high school and 10 respondents have studied primary and gymnasium school only. The respondent demographics, by level of education and place of residence, is shown in Fig. 4.

An online consumer survey aimed to find out what happens to textile waste from households in Romania because statistical data indicate that they are in very small quantities compared to many EU countries.

Also, we wanted to find out if the population knows about the textiles' environmental impact and if the level of education and residence influences this in any way.We also set out to find out if there is a link between the amount of textile waste that reaches landfills (well above the EU level), the existence of recycling centres in the localities of residence and the knowledge that textiles can be recycled. These aspects interested us because Romania will have to set up a separate collecting system for household textiles before 1 Jan 2025 (EU Directive, 2018).

Because numerous studies highlight the importance of sorting clothes and reintroducing them into use and the importance of recycling, we wanted to find out if Romanian consumers continue to buy second-hand clothes, what are their preferred forms of marketing and if they would be willing to buy products made from recycled materials.

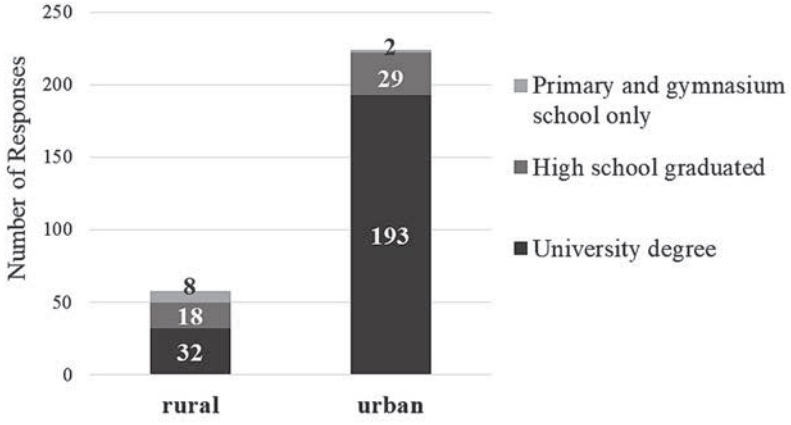

Fig. 4. Survey respondent's demographics by level of education and place of residence

3. Results and discussion

The processing of the questionnaire revealed that only 5% of the respondents throw textile products at the garbage. Most of them, 39%, give these products to friends/relatives and 34% donate them to charity centres, as it can be seen in Fig. 5. Analysing the answers to this question it has been determined that there is a similar behaviour for all categories of respondents who are not related to their level of education or their place of residence. Therefore, currently in Romania, only a small part of the clothing products that are no longer used are dumped, most of them reaching through different channels to be used by other people (directly or through charitable institutions and recycling centres) or be processed into floor cloths, dish-cloths, dusters and similar cleaning cloths, etc. and used in various household activities.

One of the contributing factors to diminishing the amount of clothes that reach the garbage is the behaviour declared by more than half of the respondents: repairing the clothes with small defects, 39% performing these activities by themselves and 19% resorting to different tailoring workshops (Fig. 6).

There is a different degree of knowledge related to the textile waste issue. This depends on the place of residence, but especially on the level of education. The data obtained is presented centrally in Table 1. As expected, it can be noticed that the degree of information increases with the level of education and is less influenced by the place of residence of the respondents. The most known analysed aspects are those related to the recycling and collection of textile products. The aspects related to pollution generated by textiles and clothing recycling alternatives are less known.

The role of education in waste issues is highlighted in numerous studies. Rada et al. (2016) underlines that the education of young people regarding the environmental protection both in family and in schools is a priority, representing an efficient way to minimize the amount of waste. So et al (2019) considers that the success of waste management necessitates the support of education, which entails both school and community education.

The results of our study highlight the fact that in terms of textile waste things are exactly the same. Worrying is the fact that although a relatively high number of respondents know that textile products can be recycled and how this can be achieved, only a small part of them use waste recycling centres - 7%. The perpetuation of this behaviour could lead in the future to an increase in the amount of textiles thrown in the garbage due to the fact that at one point the cycle of donations – re-uses will no longer be resumed.

We also consider that using the collection centres is important because in this way the clothes can be sorted and then reused and recycled in different ways. To the question, "Are there textile waste recycling centres in your place of residence?" the vast majority of those surveyed answered that they do not know (52%) or that there is none (24%). Analysing the answers according to their place of residence, it was found that only 7% rural area residents and 28% urban area ones state that there are centres for collecting textile waste in their locality (Fig. 7).

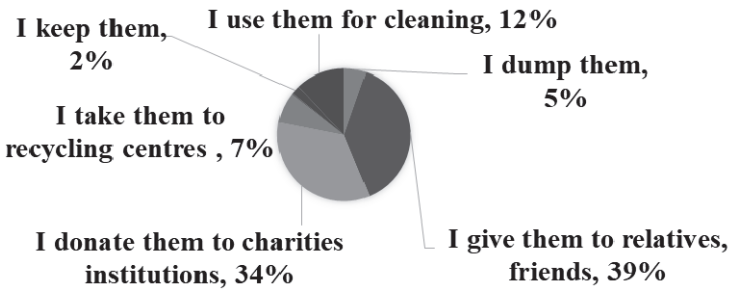

Fig. 5. Summary of answers to the question - What do you do with clothes you no longer wear?

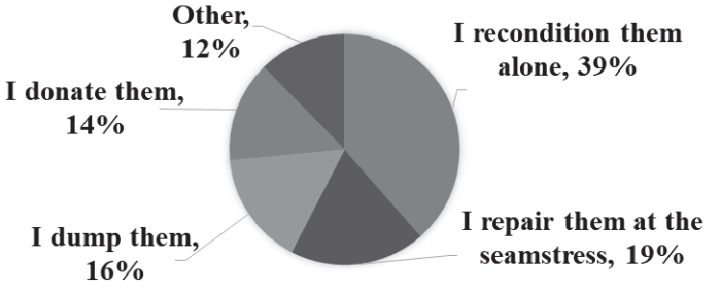

Fig. 6. Summary of answers to the question – "What are you doing with the clothes that have suffered slight defects?"

Table 1. Answers to questions related to textile waste issues according to the place of residence of the respondents and their level of education - percentage positive answers

Question	*Percentage positive answers*				
	Highest level of education completed			*Place of residence*	
	Primary and gymnasium school only	*High school graduated*	*University degree*	*Rural*	*Urban*
Can textile products be recycled?	30%	64 %	83 %	71%	81%
Do clothing and other textile products need to be collected separately in order to be reused or recycled?	20%	47%	67%	53%	64%
Did you know that the textile and clothing industry ranks second among the biggest polluters?	20%	30%	40%	33%	33%
Did you know that some clothing companies such as Zara, H&M, Puma, Levi's or Gap encourage the recycling of clothing by offering a shopping voucher or a discount to those who leave old clothes in their shops?	10%	28%	39%	38%	28%

The fact that most citizens do not know about the existence of the collection centres implicitly leads to the conclusion that those who know that the textiles could be recycled will at some point get to throw the unnecessary textiles to the garbage.

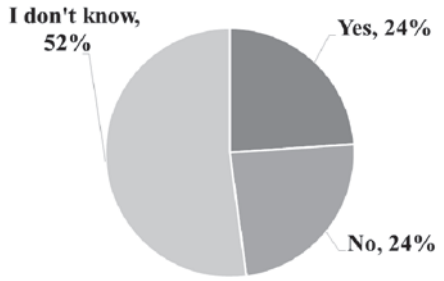

Fig. 7. Summary of answers to the question - Are there any textile waste collection centres in your place of residence?

In these conditions we consider it is essential to set up collecting centres in as many localities as possible, developing markets for used textile products, establishing rules for collecting textile waste, policies on trade in textile waste and prohibitions on incineration and storage. Promotional campaigns are also needed to inform the population about how textile waste should be collected and where those that are no longer useful can be stored.

For a long time, it predominated the opinion that second hand clothing are „dirty" and for those who cannot afford new clothing (Cuc and Tripa, 2014), but in the present, the vintage clothing culture has created an increase in economic demand for second-hand clothing and changed its perspective on second-hand usage (Cassidy and Bennett, 2012).

The fact that in Romania there are many people who buy second-hand clothes has been highlighted by other studies that have shown the size of this market. Avrigeanu and Anghel (2011) showed that in 2008 Romania's imports of second-hand clothes exceeded production of clothes for the domestic market. Another study shows that Romania is the largest importer of used clothes in Europe (Paras et al., 2019).

Our study reconfirms the fact that Romanians still have to purchase secondhand clothes and shows which are the main forms of marketing preferred by them. 54% of respondents buy second-hand clothes (76% from stores, 11% from market, 8% from fairs and 5% from the internet) and 81% would buy new clothes knowing that they are made from recycled materials.

Even if second-hand fashion is a sustainable offer since product life cycles are maximized and the need for new products diminished (Stein et al., 2020), we can't ignore the fact that because of their low prices, the large volumes of second hand clothing are constantly being imported and consumed. In the end, large volumes of re-worn clothing held by the consumers are discarded, a large waste stream at the end of the functional life of clothes being created.

4. Conclusions

Even if in Romania, at present, only a small part of the clothing products that are no longer used end up in the garbage, most of them getting to be used by other people (directly or through charitable institutions and collecting centres) or be processed into rags, cloths, etc., there is a danger that this quantity will increase in the future because most citizens have no knowledge about the existence of recycling centres or these centres do not exist in the localities where they live, but also because very few consumers turn to them.

Our study showed that even if a relatively high number of respondents know that textile products can be recycled and how this can be achieved, only a small part of them use waste collection centres. This could lead in the future to an increase in the amount of textiles thrown in the garbage, due to the fact that at one point the cycle of donations – re-uses will no longer be resumed.

The study reconfirms the fact that Romanians still have to purchase secondhand clothes and shows which are the main forms of marketing preferred by them. It also shows that there is a potential growth of the market for products obtained from the recovery,

recycling, and re-use of textiles - potential that will have to be exploited and developed in the future.

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