

# A CROSS MODEL FOR INDUSTRIAL WORKERS REGARDING BIOPLASTIC

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**Abstract:** The vision in the field of industry is to build a world in which plastic will never end up as waste, which means efforts in the area of recycling and reuse of packaging. By applying a questionnaire in same time and period in Turkey, Romania, Italy and Finland a number of 271 respondents which were working in different fields of industry in technological process were answer to some specific questions in special about plastic waste. The questionnaire was structured in four parts that made it possible to identify workers' level of information and specific education regarding the issue of plastic in different stages of the technological process or at the workplace in different organizations. The questionnaire collects data indicators about workers' knowledge's of working methods, if they have information about the use of bio plastic in production processes or only certain raw materials, improving quality by using the new type of plastic, what are the factors that prevent the use of the new type of plastic. The study takes into account the following variables: individual characteristics (gender, age and country), information (about raw material, advantages of bio plastic), knowledge (use of plastic in production processes, recycling) and ways to promote bio plastic and workers' needs. Based on the data obtained, it was possible to create a cross model for industrial workers regarding bio degradable plastic. Workers would prefer to be informed about new trends in the industry in our case about bio plastic. The cross model for workers' awareness obtains the biggest value showing the direct relation with needs of information about the new bio plastic and waste plastic. The article presents some solutions taken in different countries by organizations with reference to the new bio plastic.

**Keywords:** management change, plastic waste, recycle, bio degradable plastic

## 1 INTRODUCTION

Sustainable development has a determining component relating to environmental issues that represent one of the Union's horizontal policies European. That is why, in the documents negotiated by Romania with the Union European

with a view to accession, an independent place was occupied by Chapter 22 "Environmental protection", and within it the "Waste" position stood out. <https://casetext.com/statute/west-virginia-code/chapter-22-environmental-resources>

Countries has committed itselfs to reduce substantially in a period of 15 years quantities of waste, to implement the necessary systems for collection, recycling and revalorization, but also those of future protection of the environment and a the population against pollution. Alignment with European standards is a priority and a necessity.

After a sharp decline in the first half of 2020 due to Covid-19, production plastic recovered in the second half of the year and with that came plastic waste.

The main problems that complicate the recycling of plastic are the quality and price of the recycled product, compared to the original plastic. Because plastics are easily adaptable to the functional or aesthetic needs of each manufacturer, the diversity of the raw material complicates the recycling process, making it expensive and affecting the quality of the final product.

We learn more about the EU's plans to reach a circular economy by 2050, including by reducing the amount of plastic. The EU is already taking steps to reduce the amount of plastic waste. But how can we increase the rate of plastic recycling?

The legacy caused by an industrialization policy that aimed only at results, without taking into account the consequences is very difficult. It will take some time soon to repair and build a frame on the fly economic and social according to Union norms. Interest is growing in "green" businesses, which will become among the most profitable in the future.

There are already models of such businesses. The buyer of electrical or electronic equipment pays the green tax, a visible tax, different from one product to another, passed on by the retailer to the manufacturer for him to hand it over for management collective organizations responsible for the transport and processing of waste. Almost a third of plastic waste is recycled in Europe (<https://geeky.news/how-does-the-plastic->

recycling-process-work/). Plastic production has grown exponentially worldwide in just a few decades, from 1.5 million tons in 1950 to 359 million tons in 2018.

Sustainable development requires improving human well-being, but the consequences of climate change and the growing demand for energy and resources make this goal more difficult. By recycling we not only protect the environment and resources for future generations, but also reduce energy consumption and greenhouse gas emissions.

A product or material is sustainable if it is also sustainable from an ecological, economic and social point of view. Plastics make a huge contribution to environmental sustainability in Peano (2019) opinion through their energy saving potential and intrinsic recycling and energy recovery options.

From economic point of view, plastics are an important part of the economy. Socially, the plastics industry is a major and inclusive employer with a focus on training and education. Plastic materials have a very good ecological profile and consequently, plastic can be seen as a "borrow" of oil.

### *1.1 Circular economy for waste plastic*

Researchers Flynn et al (2019), Ávila-Gutiérrez et al (2019) and Jang et al (2020) pay attention to circular economy and later by Rosenboom et al (2022).

Oguge et al (2021), Maitlo et al (2022) investigate the knowledge and attitudes towards plastic pollution taking in consideration that the circular economy will help to reduce waste and keep materials in the economy. Ávila-Gutiérrez et al (2019) sustain the importance of new circular economy 4.0 but Bolla et al (2021) and Flynn et al (2019) present also the importance of standards in new circular economy for each country. Rosenboom et al (2022) mention the importance of bioplastic for circular economy, as a matter of fact the research study apply for industrial workers' attitude and awarress for environment

and plastic knowledge is trying to measure the level of information they have already, to examine whether their role as responsible consumer and their attitudes toward the plastic products and their perception to bio plastic.

The actions specific to the circular economy for plastic are:

- 1- Removal of plastic objects;
- 2- Innovation of plastic materials and their reuse, recycling or compost ability;
- 3- Circulation of plastic articles in the economy and outside the environment.

The concept offers a circular process of inputs and outputs to ensure materials and resources remain in the production and consumption process. A very large percentage of abandoned waste is plastic, glass and metal beverage packaging waste. They should enter the packaging waste recycling process to increase the reuse of raw materials and conserve our limited natural resources.

There are three pillars on which sustainability can be realized and bring a positive contribution for new bio material to be sustainable: environmentally, economically and socially sustainable presented in Figure 1.

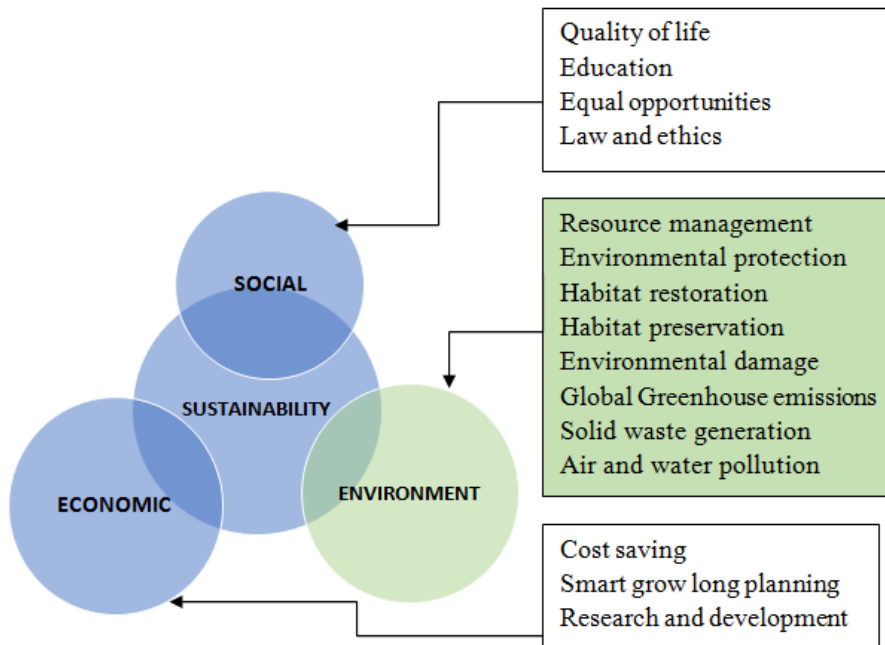


Figure 1. Relation between sustainability components

On technological process they are using raw material and inform them about the importance of bio plastic and regarding recycling process. Students who major in environmental sciences have a higher score than students in social sciences, the differences in major's significantly different behaviors to reduce the use of plastic,

where students majoring in environmental sciences have a better behavior to reduce the use of plastic in everyday life than social science students.

Chin et al. (2023), also studies the knowledge, the attitude towards plastic pollution, but also focuses on another factor,

namely the practices regarding the minimization of plastic pollution. There are other methods of reducing plastic use and pollution, by increasing environmental awareness, formal and informal education and providing recycling facilities in nearby communities.

Wang et al (2020) and Shen et al(2020) create a model taking in consideration attitudes and behavioral intentions regarding the environmental.

Faize and Akhtar (2019), identify also the environmental knowledge and environmental attitude in undergraduate students. We can mention the researchers Maurer and Bogner (2019) and Liu, et al (2020) which were modeling environment from environmental knowledge, values and behavior point of view.

Adeniran and Shakantu (2022) instead studied the health and environmental impacts of plastic waste disposal in cities about the negative environment and the health effects of plastic. These behaviors after Kahn (2019) were manifested in purchasing products with plastic packaging, preparing shopping bags, reusing plastic bags, taking your own lunch box and having food on sites to reduce single-use plastic packaging. This study also found the positive

correlation between environmental knowledge of plastic waste and plastic waste reduction behavior in daily life.

Abu Jadayil et al (2020) and Adeniran and Shakantu, (2022) were focused on plastic waste and the serious effect on the environment and sustainable development and ecological initiatives. The present research undertook an empirical investigation of plastic waste issues, environmental concerns and various mitigation initiatives. He further investigated the waste management system using closed loop recycling.

The circular economy concept Figure 2, offers an alternative to the current linear: take, make, use, dispose model of the economy and aims to keep resources in use as long as possible, to extract maximum value from them and to recover and regenerate products and end-of-life materials.

The circular economy for plastics considers every stage of a product's life cycle. Circulation of plastic articles in the economy and outside the environment. Oguge et al. (2021) investigated peoples' knowledge and attitudes towards plastic waste, and the results highlighted the need for awareness campaigns regarding plastic recycling.

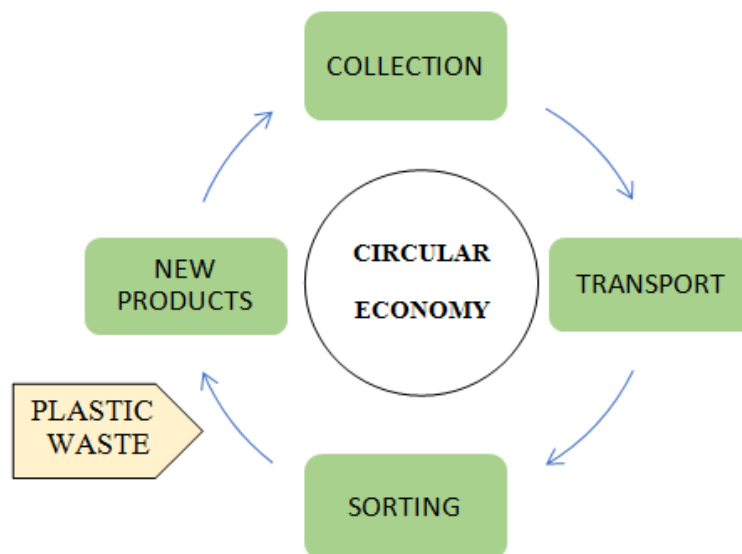


Figure 2. The connection between circular economy and plastic waste

Taking into account the studies carried out about the behavior, attitude, knowledge and needs of peoples or citizens regarding plastic waste, for this study, we chose a new research variable, namely the awareness of industrial workers in technological processes.

Workers are open to renew the product and technological process because they now the new way to Industry 4.0 and also the new Quality 4.0 on a global market. The study is trying to identify workers knowledge's, needs and awareness regarding the waste plastic.

## 2 CASE STUDY

The final research of that study was to create A Cross Cultural Model a bridge between countries in our case Turkey, Romania, Finland and Italy establish the common elements, the behavior and attitude of industrial workers regarding the importance of bio degradable plastic.

Other target were to establish industrial workers' awarrens and attitude upon plastic, recycling and bio plastic knowledge's can influence the sustainable environment.

A number of 271 respondents, from different countries participate through face-to-face interviews and online survey which was applied between June -July 2022. The studies carried out up regarding plastic waste have been carried out in different fields, but the approach

of industry personnel has been researched less for example industrial workers.

The statistical instruments used for data base were SPSS software package and Smart PLS program.

The survey was structured in four parts:

Part1: The first part investigated individual characteristics of the respondents (gender, age, education and country culture);

Part 2: The second part was structured to identify their participation in different activities regarding plastic recycling;

Part 3: The third part of survey identify respondents knowledge, needs and awareness about bio degradable plastic in technological process.

Part 4: The last part of survey was created to identify the way of promotion of bioplastic.

The items from Part 2 are presented below, the workers had the opportunity to select for part 2 one of the options 'Yes', 'No "or 'Sometimes'.

For Part 3. to measure the workers' knowledges a Likert-scale-were used ranging from 1 -5, where 1 represent "I totally disagree' to 5 which represent 'Very much agree".

Part 4 was created to identify how industrial workers prefer to obtain the informations and to promote bio plastic in organisations.

They select the favorite way and method to improve their knowledge and needs of information.

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### **PART 2. Industrial workers knowledge's about bio plastic use in organization technological process**

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Studies/researches/actions are carried out in our company to reduce the amount of waste.

We prefer to use bio plastic raw materials, even if they are expensive.

We are sensitive to the recycling (batteries, paper, etc.) wastes generated during the pr6oduction process.

We are sensitive to the recycling of waste materials in our industry and other existing facilities.

We use recycled waste raw materials in the production of suitable products.

The products in our company are produced in accordance with special recycling guidelines according to quality standards.

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**PART 3. Bio plastics being biodegradable provide many conveniences to industrialists.**

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We make enough efforts to use bio plastic products in production.

There is no issue in the production process of bio plastic products.

We are ready to cooperate with local governments to promote the use of bio plastic products.

Equipped/well-trained personnel are required for the production of products from bio plastic raw materials.

Customers' expectations about the product make it difficult for us to use bio plastic raw materials.

The use of bio plastic materials in products is not among the first requests of customers.

Some of the equipment in production is not suitable for the use of bio plastic raw materials

There is not enough research on determining the lifespan of products obtained from bio plastic raw materials.

Government incentives are needed for the use of bio plastic raw materials in the production.

Government policies should be developed to inform the public about bio plastic products.

The cost of bio plastic raw materials is high.

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**PART 4. Which of the following options would you recommend to promote the use of bio plastic products?**

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- a. Billboards should have awareness raising articles.
  - b. There should be lessons in schools regarding bio plastic products.
  - c. Television programs should be made.
  - d. Local governments should carry out information activities.
  - e. Courses should be opened in the relevant departments of universities on bio plastic products.
  - f. Social responsibility projects should be developed with students.
  - g. Conferences with broad participation should be organized.
  - h. Manufacturers should be informed about bio plastic products.
  - i. Public service announcements about bio plastic products should be prepared.
  - j. The benefits of bio plastic products should be emphasized in advertisements.
  - k. Industry-University joint projects should be carried out.
  - l. Other (Please write.) .....
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### 3 RESEARCH METHODOLOGY

Using the same survey in all countries in same period it was possible to establish a Cross Model for workers from different countries and identify the common and the differences between their awareness, needs and behavior regarding biodegradable plastic in their work activities.

To determine the dimensions of worker’s knowledge and identify their needs, their culture education about bio products and bio degradable plastic an Explanatory Factor Analysis (EFA) is applied to the data set.

By independent samples *t* test, the hypotheses were tested using the SPSS statistical analyses software. In this study, the following factors were taken into consideration: individual characteristics (country as culture), worker’s needs, workers knowledge and participation in environment and awareness regarding biodegradable plastic.

A Ringle et al (2015) Smart PLS program was used to establish the connection and correlation between variable and model solution it is presented in Figure 3.

Workers awareness, knowledge and needs are not affected by culture or country, the plastic problem it is similar all over the world.

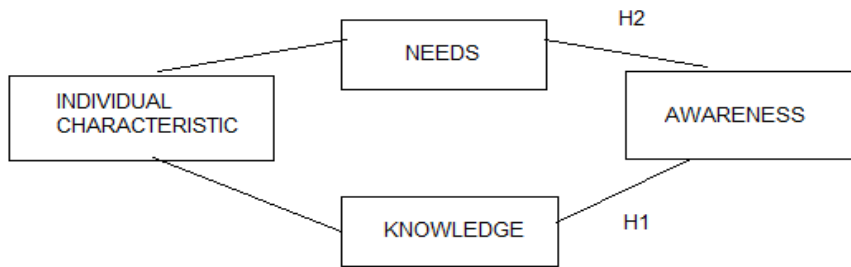


Figure 3. Research model

Because of that the study propose was to create a cross model for industrial workers taking in consideration only workers needs N1, N2,N3, N4 and N5 questions), Knowledge (K1, K2 and K3 questions ) and awareness (A1, A2,A3, and A4 questions).

Hypothesis for the model are:

H<sub>1</sub>: *Worker awareness towards plastic waste effect their Knowledge.*

H<sub>2</sub>: *Worker awareness towards plastic waste effect their Need.*

The Cronbach’s coefficient obtain has a value of 0.733 that’s mean the data are available, and model can be realised.

|           |   |
|-----------|---|
| <b>K1</b> | Bio plastics being biodegradable provide many conveniences to industrialists.                               |
| <b>A1</b> | We make enough efforts to use bio plastic products in production.   |
| <b>N1</b> | There is no issue in the production process of bio plastic products.  |
| <b>N2</b> | We are ready to cooperate with local governments to promote the use of bio plastic products.                |
| <b>K2</b> | Equipped/well-trained personnel are required for the production of products from bio plastic raw materials. |

|           |  |
|-----------|--|
| <b>A2</b> | Customers' expectations about the product (impact strength, chemical stability, high dimensional stability, etc.) make it difficult for us to use bio plastic raw materials. |
| <b>N4</b> | The use of bio plastic materials in products is not among the first requests of customers.   |
| <b>N5</b> | Some of the equipment in production is not suitable for the use of bio plastic raw materials   |
| <b>N3</b> | There is not enough research on determining the lifespan of products obtained from bio plastic raw materials.  |
| <b>A3</b> | Government incentives are needed for the use of bio plastic raw materials in the production.   |
| <b>A4</b> | Government policies should be developed to inform the public about bio plastic products.   |
| <b>K3</b> | The cost of bio plastic raw materials is high.   |

## 4 RESULTS

### 4.1 Individual characteristics

Because the target was to create a cross cultural model regarding the bio plastic importance and necessity the first part of survey identifies few individual characteristics like country and gender like in Table 1.

Table 1. Country culture

|         | Frequency | %     | Valid % | Cumulative % |
|---------|-----------|-------|---------|--------------|
| Romania | 206       | 76,0  | 76,0    | 76,0         |
| Turkey  | 14        | 5,2   | 5,2     | 81,2         |
| Italy   | 21        | 7,7   | 7,7     | 88,9         |
| Finland | 30        | 11,1  | 11,1    | 100,0        |
| Total   | 271       | 100,0 | 100,0   |              |

Majority of respondents are female 60.5% and 38.7 % male, from all four countries which are more open to the subject in our case plastic and replacement with bio plastic.

The biggest value for female from Romania, Italy, Turkey and Finland, confirm once again that they are sensitive to recycle waste, to 3R's which is important for industry and to reuse of materials in production.

76 % percent from respondents are from Romania, 5.2% from Turkey, 7.7 % from Italy and 11.1 % from Finland.

When we create the cross model of workers regarding the bio plastic we will not take in consideration the country as a variable.

### 4.2 Industrial workers knowledges about bioplastic in technological process

The second part of survey was created to identify the knowledge's of workers involved in industrial technological process where it is used plastic and also the relation with customers and replacement of raw materials in process. Table 2 present the results obtain about the worker's knowledge about the plastic phenomena in Turkey, Romania, Italy and Finland.

Table 2. Knowledge's that petrol product plastics take a long time to decompose in nature?

|                     | Frequency | %     | Valid % | Cumulative % |
|---------------------|-----------|-------|---------|--------------|
| Yes                 | 227       | 83,8  | 83,8    | 83,8         |
| No                  | 29        | 10,7  | 10,7    | 94,5         |
| I am not interested | 15        | 5,5   | 5,5     | 100,0        |
| Total               | 271       | 100,0 | 100,0   |              |

A percent of 83.8 % from respondents know the importance of bio plastic, especially because they are working in the field and they depend of the market demand, because of petrol on global market.

A low percent of workers are not interested or they don't have any idea about the plastic problem, maybe because they are focus in their job and routine.

From Table 3 we can observed that a percent of 49,1 % of respondents are agree and totally agree with the new advantages of using



bio plastic in technological process, which can have a positive impact in future taking in consideration that plastic remain a problem which is not resolve yet. A percent of 19.2 % are

reluctant because the novelty and innovation requires extra training and information and they are not willing to readjust to the new trends.

Table 3. Bio plastics being biodegradable offer many advantages to industrialists.

|                    | Frequency | %     | Valid % | Cumulative % |
|--------------------|-----------|-------|---------|--------------|
| I totally disagree | 19        | 7,0   | 7,0     | 7,0          |
| I disagree         | 33        | 12,2  | 12,2    | 19,2         |
| Somewhat agree     | 86        | 31,7  | 31,7    | 50,9         |
| I agree            | 66        | 24,4  | 24,4    | 75,3         |
| Very much agree    | 67        | 24,7  | 24,7    | 100,0        |
| Total              | 271       | 100,0 | 100,0   |              |

From Table 4 show that workers know if they are using or not bio plastic. It seems that a law percent of 17.3 % are using only bio plastic in their production. An equal percent of 41.7 % only in some part of production and 41% percent are not using the new bio plastic.

We can see that they are very well informed about the plastic issue and in conclusion there are no borders for information and knowledge. The phenomenon is known to be faced both in the production stage and technological process as well as materials. (Table 5)

Table 4. Do you use bio plastics in your productions?

|       | Frequency | %     | Valid % | Cumulative % |
|-------|-----------|-------|---------|--------------|
| Yes   | 136       | 50,2  | 50,2    | 50,2         |
| No    | 135       | 49,8  | 49,8    | 100,0        |
| Total | 271       | 100,0 | 100,0   |              |

Table 5. What is your use of bio plastic products in the production process?

|  | Frequency | %     | Valid % | Cumulative % |
|--|-----------|-------|---------|--------------|
| We use only bio plastic raw materials in our production.         | 47        | 17,3  | 17,3    | 17,3         |
| We use bio plastic raw materials in some parts of the production | 113       | 41,7  | 41,7    | 59,0         |
| We do not use bio plastic raw materials in the production.       | 111       | 41,0  | 41,0    | 100,0        |
| Total  | 271       | 100,0 | 100,0   |              |

Regarding also about the worker's information and knowledge's in field in Table 5 we present the workshops to inform people about answers to the items about using of bio plastic in the production process.

Table 6. We are sensitive to waste recycling in our industry and in other existing units.

|       | Frequency | %     | Valid % | Cumulative % |
|-------|-----------|-------|---------|--------------|
| Yes   | 203       | 74,9  | 74,9    | 74,9         |
| No    | 68        | 25,1  | 25,1    | 100,0        |
| Total | 271       | 100,0 | 100,0   |              |

From Table 6 we can observe that in each organization workers are involved in their activities and have information about the importance of the waste and recycling, behavior upon environment because the phenomena affect their job. For 74.9 % respondents the

waste and recycling subject in industry it is important. 25.1 % percent of industrial workers are not sensitive to waste recycling in the process where they are involved.

As we know from total quality management it is important to involve also the workers in organization system because only together they are a complex system which guarantees the life cycle. (Table7).

41.7 % from respondent's part of the production because they are not interested. The people are involved in the technological process and manufacture products in all countries and 50.2 % percent from respondents they know that they are using bio plastic in the production process.

19.2 % percent from workers agree with the advantages of new material used in industrial process so companies from all countries can guarantee environment quality and protection.

Table 7. Bio plastics being biodegradable offer many advantages to industrialists

|       | Frequency          | %     | Valid % | Cumulative % |
|-------|--------------------|-------|---------|--------------|
| Valid | I totally disagree | 19    | 7,0     | 7,0          |
|       | I disagree         | 33    | 12,2    | 19,2         |
|       | Somewhat           | 86    | 31,7    | 50,9         |
|       | I agree            | 66    | 24,4    | 75,3         |
|       | Very much          | 67    | 24,7    | 100,0        |
| Total | 271                | 100,0 | 100,0   |              |

### 4.3 Workers perception regarding the bio plastic

The new strategies may reduce public debate in the short term and give the impression of high activity, but it is not effective in the interests of the environment and sustainable development. The plastics strategy is a key element in Europe's transition to a circular and carbon-neutral economy.

It will help achieve the 2030 sustainable development goals, the goals of the Paris Agreement on climate change and the EU's industrial policy goals.

In Table 8 we can see that 58 % from respondents know that they need sustain and help from state to implement the new bio degradable plastic trend in industry and in our daily life.

Table 8. We are ready to cooperate with local governments to promote the use of bio plastic products

|       | Frequency          | %   | Valid % | Cumulative % |
|-------|--------------------|-----|---------|--------------|
| Valid | I totally disagree | 17  | 6,3     | 6,3          |
|       | I disagree         | 22  | 8,1     | 14,4         |
|       | Somewhat           | 84  | 31,0    | 45,4         |
|       | I agree            | 58  | 21,4    | 66,8         |
|       | Very much          | 90  | 33,2    | 100,0        |
|       | Total              | 271 | 100,0   | 100,0        |

Also respondents from all countries national government must to come with new laws and rules to protect the organization new orientation and to encourage the investment in new technology and used of bio plastic raw materials. 14.4 % from industry worker are thinking that it is not necessary the implication of government in implementation of innovating in production. And the outsiders in 31 % they don't have any opinion.

In Table 9 a maximum value of 56.8 % from respondents considers that government implication in dissemination of new material it is beneficial for production organization.

Only 15.8 % percent consider that involving the government it is beneficial for organization. Again same percent of 28.4 % of outsiders who are just watching not involving.

Table 9. Government policies should be developed to inform the public about bio plastic products.

|                    | Frequency | %     | Valid % | Cumulative % |
|--------------------|-----------|-------|---------|--------------|
| I totally disagree | 12        | 4,4   | 4,4     | 4,4          |
| I disagree         | 31        | 11,4  | 11,4    | 15,9         |
| Somewhat agree     | 77        | 28,4  | 28,4    | 44,3         |
| I agree            | 66        | 24,4  | 24,4    | 68,6         |
| Very much agree    | 85        | 31,4  | 31,4    | 100,0        |
| Total              | 271       | 100,0 | 100,0   |              |

#### 4.4 Workers opinion about impact of bio plastic cost

The obtained result was predictable because the novelty always has a strong impact on consumers and users, but with the increase in demand the price will become acceptable (Table 10.).

Table 10. The cost of bio plastic raw materials is high

|                    | Frequency | %     | Valid % | Cumulative % |
|--------------------|-----------|-------|---------|--------------|
| I totally disagree | 18        | 6,6   | 6,6     | 6,6          |
| I disagree         | 32        | 11,8  | 11,8    | 18,5         |
| Somewhat agree     | 82        | 30,3  | 30,3    | 48,7         |
| I agree            | 70        | 25,8  | 25,8    | 74,5         |
| Very much agree    | 69        | 25,5  | 25,5    | 100,0        |
| Total              | 271       | 100,0 | 100,0   |              |

#### 4.5 Industrial worker suggestion to promote bio plastic

The workers were asked to select from the answer options provided by the questionnaire which is their preferred option in the removal of bio plastic products,

For 51.3% percent from workers' costs of raw material reflect the added value and in time will be decreasing and a segment of 18.4 % are total disagree and disagree with the high cost because will affect the people perception and behavior.

Same opinion was share by Maitlo et al (2022), who mention that educational institutions and public places are suitable environments for holding sessions on the importance of plastic waste and environment protection. Schools and universities are important pillars in people education, that's why the reason that industrial workers suggest the cooperation with universities for the promotion of new materials or techniques.

Also, the role of universities as nurseries for future employees and trailblazers was agreed only by 33.9 % from industrial employees (Table 11).

From Table 12 a 52.8% percent from respondents gives a positive feedback to billboards as source information, schools and universities for lectures, courses, trainings and

create a virtual world as environment for practical exercises.

Table 11. University joint projects should be carried out

|         | Frequency | %     | Valid % | Cumulative % |
|---------|-----------|-------|---------|--------------|
| I agree | 92        | 33,9  | 33,9    | 33,9         |
| No idea | 179       | 66,1  | 66,1    | 100,0        |
| Total   | 271       | 100,0 | 100,0   |              |

Table 12. Billboards should have awareness raising articles

|         | Frequency | %     | Valid % | Cumulative % |
|---------|-----------|-------|---------|--------------|
| I agree | 143       | 52,8  | 52,8    | 52,8         |
| No idea | 128       | 47,2  | 47,2    | 100,0        |
| Total   | 271       | 100,0 | 100,0   |              |

A method used by companies is the specialization and participation in trainings of the staff employed in order to present the latest news in the field was approved by 28.4% percent from industrial workers (Table 13).

Table 13. Conferences with broad participation should be organized.

|         | Frequency | %     | Valid % | Cumulative % |
|---------|-----------|-------|---------|--------------|
| Agree   | 77        | 28,4  | 28,5    | 28,5         |
| No idea | 194       | 71,6  | 71,5    | 100,0        |
| Total   | 271       | 100,0 |         |              |

In Table 14 a 62.7 % percent from respondents they don't know if television can be used as a tool for information the other segment in 37.3 % percent.

Table 14. Television programs should be made.

|         | Frequency | %     | Valid % | Cumulative % |
|---------|-----------|-------|---------|--------------|
| Agree   | 101       | 37,3  | 37,3    | 37,3         |
| No idea | 170       | 62,7  | 62,7    | 100,0        |
| Total   | 271       | 100,0 | 100,0   |              |

They consider that television advertising and promotion of specific program can educate people.

According to the opinion of the workers from the four countries, the presentation and support of lectures on different topics was obtained in our case about bio plastic case with a maximum score of case about bio plastic with a maximum score of 53.9%,

We can observe that the country and gender cannot influence the behavior and attitude of importance of replacement of plastic from our life.

A vital, acute problem of our society is given by the abandonment of waste in public spaces (littering), from where it ends up in the soil or in educate people water courses.

## 5 A MODEL FOR INDUSTRIAL WORKERS REGARDING BIOPLASTIC

To create the model we take in consideration the answers of the 271 respondents from industrial activities, small and medium organizations and individual from Turkey, Romania, Finland and Italy.

We didn't take in consideration the country because the respondents numbers are in different from a country to another, for that reason we select only respondents needs, their knowledge and awareness regarding the plastic waste.

The cross model for industrial workers it is presented in Figure 4.

The model for industrial workers presents a good connection between needs and awareness with a value of 0.507 which present workers open to new and which understand the needs of transfer from plastic to bio plastic.

The variables for industrial workers it is presented below.

|           |           |       |         |
|-----------|-----------|-------|---------|
| Knowledge | Awareness | 0.399 | minimum |
| Needs     | Awareness | 0.507 | maximum |

The low value of 0.399 was obtained for industrial workers between knowledge and awareness which show a need for trainings and novelty in manufacturing process.

To sustain the final conclusions we present the following results:

a) For variable need for item N3 *"There is not enough research on determining the lifespan of products obtained from bioplastic raw materials"* was obtain a low value of 0.719 which give us a general view of employers need in organization, to be able to create a good work environment.

b) For variable awareness for item A2 *"Customers' expectations about the product (impact strength, chemical stability, high dimensional stability, etc.) make it difficult for us to use bioplastic raw materials"* we obtain the biggest value of 0.819 as a provocation in future to maintain customer in center of organization and their needs.

c) For variable awareness for item A1 *"We make enough efforts to use bioplastic products in production"* we obtain the lowest value of 0.273 which it is a signal that the process need a continuous improvement regarding the transfer from plastic to bio plastic.

d) For variable knowledge for item K1 *"Bio plastics being biodegradable provides many conveniences to industrialists."* a low value of 0.314 measure the pulse in organization about the bio plastic benefits.

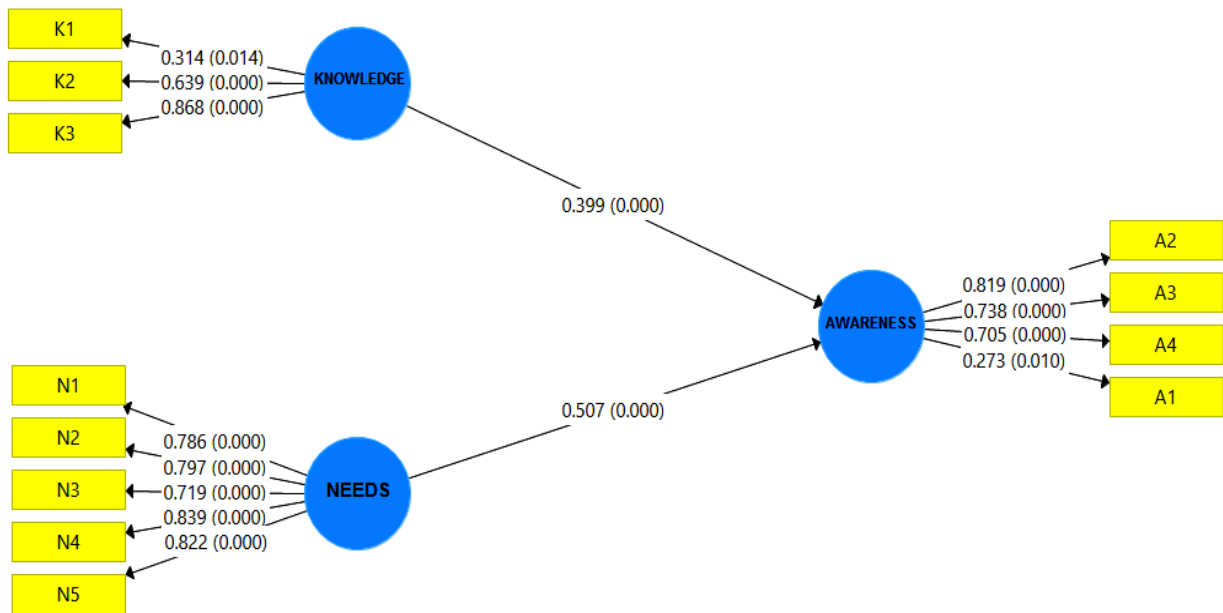


Figure 4. A Cross Model for Industrial workers regarding bio plastic

## 6 DISCUSSIONS

The study involves industrial workers from different specialist fields in different countries. Harmonization with environmental protection and the implementation of new biodegradable plastic is seen a little differently.

The results show a changing attitude when talking about plastic and plastic waste and especially recycling. Some organizations have found solutions depending on the field of production. One solution that can be used is computer vision, where the system is used in plastics production to check products and parts for certain characteristics. Also, the life cycle of the designed products is taken into account in the design phase, taking into account their recycling at the end of the life cycle.

The pandemic has led to an increase in plastic waste, so the manufacturing of medical products and the identification of innovative solutions that have plastic elements as components must also be mentioned. Another

challenge of the plastic waste stream is for businesses or commercial producers. In addition to industrial producers and those in the consumer goods industry, they are also taking measures to reduce plastic consumption or reduce pollution, but for the entire road are arduous and long.

Organizations in the industrial field are already investing in environmental protection. The new bio plastic also came with a series of new possibilities in the world of plastic material production that allows the creation of stronger and more aesthetic parts and the addition of a product's function. The most important solution is the low production cost using the new biodegradable or bio plastic material. Therefore, the importance of technological capability in plastics manufacturing should not be neglected, as it plays a key role in the quality, price and production speed of plastic products. Although all the big players in the consumer goods industry are taking steps to reduce plastic consumption or reduce pollution, it is clear that

the road is long and the journey is only just beginning.

The shift towards a circular economy in which plastics never become waste while creating economic opportunities appears to be an effective strategy for starting to tackle the problem of plastic litter. The conceptualization and practice of circular economy has so far largely been undertaken by academics, policy makers, businesses and foundations, while the implementation remains inadequate.

We can observe the new model for reuse in circular economy in Figure 5.

The four reuse models apply for plastic are promoting the use of renewable and recyclable alternatives to plastics:

1-refill at workplace users refill their reusable containers at work;

2-return from workplace - packaging is picked up from work by a pickup service;

3-refill on and go - users refill their reusable containers away from workplace;

4-return on and go - users return the packaging at a deposit or drop off point.



Figure 5. The 4 Reuse model in circular economy

Circular economy solutions for plastics should focus on the elimination of single-use plastics and the efficient management of long-

life plastics such as those used in vehicles and construction.

Circular economy solutions for plastics include:

- ✓ Using plastic waste as a resource;
- ✓ Designing non-toxic degradable alternatives to single-use plastic;
- ✓ Encouraging recycling;
- ✓ Adoption of new and sustainable business models;
- ✓ Development of information platforms to help circular solutions

Where waste management is not developed and implemented, it is often the poorest people that bear the greatest cost of plastic pollution and environmental degradation. Where government and business have not taken the necessary actions, local communities and grassroots organizations have often initiated their own small-scale circular economy initiatives in order to reduce the impacts of plastic litter on their environment and to relieve the pressure on local ecosystems and services.

## 7 CONCLUSIONS

Using the information from the presented case study we were able to identify:

- culture or country can not influence the workers knowledge and needs;
- staff needs and industrial workers' needs;
- workers desire for continuous training and specialization in new methods;
- finding innovative solutions for production processes;
- new technologies are a key step towards big gains in plastics recycling.
- the role of universities in training and research activities;
- the necessity of cooperation between organisation and universities.

Also the cross model present the connection between workers needs and awareness and between awareness and knowledge.

Regardless of the country, industrial companies invest massively in environmental protection, by using technologies that save fuel and energy, or by reducing pollution and waste.

The cross model can be used by any organisation to identify the workers needs and their knowledges about the production, technological process and materials used.

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### BIBLIOGRAPHY

- Abu Jadayil, W.; Qureshi, M.R.N.M.; Ajaj, R.; Aqil, E.; Shawahin, G.; Anver, H.; Aljeawi, S. An Empirical Investigation on Plastic Waste Issues and Plastic Disposal Strategies to Protect the Environment: A UAE Perspective. *Sustainability* 2022, *14*, 16719.
- Adeniran, A.A.; Shakantu, W. The Health and Environmental Impact of Plastic Waste Disposal in South African Townships: A Review. *Int. J. Environ. Res. Public Health* 2022, *19*, 779.
- Ávila-Gutiérrez, M.J.; Martín-Gómez, A.; Aguayo-González, F.; Córdoba-Roldán, A. Standardization framework for sustainability from circular economy 4.0. *Sustainability* 2019, *11*, 6490.
- Bolla, R.; Abdelkafi, N. *Understanding ICT Standardization-Principles and Practice*; Tredition: Hamburg, Germany, 2021.
- Coco Chin, K.K.; Mahanta, J.; Nath, T.K. Knowledge, Attitude, and Practices toward Plastic Pollution among Malaysians: Implications for Minimizing Plastic Use and Pollution. *Sustainability* 2023, *15*, 1164.
- Faize, F.A.; Akhtar, M. Addressing environmental knowledge and environmental attitude in undergraduate students through scientific argumentation. *J. Clean. Prod.* 2019, *252*, 119928.
- Flynn, A.; Hacking, N.; Xie, L. Governance of the circular economy: A comparative examination of the use of standards by China and the United Kingdom. *Environ. Innov. Soc. Transit.* 2019, *33*, 282–300.
- Jang, Y.C.; Lee, G.; Kwon, Y.; Lim, J.H.; Jeong, J.H. Recycling and management practices of plastic packaging waste towards a circular economy in South Korea. *Res. Conserv. Recycl.* 2020, *158*, 104798.
- Khan, F.; Ahmed, W.; Najmi, A. Understanding consumers' behavior intentions towards dealing with the plastic waste: Perspective of a developing country. *Res. Conserv. Recycl.* 2019, *142*, 49–58.
- Liu, P.; Teng, M.; Han, C. How does environmental knowledge translate into pro-environmental behaviors? The mediating role of environmental attitudes and behavioral intentions. *Sci. Total Environ.* 2020, *728*, 138126.
- Maitlo, G.; Ali, I.; Maitlo, H.A.; Ali, S.; Unar, I.N.; Ahmad, M.B.; Bhutto, D.K.; Karmani, R.K.; Naich, S.u.R.; Sajjad, R.U.; Ali, S.; Afridi, M.N. Plastic Waste Recycling, Applications, and Future Prospects for a Sustainable Environment. *Sustainability* 2022, *14*, 11637.
- Maurer, M.; Bogner, F.X. Modelling Environmental Literacy with environmental knowledge, values and (reported) behaviour. *Stud. Educ. Eval.* 2020, *65*, 100863.
- Oguge, N.; Oremo, F.; Adhiambo, S. Investigating the Knowledge and Attitudes towards Plastic Pollution among the Youth in Nairobi, Kenya. *Soc. Sci.* 2021, *10*, 408.
- Peano, C.; Merlino, V.M.; Sottile, F.; Borra, D.; Massaglia, S. Sustainability for Food Consumers: Which Perception? *Sustainability* 2019, *11*, 5955.
- Ringle, C. M., Wende, S., and Becker, J.-M. 2015. "Smart PLS 3." Boenningstedt: Smart PLS GmbH, <http://www.Smartpls.com>.



- Rosenboom, J.-G.; Langer, R.; Traverso, G. Bioplastics for a circular economy. *Nat. Rev. Mater.* 2022, 7, 117–137
- Shen, M.; Song, B.; Zeng, G.; Zhang, Y.; Huang, W.; Wen, X.; Tang, W. Are biodegradable plastics a promising solution to solve the global plastic pollution? *Environ. Pollut.* 2020, 263, 114469.
- Wang, R.; Qi, R.; Cheng, J.; Zhu, Y.; Lu, P. The behavior and cognition of ecological civilization among Chinese university students. *J. Clean. Prod.* 2020, 243, 118464.
- <https://casetext.com/statute/west-virginia-code/chapter-22-environmental-resources>
- <https://geeky.news/how-does-the-plastic-recycling-process-work/>
- <https://www.skaza.com/blog/plasticmanufacturing/importance-of-technological-capabilityin-plastics-manufacturing>
- <https://www.europarl.europa.eu/news/ro/headlines/society/20181212STO21610/deseurile-din-plastic-si-reciclarea-in-ue-in-cifre>
- <https://www.greenpeace.org/romania/articol/4507/pe-nu-va-fi-un-viitor-nesufocat-de-plastic/>
- [https://adevarul.ro/news/societate/romania-petoreasca-vad-romanii-rosu-atunci-aud-verde-analiza-1\\_6161d5555163ec42712f6275/index.html](https://adevarul.ro/news/societate/romania-petoreasca-vad-romanii-rosu-atunci-aud-verde-analiza-1_6161d5555163ec42712f6275/index.html)
- <https://www.invisiblenature.ro/sustainability/studiu-alternativ-pentru-o-romania-fara-plastic/>
- <https://www2.deloitte.com/ro/ro/pages/tax/article/s/legea-anti-plastic-mai-bine-pentru-mediul-mai-provocator-pentru-firme.html>
- <https://www.ttonline.ro/revista/materiale-plastice/industria-europeana-a-plasticului-sperand-la-ce-e-mai-bine-pregatindu-se-pentru-ce-e-mai-rau>
- <https://scitechdaily.com/new-technology-is-key-step-toward-big-gains-in-plastics-recycling/>
- <https://www.skaza.com/blog/plastic-manufacturing/importance-of-technological-capability-in-plastics-manufacturing>