WASTE MANAGEMENT PRACTICES AND PUBLIC PERCEPTION: A CASE STUDY OF REVERSE VENDING MACHINE USABILITY IN THE PELAGONIA REGION

MONIKA ANGELOSKA – DICHOVSKA
ASSOCIATE PROFESSOR, FACULTY OF ECONOMICS – PRILEP, UNIVERSITY "ST.KLIMENT OHRIDSKI" BITOLA, REPUBLIC OF NORTH MACEDONIA
e-mail: monika.angeloska@uklo.edu.mk

EMILIJA GJORGJIOSKA
ASSOCIATE PROFESSOR, FACULTY OF ECONOMICS – PRILEP, UNIVERSITY "ST.KLIMENT OHRIDSKI" BITOLA, REPUBLIC OF NORTH MACEDONIA
e-mail: emilija.mateska@uklo.edu.mk

MERI BOSHKOSKA
FULL PROFESSOR, FACULTY OF ECONOMICS – PRILEP, UNIVERSITY "ST.KLIMENT OHRIDSKI" BITOLA, REPUBLIC OF NORTH MACEDONIA
e-mail: meri.boskoska@uklo.edu.mk

MARGARITA JANESKA
FULL PROFESSOR, FACULTY OF ECONOMICS – PRILEP, UNIVERSITY "ST.KLIMENT OHRIDSKI" BITOLA, REPUBLIC OF NORTH MACEDONIA
e-mail: margarita.janeska@uklo.edu.mk

Abstract

In today's rapidly evolving world, environmental sustainability and waste management pose significant challenges. Consumer habits in many countries often lead individuals to behave irrationally, exploiting resources selfishly and egocentrically, disregarding the environmental damage caused by such actions. While many developed countries actively seek creative solutions to enhance public awareness of waste reduction, recycling, and reuse, numerous less developed countries, including the Republic of North Macedonia, are at the early stages of transitioning toward a green economy. Initial efforts are underway to shift awareness and foster sustainable waste behavior among both individuals and legal entities.

This paper aims to explore the citizens' waste behavior and challenges in the Pelagonia Region in the Republic of North Macedonia, with the goal of promoting the adoption of eco-friendly solutions, such as Reverse Vending Machines (RVM). The study also seeks to enhance awareness and promote waste management behavior through the research process and communication with the citizens.

A survey was conducted, collecting data from 842 citizens in the Pelagonia region to gain insights into their perspectives. Statistical analysis of the collected data in the SPSS software package indicates that citizens' waste sorting practices are influenced by their age and employment status. However, the citizens' information for reverse vending machines and their use does not depend on this cluster affiliation. The analyses confirm that in the Republic of North Macedonia as a developing country, efforts are still needed to raise awareness and enhance education regarding eco-sustainable practices and behaviors among the population.

Keywords: *waste management, reverse vending machines, environmental behavior, ecological citizen, Pelagonia region, sustainable economy*.

Classification JEL : *Q53, Q56, C12, K32, D12*

1. Introduction and context of the study

The daily habits and lifestyles of people have become a reflection of excessive product consumption, leading to the generation of substantial amounts of waste. Inadequate waste management poses significant challenges to pollution globally. The transition to a circular economy

not only offers an opportunity to address the triple planetary crises of pollution, climate change, and biodiversity loss but is also imperative to ensure future prosperity (Bojkovska et al., 2023).

Waste is a global issue. If not properly dealt with, waste poses a threat to public health and the environment. Waste management is one of the essential utility services underpinning society in the 21st century, particularly in urban areas. Ensuring proper sanitation and solid waste management sits alongside the provision of potable water, shelter, food, energy, transport and communications as essential to society and to the economy as a whole. Low- and middle-income countries still face major challenges in ensuring universal access to waste collection services, eliminating uncontrolled disposal and burning and moving towards environmentally sound management for all waste. Waste management practices and waste prevention could lead to a 10 to 20% reduction in global greenhouse gas emissions (UNEP, 2015).

Approximately 30% of global waste materials contribute to the rapid climate changes and continuous ecological disturbances on our planet. Among all sectors, the packaging industry, where plastics are the primary materials, represents an enormous amount of wasted material and pollution. The current global scenario is disheartening, given that many products and packaging are designed in an unrecyclable manner, often used once and then discarded. According to the European Union's report in 2018, Europe collected 29.1 million metric tons of plastic waste, with only 32% being recycled, while 7.2 million metric tons ended up in landfill sites (Nandy et al., 2022). Plastic waste accounts for approximately 10%-12% of all municipal waste worldwide and contributes to 80% of the waste found in the world's oceans, primarily entering through rivers and sewage systems (UNDP, 2023).

The OECD report reveals that the world's production of plastic waste has doubled over the past two decades, surging from 2000 to 2019 to a staggering 460 million tonnes. Unfortunately, the majority of this plastic waste finds its way into landfills, incinerated or leaked into the environment, with only a mere 9% being successfully recycled. Although 15% is collected for recycling, a significant 40% of that ends up being disposed of as residues. The remaining breakdown of plastic waste management is as follows: 19% is incinerated, 50% is disposed of in landfills, and 22% circumvents formal waste management systems, ending up in uncontrolled dumpsites, being burned in open pits, or finding its way into terrestrial and aquatic environments. This disproportionate impact is particularly pronounced in economically disadvantaged countries (OECD, 2022).

Numerous environmental issues, including air and water pollution as well as odors, stemming from waste disposal are outcomes of human actions. Consequently, the active involvement of citizens in sustainable waste management behaviors should be extensively encouraged and promoted. The waste management behaviors of citizens can significantly contribute to addressing waste management challenges by reducing the volume of solid waste and efficiently managing waste to minimize potential environmental impacts (Janmaimool, 2017). The 2030 Agenda, adopted by global leaders in 2015, emphasized the importance of public involvement, recognizing that achieving the Sustainable Development Goals (SDGs) relies on the support and engagement of the people (OECD Development Communication Network and Ibero-American General Secretariat, 2019).

The connection between citizens, waste management and circular economy lies in their roles as consumers and waste producers. Individual awareness while performing these two roles can lead to more responsible consumption and compliance with waste separation and collection schemes resulting in increased reuse and recycling (Izdebska & Knieling, 2020).

One of the innovative and environmentally friendly solutions that can impact citizens' waste management behavior is the use of reverse vending machines (RVM). Reverse vending machines (RVMs) provide a practical and eco-friendly way for citizens to return used bottles and cans, receiving certain incentives in return. These innovative machines not only facilitate the recycling process but also encourage active public participation in addressing the global issue of pollution and environmental protection. By promoting recycling and responsible waste disposal, these machines play a crucial role in advocating for a cleaner and greener planet.

As in many developing countries, waste management is a crucial and significant challenge, and in the Republic of North Macedonia, this issue is of great importance for future development. The total amount of generated municipal waste in the Republic of North Macedonia in 2022 amounted to 856,766 tons. In 2022, the annual amount of generated municipal waste per capita is 467 kg, which is 3.3% more than the annual amount in 2021 (State Statistical Office, 2023). Comparing these figures with the data from 2011, it can be observed that the amount of generated waste per capita annually in 2022 has increased by 110 kg, or almost 24% compared to 2011. From the total quantity of collected waste at the national level, as much as 85% belongs to mixed municipal waste (waste that is not sorted and contains waste belonging to different waste categories), while only 2.15% belongs to plastic waste and 0.3% to metal waste (iron, steel, and aluminum). The data on waste unfortunately show that in the country, including the Pelagonia region, waste is insufficiently sorted. In North Macedonia, the process of using Reverse Vending Machines has modestly begun; however, awareness, knowledge, and habits regarding this type of machines are still limited. This paper represents an attempt to encourage citizens' behavior in waste management.

This paper comprises both theoretical and empirical elaboration. The initial section serves as an introduction, while the second part elaborates into the concept of waste management and citizen behaviors. Following that, the third part outlines the features and functionalities of the Reverse Vending Machine. Empirical research results and discussions regarding citizens' perceptions of adopting eco-friendly practices, including habits and awareness of reverse vending machines in the Pelagonia region of the Republic of North Macedonia, are presented in the fourth part. The last section of the paper presents the conclusions and recommendations of the study.

2. Waste management concepts and citizens behavior

Waste comes in various forms, and its characterisation can be expressed through different criteria. Common characteristics utilized in waste classification encompass physical states, physical properties, reusability potential, biodegradability potential, production source, and the level of environmental impact (Demirbas, 2011; Dixon & Jones, 2005; White et al., 1995 as cited in Amasuomo & Baird, 2016). According to White et al. (1995), waste can be broadly categorized into three main types based on its physical states: liquid, solid, and gaseous waste (Amasuomo & Baird, 2016).

Household solid waste management has been and will continue to be a major issue facing countries worldwide, particularly in the cities of developing countries (Zhang et al., 2015). Waste management involves a process whereby wastes are collected, transported and disposed of in the best possible way of limiting or eliminating the harmful effect of wastes. This aspect of environmental management is as important as other public amenities or infrastructures without which the life of a contemporary man would be extremely difficult. Human interactions with the environment (human activities) have always resulted in waste production (Amasuomo & Baird, 2016).

For the successful handling and management of waste, coordination, communication, and joint action among multiple key actors are essential, involving not only institutions and organizations but also citizens. Numerous studies verify this, as households are recognized as significant contributors to waste generation.

Waste prevention has been regarded by policymakers and environmental agencies as the sustainable option to decrease the impact of waste generation. However, waste prevention is not only the result of administrative activities rather, it results from the countless choices that individuals make in their daily lives (Bortoleto, 2015). The efficiency of a waste management system depends on many factors, including residents' waste management practices and a governmental commitment to sustainable waste management (Nguyen et al., 2023). Undoubtedly, the behavior of the population and households towards waste and its segregation are crucial in the process of establishing a sustainable economy.

When global leaders adopted the 2030 Agenda in 2015, they referred to it as an agenda "of the people, by the people, and for the people." They recognized that, similar to contemporary policy goals, the achievement of the Sustainable Development Goals (SDGs) relies on public support (OECD Development Communication Network and Ibero-American General Secretariat, 2019). According to Barr, Ebreo and Vining, and Pandi household waste constitutes a significant portion of overall waste, thus understanding the predictors of household waste management behavior is crucial for behavior change (Kaplan et al., 2019).

Basu (2009) pointed out that due to the increasing volume of waste, the continuous disposal of waste to landfills is unsustainable. Hence, Basu argues that the processing of waste is a necessary step needed to safeguard public health (Amasuomo & Baird, 2016).

In the literature, various concepts of citizens' behavior towards waste treatment are encountered, all of which share the ultimate goal of preserving the environment and contributing to a sustainable economy.

The following terms are encountered in citizens' behavior: ecological behavior, environmental behavior, pro-environmental behavior, waste behavior, consumer behavior for circular economy, recycling behavior, waste separation behavior etc. However, to encourage such behavior among citizens, as emphasized by some authors, it is necessary to understand the factors that affect residents' waste separation behaviors. This understanding can aid in constructing effective environmental campaigns for a community (Zhang et al., 2015).

Several empirical studies have identified factors influencing waste handling behaviors using the theory of planned behavior. According to this theory, the following factors stand out: attitude as a major predictor of pro-environmental behavioral intention, the effectiveness of public messages from mass media in promoting green behaviors, the availability of suitable opportunities, facilities, and knowledge about recycling, behavioral control, and personal norms.

The ecological citizen is anticipated to embrace a specific set of values that form the foundation for her inclination toward pro-environmental behavior. Alternatively, following the legitimacy definition, they should at least be willing to accept new policies aligned with the environmentally protective agenda of ecological citizenship (Matti, 2008). According to European Network for Environmental Citizenship (2018) an environmental ctizenship is defined as the responsible pro-environmental behavior of citizens who act and participate in society as agents of change in the private and public sphere, on a local, national, and global scale, through individual and collective actions, in the direction of solving contemporary environmental problems, preventing the creation of new environmental problems, achieving sustainability as well as developing a healthy relationship with nature.

Waste separation behavior is defined as the process of segregating household waste into distinct disposal bags within a designated area (Wang, 2021, as cited in Zhang, 2023).

3. The Features and Functionalities of Reverse Vending Machines and their usability in the Republic of North Macedonia

RVM is a machine that accepts used plastic bottles and in return, provides the user with money in the form of coupon/vouchers or e-wallet money (Pramita et al., 2019). In 1920, Elmer M Jones and Sue Walker Vance filed a patent application for a vending machine in the United States, which was accepted and patented in November 1925 (United States Patent Office, Vending machines patent application serial No. 409.808).

However, this machine was first produced and put into operation by the Swedish company Wicanders in the late 1950s. Initially, these machines accepted only plastic but not aluminum and glass, nor did they allow the input of a larger quantity of bottles at the same time. The reverse vending machine was upgraded in 1962 by engineer Aage Tveitan, when the improved machine started accepting bottles of different materials and more bottles simultaneously (Taylor, 2021).

Further this invention was developed into a more sophisticated form that relates generally to recycling, and more particularly, to a machine for redeeming recyclable beverage containers of the type which carry optically readable information codes (United States patent, Coyne at al. Patent No. US 6,547,055 B2).

The principle of operation of the reverse vending machine involves, after taking the container, crushing, breaking, or otherwise reducing the volume of the waste and sorting it into sections according to the material specifications. Then, depending on the quantity of recycled containers, it returns money or another form of incentive to the recycler. The invention of the reverse vending machine is dedicated to the search for cost efficient, simple and space saving technology which effectively performs environmental and economical tasks (Stojanov, 2015).

Half a century later, this machine became a standard for all countries adhering to recycling and sustainability policies. Globally, the number of vending machines in use is enormous, and they are most commonly placed in public spaces, railway/bus stations, supermarkets, shopping centers, etc.

RVMs are meant to occur as promoting agents of a more virtuous recycling system by shortening the regular path envisaged by urban waste management systems. Rather they should be there appositely to mediate the interaction between recycling facilities and citizens (Giardullo, 2019). Their primary function of RVM is to mediate this interaction, thereby establishing a re-use pathway for plastic as a raw material and contributing to the development of a more sustainable waste cycle. RVMs are perceived to contribute to the circular economy, such as a more flexible and more convenient option for the citizens that represents a very crucial part of the waste management chain. This dual purpose aligns with key principles of a circular economy, promoting both a more efficient recycling process and the creation of value from waste. The monetary incentive that is provided by RVMs is strong motivation to engage the general public in recycling efforts (Amantayeva et al., 2021). "Cash for trash" is a well functioning motto for tackling litter and keeping the environment clean.

Smart reverse vending machines are improving waste management by reducing the amount of waste that goes to landfills. According to the United Nations Environmental Programme (UNEP), about 60% of the world's plastic waste ends up in landfills. As a result, this leads to significant environmental problems. Smart RVMs can sort recyclables efficiently, reducing the amount of waste that goes to landfills. Furthermore, it is estimated that smart RVMs can save up to 90% of the energy needed to recycle materials (Aco Recycling, 2023).

In the Republic of North Macedonia, this global trend of sorting through the use of reverse vending machines for collecting plastic bottles and cans was first introduced by the company Pakomak LLC Skopje. By mid-2023, Pakomak had installed a total of 28 vending machines (donated by the Swiss Embassy), mainly in the territories of the cities of Skopje and Tetovo, representing a significant step towards sustainable waste management. Through the installed RVMs, citizens sort more than 350,000 items monthly. Pakomak subsidizes the sorting and collection of plastic bottles and cans by awarding green points through the use of the mobile application Ekomak. The green points earned can be converted into vouchers that citizens can use for shopping in certain stores, paying municipal and public services, or making donations. With the use of reverse vending machines, and after the installation of an additional 28 machines, it is expected that the quantity of collected bottles and cans will increase to around 600-700,000 per month (Ivanovski, 2023).

On the other hand, according to the statistical data the amount of generated waste in the Republic of North Macedonia has increased by 3,3% compared to the 2021 and even by around 24% compared with 2011 (State Statistical Office, 2023). The statistics divided by regions shows that in Pelagonia region in 2022 were generated 90 758 tons waste, and 76 646 tons waste were collected.

Since Pelagonia region is one of the most important creators of economic development of the county, its influence is significant in terms of number of citizens, households, active commercial subjects etc. According to the fact that there is not any RVM installed there, information about

conscience, knowledge, citizens' waste management behaviors and perception of the usability of reverse vending machines are of crucial importance.

4. Research and discussion

4.1. Methodology

The primary objective of the research is to identify the awareness, habits, and tendencies regarding eco-practices among citizens (citizens environmental behavior) and their attitudes towards the use of reverse vending machines.

The research was conducted in the Pelagonia region of the Republic of North Macedonia through direct data collection using a structured, non-disguised questionnaire. The questionnaire included both closed and open-ended questions with the aim of obtaining deeper insights. The research took place during the period from 1st July to 1st August 2023.

To achieve the research objective, a questionnaire was designed, consisting of three parts. The first part included questions related to the general characteristics of the respondents. The second set of questions was designed to identify the current eco-practices of the respondents. The third set of questions was conceived to gather data on the respondents' perceptions of the use of reverse vending machines and whether they were familiar with how they function. The research was conducted electronically and included 842 respondents. The collected data were analyzed using survey administration software - Google Forms and SPSS software package. The hypotheses were tested using the non-parametric Chi-square test, with the significance of results set at a 5% risk or a confidence level of 95% in statistical inference.

This problem is for the first time subject of analysis in the Republic of North Macedonia and Pelagonia region. Therefore, the results and conclusions can be considered as original, positioning this paper as a pioneer in the region. With this research, our goal is to establish a foundation for further research, focusing on improving citizens' behavior as a fundamental base for enhancing public awareness of waste reduction, recycling, and reuse.

4.2. Population and sample structure

The research encompassed a total of 842 respondents, of which 32% were male and 68% were female. According to the age structure, the largest percentage of respondents, accounting for 34%, belonged to the age group of 30 to 40 years. Following this, respondents in the age range of 41 to 50 years constituted 27.4%, those in the age group of 15 to 29 years were at 20.4%, respondents aged 51 to 64 years were at 16%, and the least represented were respondents above 64 years at 2.2%.

In terms of education, the majority of respondents had completed higher education (457 or 54.28%), followed by those with completed postgraduate or doctoral studies (193 or 22.92%), individuals with secondary education (182 or 21.62%), those with primary education (6 or 0.71%), and respondents with vocational education (1 or 0.12%). There were also 3 respondents (0.36%) without formal education.

Regarding employment status, 701 respondents (83.25%) were employed, 67 (7.96%) were students, 44 (5.23%) were unemployed, 27 (3.21%) were retired, and 3 (0.36%) provided responses classified as "other."

In relation to waste sorting practices, 48% of the respondents indicated that they regularly engage in waste sorting, while the remaining respondents stated that they sometimes or never participate in waste sorting.

From the research, it can be concluded that although 66% of the respondents are aware of the time required for plastic bottles to decompose, 50% of them do not engage in waste separation.

The data analysis from the research confirms that environmental behavior among citizens can be encouraged through targeted initiatives and incentives. Specifically, from Figure 1, it can be

observed that 89% (452 respondents) confirm that they would engage in more waste sorting if they were to receive certain incentives for doing so.

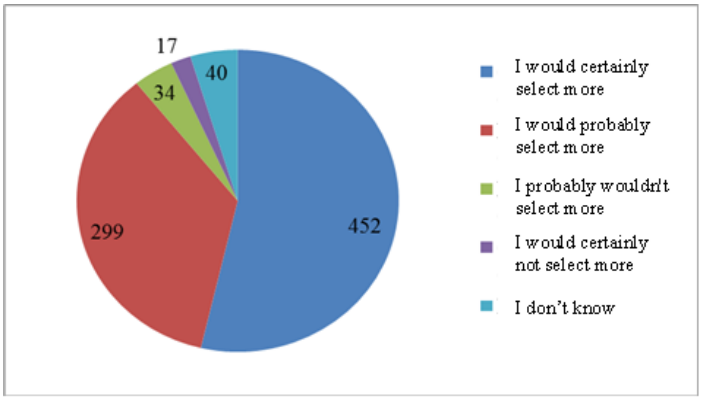


Figure 1. Interest in citizens environmental behavior as a result of incentives

In the third section of the survey questionnaire, it can be observed that approximately 69% of respondents have heard or seen somewhere installed machines for collecting used plastic bottles and cans. About 94.4% of respondents indicated that they would use such machines if they were installed in their city.

Regarding reverse vending machines and citizens' awareness of their functioning, half of the respondents, or 52% (438), stated that they have heard and are aware of how such machines operate. On the other hand, 31% (264) of the respondents reported that they are not aware, while 17% (140) indicated that they don't know or are uncertain about the functioning of these machines (figure 2).

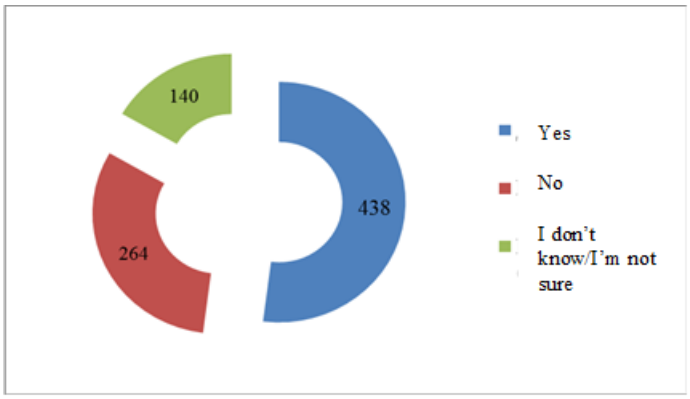
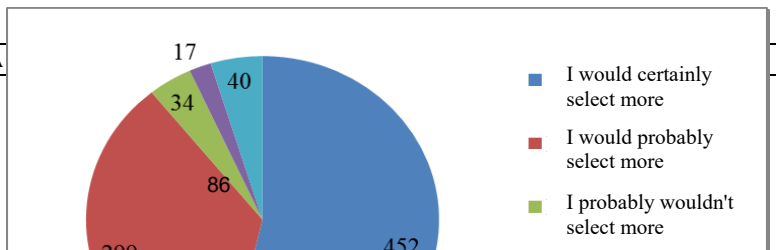


Figure 2. Awareness of the functioning of reverse vending machines

In continuation of this study, hypotheses were tested regarding citizens' waste sorting practices and awareness of reverse vending machines.

4.3. Hypothesis testing

By applying the χ^2 test in the SPSS software package, with input information and the corresponding empirical and calculated (theoretical) values of responses from respondents for each individual question (closed-ended questions from the second and third parts of the survey), in accordance with the subject and objective of the research, the following two general hypotheses were tested:



H_{01} - The waste sorting practices of citizens are not dependent on their cluster membership (age and employment status).

H_{02} - Citizens' awareness of reverse vending machines are not dependent on their cluster membership (age and employment status).

Specific hypotheses derived from the first general hypothesis are:

H_{011} - Waste sorting is not dependent on the cluster membership of citizens (age and employment status).

Subsidiary hypotheses for this specific hypothesis are:

H_{0111} - Waste sorting is not dependent on the age of citizens.

H_{0112} - Waste sorting is not dependent on the employment status of citizens.

With the analysis of the data from question 1 in the second part of the questionnaire, the following results were obtained:

Table 1. Results of subsidiary hypothesis testing H_{0111} and H_{0112}

Hypothesis	Degrees of Freedom	Alpha Error	Critical chi-square	Computed chi-square	Conclusion
H_{0111}	12	0,05	21,05	29,71	**Reject Hypothesis**
H_{0112}	15	0,05	25	5458,42	**Reject Hypothesis**

From the data in the table 1, it can be observed that all computed test values are greater than the critical values for the respective degrees of freedom. This implies that both subsidiary hypotheses are rejected, and the following conclusions can be drawn:

- Waste sorting depends on the age of citizens, and
- Waste sorting depends on the employment status of citizens.

Conclusion: The first specific hypothesis of the first general hypothesis is rejected, indicating that waste sorting is dependent on the cluster membership of citizens (age and employment status).

H_{012} - The awareness of how long it takes for plastic bottles to decompose does not depend on the cluster membership of citizens (age and employment status).

Subsidiary hypotheses for this specific hypothesis are:

H_{0121} - The awareness of how long it takes for plastic bottles to decompose does not depend on the age of citizens.

H_{0122} - The awareness of how long it takes for plastic bottles to decompose does not depend on the employment status of citizens.

With the analysis of the data from question 3 in the second part of the questionnaire, the following results were obtained:

Table 2. Results of subsidiary hypothesis testing H_{0121} and H_{0122}

Hypothesis	Degrees of Freedom	Alpha Error	Critical chi-square	Computed chi-square	Conclusion
H_{0121}	4	0,05	9,49	13,9	**Reject Hypothesis**
H_{0122}	5	0,05	11,07	77,62	**Reject Hypothesis**

From the data in the table 2, the following conclusions can be drawn:

- Awareness of how long it takes for plastic bottles to decompose depends on the age of citizens, and
- Awareness of how long it takes for plastic bottles to decompose depends on the employment status of citizens.

Conclusion: The second specific hypothesis of the first general hypothesis is rejected, indicating that awareness of how long it takes for plastic bottles to decompose depends on the cluster membership of citizens (age and employment status).

Specific hypotheses derived from the second general hypothesis are:

H_{021} - The awareness of the existence of machines for collecting used plastic bottles and cans somewhere doesn't depend on their cluster membership (age and employment status).

Subsidiary hypotheses for this specific hypothesis are:

H_{0211} - The awareness of the existence of machine for collecting used plastic bottles and cans somewhere doesn't depend on the age of citizens.

H_{0212} - The awareness of the existence of machines for collecting used plastic bottles and cans somewhere doesn't depend on the employment status of citizens.

With the analysis of the data from question 1 in the third part of the questionnaire, the following results were obtained:

Table 3. Results of subsidiary hypothesis testing H_{0211} and H_{0212}

Hypothesis	Degrees of Freedom	Alpha Error	Critical chi-square	Computed chi-square	Conclusion
H_{0211}	12	0,05	21,03	10,84	**Accepted Hypothesis**
H_{0212}	15	0,05	25	13,83	**Accepted Hypothesis**

From the data in the table 3, it can be observed that all computed test values are smaller than the critical values for the respective degrees of freedom. This implies that both subsidiary hypotheses are accepted, and the following conclusions can be drawn:

- The awareness of the existence of machines for collecting used plastic bottles and cans doesn't depend on the age of citizens, and

- The awareness of the existence of machines for collecting used plastic bottles and cans doesn't depend on the employment status of citizens.

Conclusion: The first specific hypothesis of the second general hypothesis is accepted, indicating that the awareness of the existence of machines for collecting used plastic bottles and cans somewhere doesn't depend on their cluster membership (age and employment status).

H_{022} - The use of such machines for collecting used plastic bottles and cans by citizens, if they are placed in the living area, does not depend on their cluster membership (age and employment status).

Subsidiary hypotheses for this specific hypothesis are:

H_{0221} - The use of such machines for collecting used plastic bottles and cans by citizens, if they are placed in the living area, does not depend on the age of citizens.

H_{0222} - The use of such machines for collecting used plastic bottles and cans by citizens, if they are placed in the living area, does not depend on the employment status of citizens.

With the analysis of the data from question 3 in the third part of the questionnaire, the following results were obtained:

Table 4. Results of subsidiary hypothesis testing H_{0221} and H_{0222}

Hypothesis	Degrees of Freedom	Alpha Error	Critical chi-square	Computed chi-square	Conclusion
H_{0221}	8	0,05	15,51	7,12	**Accepted Hypothesis**
H_{0222}	10	0,05	18,31	12,23	**Accepted Hypothesis**

From the data in the table 4, it can be observed that all computed test values are smaller than the critical values for the respective degrees of freedom. This implies that both subsidiary hypotheses are accepted, and the following conclusions can be drawn:

- The use of such machines for collecting used plastic bottles and cans by citizens, if they are placed in the living area, does not depend on the age of citizens, and
- The use of such machines for collecting used plastic bottles and cans by citizens, if they are placed in the living area, does not depend on the employment status of citizens.

Conclusion: The second specific hypothesis of the second general hypothesis is accepted, indicating that the use of such machines for collecting used plastic bottles and cans by citizens, if they are placed in the living area, does not depend on the cluster membership of citizens (age and employment status).

5. Conclusion

The efficiency of a waste management system depends on many factors, but one of the key indicators includes residents' waste management practices. The need to increase the eco-awareness of the citizens, as well as to change the waste management habits, represent the basis for applying the concept of environmental behavior. The complexity of this challenge requires a comprehensive approach involving various stakeholders and demands sustained effort over an extended period.

Numerous key actors are involved in the transition to a sustainable economy, and each one is crucial in determining how this transformation develops. These actors, which may include governmental bodies, non-governmental organizations, businesses, and citizens, collectively

contribute to the complex process of fostering environmental sustainability behavior. They assume distinct roles, take on specific responsibilities, and undertake tasks that collectively contribute to the overall success of this transition. Among these actors, citizens stand out as significant contributors to the dynamics of waste within society. Their attitudes, behaviors, and practices regarding waste management significantly influence the overall success of waste management initiatives within the broader economic framework.

Analyzes in the Pelagon region confirm that the practice of waste management is not a regular process practiced by all citizens; a certain part has the habit of regular waste sorting, but still a large part of the population does not have such an environmental practice of behavior. Encouraging environmental behavior among citizens can be achieved through targeted initiatives and motivating factors, with a particular emphasis on the interest in the use of reverse vending machines. Namely, the interest in the use of reverse vending machines is highlighted. The environmental knowledge, awareness and practices of citizens in the Pelagon region are dependent on cluster membership, considering factors such as age and employment status. Therefore, there is a need for more comprehensive and categorized cluster programs and initiatives to not only enhance citizens' ecological knowledge but also encourage environmentally friendly behavior.

Citizens express interest in using RVM regardless of their cluster affiliation anticipating, motivating factors and an increase in their knowledge about there usage. These conclusions indicate that there is plenty of space for education and transformation of the citizens' behavior forward, improving their level of so-called "ecological citizens" and their inclination toward pro-environmental behavior. Recognizing the crucial role of citizens in this context emphasizes the importance of engaging and mobilizing the public in initiatives aimed at achieving a sustainable and environmentally conscious society. Importing waste sorting and using RVM on a daily basis as one of the core values for every average citizen in this region and broadly can be a significant step up forward achieving the needed level of "ecological citizen". As citizens become more informed and conscientious about their environmental impact, they can actively contribute to the positive transformation of waste management practices and, by extension, the broader economic sustainability efforts.

6.Reference

[1] Aco Recycling, Impact of Smart Reverse Vending Machines on Recycling and Deposit Collection, 2023, available from: https://www.acorecycling.com/blog/impact-of-smart-reverse-vending-machines-on-recycling/ [retrieved on: 1 September 2023].

[2] Amasuomo E.& Baird J., (2016). The Concept of Waste and Waste Management., *Journal of Management and Sustainability*, Vol. 6, No. 4; 2016, p.89. DOI: 10.5539/jms.v6n4p88 available from:https://www.researchgate.net/publication/311161719_The_Concept_of_Waste_and_Waste_Management [retrieved on: 20 November 2023].

[3] Amantayeva A., Alkuatova A., Kanafn I., Tokbolat S., Shehab E (2021). A systems engineering study of integration reverse vending machines into the waste management system of Kazakhstan, *Journal of Material Cycles and Waste Management* 23 (3)**.**

[4] Bortoleto A.P., (2015). Waste Prevention Policy and Behaviour, New approaches to reducing waste generation and its environmental impacts, Routledge, p.4.

[5] European Network for Environmental Citizenship, (2018). Available from: https://enec-cost.eu/our-approach/enec-environmental-citizenship [retrieved on: 1 October 2023].

[6] Giardullo, P., (2019) Automatizing Green Practices? The Analysis of Reverse Vending Machines as a Re-contamination of Theories of Practices, Sociologica. V.13 N.3 (2019), pp.149-166.

[7] Ivanovski F., (2023). Interview with the Switzerland's ambaasador in Macedonia Veronik Ulman and Filip Ivanovski, The citizens are increasingly using the reverse vending machines

available from: Граѓаните се повеќе ги користат повратните Вендинг машини за селективно одложување на отпад! (denar.mk) [retrieved on: 15 September 2023].

[8] Izdebska O. & Knieling J., (2020). Citizen involvement in waste management and circular economy in cities: key elements for planning and implementation, *European spatial research and policy*, Volume 27, Number 2, 2020, p.115.

[9] Janmaimool P., (2017). Application of Protection Motivation Theory to Investigate SustainableWaste Management Behaviors, MDPI, *Sustainability* 2017, 9(7), 1079.

[10] Kaplan Mintz K., Henn L., Park J.& Kurman J., (2019). What predicts household waste management behaviors? Culture and type of behavior as moderators, *Resources, Conservation and Recycling*, Volume 145, June 2019, pp.11-18.

[11] Matti S. (2008). From Sustainable Consumers to Ecological Citizens: Elucidating Attitudes towards Individual Environmental Action in Sweden, SHARP Programme, Working paper 14, pp.3-29.

[12] Nandy S., Fortunato E., Martins R., (2022). Green economy and waste management: An inevitable plan for materials science, *Progress in Natural Science: Materials International*,Volume 32, Issue 1, February 2022, Pages 1-9 https://www.sciencedirect.com/science/article/pii/S1002007122000016 [retrieved on: 20 September 2023].

[13] OECD, (2022). Global Plastics Outlook: Economic Drivers, Environmental Impacts and Policy Options, OECD Publishing, Paris, available from: https://doi.org/10.1787/de747aef-en. https://www.oecd.org/environment/plastic-pollution-is-growing-relentlessly-as-waste-management-and-recycling-fall-short.htm [retrieved on: 20 October 2023].

[14] OECD Development Communication Network (DevCom) & Ibero-American General Secretariat (SEGIB) (2019). Engaging Citizens for Sustainable Development in the Ibero-American Region, JOINT POLICY NOTE, available from: https://web-archive.oecd.org/2019-10-18/533510-Engaging_Citizens_for_Sustainable_Development_in_IberoAmerica_0919.pdf [retrieved on: 20 November 2023].

[15] Pramita S.K., Mamatha S.V., Prathamesh Mhatre, Abhishek Gowda S., Deeksha R. and Srikanth U., (2019). A Study on Challenges for Adoption of Reverse Vending Machine: A Case of North Bengaluru, India, Proceedings of the World Conference on Waste Management, Vol. 1, Issue 2, 2019, pp. 15-29. available from: https://tiikmpublishing.com/data/conferences/doi/wcwm/26510251.2019.1202.pdf [retrieved on: 25 September 2023].

[16] State Statistical Office (2023). Republic of North Macedonia, Communal Waste, 2023, No.9.1.23.01

[17]Stojanov. M., (2015). Reversible Vending: Features and World Practice, RSP, (45) pp. 211-220.

[18] Taylor M., (2021) Reduce, Reuse, Recycle with the Reverse Vending Machine – USC Viterbi School of Engineering, available from:https://illumin.usc.edu/reduce-reuse-recycle-with-the-reverse-vending-machine/[retrieved on: 25 September 2023].

[19] Nguyen A.T., Nguyen N., Phung P & Yến-Khanh N., (2023). Residents' waste management practices in a developing country: A social practice theory analysis, Environmental Challenges, Volume 13, available from: https://www.sciencedirect.com/science/article/pii/S2667010023000938 [retrieved on: 12 December 2023].

[20] UNDP, (2023).Study of Plastic Waste in Republica Moldova, Zero Plastic, 2023, available from: https://www.undp.org/sites/g/files/zskgke326/files/2023-07/study_plastic_waste_in_moldova.pdf [retrieved on: 10 December 2023].

[21] UNEP, (2015). Global Waste Management Outlook, United Nations Environment Programme. Available from: https://www.unep.org/resources/report/global-waste-management-outlook [retrieved on: 10 November 2023].

[22]United States patent, John A. Coyne, Stuart R. Aldrich, Griffin S. Hampson, Krios M. Kriva, Patent No. US 6,547,055 B2.

[23]United States Patent Office, Vending machines patent application serial No. 409.808.

[24] Zhang D., Huang G.,†,Yin X, and Gong Q., (2015). Residents' Waste Separation Behaviors at the Source: Using SEMwith the Theory of Planned Behavior in Guangzhou, China, *International Journal of Environmental Research and Public Health,* vol. 12, 9475-9491, p.9476, available from: https://www.researchgate.net/publication/281813886_Residents'_Waste_Separation_Behaviors_at_the_Source_Using_SEM_with_the_Theory_of_Planned_Behavior_in_Guangzhou_China [retrieved on: 20 November 2023].

[25] Zhang X., (2023). A systematic literature review on individuals' waste separation behavior, *Resources, Environment and Sustainability*, Volume 14, 100137, available from: https://www.sciencedirect.com/science/article/pii/S2666916123000300#b141 [retrieved on: 12 December 2023].

[26] Бојковска К., Тошева Е. & Ангелоска – Дичовска М. (2023). Циркуларна економија: глобален концепт на одржливост – монографија, Македонско научно друштво, Битола/ Bojkovska K., Tosheva E. & Angeloska – Dicovska M. (2023) Circular economy: global concept of sustainability – monograph, Macedonian science association-Bitola.