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FACULTY OF ECONOMICS – PRILEP

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PROCEEDINGS

18-19 September 2026, Prilep, North Macedonia

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LEVEL OF AWARENESS AND PRACTICES REGARDING PACKAGING WASTE SELECTION IN NORTH MACEDONIA

Aleksandar Mateski[1], Filip Ivanovski[2], Emilija Gjorgjioska[3], Violeta Gligorovski[4]

Abstract

Amid ongoing efforts in the European Union toward a significant shift in reducing packaging waste, prevailing reports from the region indicate that Macedonian citizens do not primarily select their waste sufficiently, that there is a lack of adequate infrastructure for waste separation, and that public utility companies face financial constraints. In line with the Extended Producer Responsibility principle (EPR), producers are required to undertake activities aimed at informing the public and raising awareness in order to promote benefits and interest in packaging waste management, separate collection, and recycling of specific waste streams, with the goal of achieving higher levels of national target compliance. Continuous public awareness-raising remains one of the key challenges in effective packaging waste management, while a notable research gap exists in Macedonian academic literature regarding national waste separation habits. This paper consolidates findings from four public opinion surveys conducted on a sample of 1,200 respondents from North Macedonia. The analysis focuses on waste separation practices and habits, the attractiveness of separating different waste fractions, preferred incentives, public attitudes toward Reverse Vending Machines (RVM), and the main challenges faced by consumers in managing specific waste streams.

The authors will use analytical and comparative analysis methods to examine relevant changes in public opinion trends, habits, and behavior regarding the separation of packaging waste over the past years. The findings will identify the

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main problems that should be the focus of future activities aimed at improving packaging waste management.

Keywords: Packaging waste, collective waste management operator, reverse vending machines, deposit return system (DRS), plastic waste, ESG (Environmental, Social, and Governance)

1. Introduction

Mass production and mass consumption have shown their negative side, hyper production of waste. In our everyday life we are used to consuming goods that are packed in different packages at the same time: pallets, cartoons, plastic bags, aluminium cans etc.

According to Worldometrics, plastic bottle production totals 500 billion units each year, which generates 300 million tons of waste annually. Hundreds of thousands of tons from bottles contribute to the 8 million tons of plastic that reach the oceans (Bergman, 2026). A study based on mathematical method in order to predict the use of plastics shows that the global use of plastics is expected to increase from 464 Mt in 2020 up to 884 Mt in 2050, with up to 4725 Mt of plastics accumulated in stock in 2050 (from the year 2000) (Dokl et.al 2024).

Waste generation is projected to increase dramatically in the next dozen years, from 1.3 billion tonnes per year today to 2.2 billion tonnes per year by 2025, with high increases in middle-income developing countries (World Bank. 2012).

In the 2030 Agenda for Sustainable Development adopted by United Nations, one of the goals is ensuring sustainable consumption and production patterns that includes changing approaches and perspectives on waste to shift from end of-pipe solutions to reduce, reuse, recycle (3R) approaches, which close material loops and reduce resource extraction needs. The need to recycle (e.g., through take-back programs), reuse (e.g., by avoiding single-use plastic bags), and reduce consumption is something that many people are already aware of (Bulut, et al., 2023). In order to decrease our reliance on raw materials and increase recycling and "circular economy" approaches to reduce environmental pressure and impact, few targets have been identified as: achieve the environmentally sound management of chemicals and all wastes throughout their life cycle and significantly reduce their release to air, water and soil and also substantially reduce waste generation through prevention, reduction, recycling and reuse (United Nations General Assembly, 2015). Also, according to the Agenda, one of the targets is supporting developing countries to strengthen their scientific and technological capacity to move towards more sustainable patterns of consumption and production.

In a survey conducted by European Commission titled: Citizens action for reducing waste, over half of Europeans would consider correctly sorting their waste or using reusable packaging to reduce the amount of waste (European Commission (2024). According to Eurostat data for 2023 an average of 35.3 kg of

plastic packaging waste was generated in 2023 for each person living in the EU, and out of this, 14.8 kg were recycled. According to Eurostat, countries with the highest rate of recycling plastic waste are Belgium and Latvia with a rate almost 60%. The average recycling rate in the EU is 42%.

A survey conducted in Turkey reported that 45% of respondents regularly separate packaging waste. The findings of the survey suggest that higher education levels correlate with increased awareness and more responsible waste management practices, highlighting the importance of education in improving these practices (Elmaslar Özbaş, et al. 2026).

According to Barnosky et al. the barriers for individuals to recycle presented in the literature may be broadly categorized into three categories: lack of knowledge (How to recycle; why it is important; how does the system work), inconvenience (time cost; perception of dirtiness; lack of effective facilities and/or storage space) and lack of personal responsibility (Lack of intrinsic motivation; Lack of collective action ("Just me" won't make a difference); and Lack of trust in the other actors in the system).

The necessary factors that may trigger the public behavior in this case i.e recycling waste, in the theory (Timlett & Williams, 2008) are divided in:

- Enablers – factors that improve the infrastructure, increase the specialized education and amount of information about that usefulness of that behaviour, also and removal of barriers,
- Encouragement – implementation of taxes, penalties, rewards,
- Engagement - communication, feedback mechanisms, stakeholder consultation, community engagement, and bottom-up policy-making
- Exemplify - leading and influence of good examples and practices.

One of the possible ways to recycle packaging waste by individuals is using reverse vending machines (RVM). The Reverse Vending Machine (RVM) is an innovative waste-collection concept in which users receive a reward for properly depositing recyclable items. RVMs facilitate the efficient collection of recyclable materials, encourage recycling practices, and ultimately contribute to more effective waste management (Tomari, et al., 2017).

Implementing supplementary programs with financial incentives and raising awareness and educating the general population about the usefulness of reverse vending machines are crucial for increasing the level of using RVM (Gjorgjioska, et al. 2023). RVMs are widely used in high-income countries, particularly in Europe and North America, where established deposit-refund schemes and supporting infrastructure have contributed to high return and recycling rates (Stojanov, 2015). Countries such as Sweden, Denmark, Norway, and Germany have successfully integrated RVMs into national recycling systems. In contrast, their adoption in developing and emerging economies remains limited, with research largely focusing on pilot projects and prototypes (Fernandes, 2025). This highlights the need for further research into the potential of RVMs to support effective waste management and the transition towards a circular economy in these countries.

The Republic of North Macedonia as a middle-income developing country with high risk and potential for pollution should undertake measures in

order to minimize adverse impacts on human health and the environment. The trend for exploring the circular economy in the area of plastic packaging has become popular among academia and researchers in the country, which is shown by the increasing number of publications. Some of the important articles are focused on managing packaging and packaging waste and analyzes the results of the implementation of the Law of management of packaging and packaging waste which was enforced in 2009 (Toshevska-Trpchevska, et al. 2017), implementation of the Law on Packaging and Packaging Waste Management and the Law on extended producer responsibility for the management of special waste streams (Mateski & Gjorgjioska 2021), legislative challenges in sustainable packaging waste management in North Macedonia (Mateski, 2026), establishment of packaging waste management system in Macedonia (Sapuric, et al. 2013) etc. There are only few researches from the country that are focused on the role of the reverse vending machines (RVM) in recycling plastic packaging waste. One of them is focused on the awareness, habits, and tendencies regarding eco-practices among citizens (citizens environmental behavior) and their attitudes towards the use of reverse vending machines in the Pelagonia region of the Republic of North Macedonia (Angeloska – Dichovska et al., 2023). Pakomak, as the first Macedonian company that introduced the global trend in selection in the Republic of North Macedonia – reverse vending machines for collecting plastic bottles and cans, has conducted few researches for internal use about the trends and habits of the using reverse vending machines.

The paper is structured into four sections. The first section provides an introduction, the second presents the research methodology, the third focuses on the survey results, and the fourth presents the conclusions and recommendations for the broader use of reverse vending machines (RVMs).

2. Methodology

The analysis is based on survey about public opinion, consciousness, habits and practices in waste packaging selection. The survey was conducted on 1200 respondents from Skopje, Bitola, Kumanovo, Tetovo, Strumica, Ohrid, Stip, Veles and Prilep. The survey was conducted in the period from 9-23 February 2026 by using CATI (computer-assisted telephone interview) selecting. The survey included 1,200 complete interviews, with a total of 4,302 telephone numbers contacted (RDD sampling). The response rate was 27.9%, and the refusal rate was 41.6%. The survey was financed by Pakomak DOO Skopje, and was conducted by Quantum communications. The results are statistical and visual presented by using Microsoft Excel. Also, in order to identify and conclude the trends in PVM use, habits, and practices, the findings of the latest research are compared with the results of public opinion surveys conducted in 2019, 2022, and 2024. These surveys examined public awareness, habits, and behaviour regarding the separation of packaging waste and were conducted for the purposes and needs of Pakomak. The surveys used the same sample size and the same CATI (Computer-Assisted Telephone Interviewing) methodology, ensuring comparability of the results over the different survey periods.

The descriptive statistic of the respondents is given in the table below.

Table 1. Demographic Characteristics of the Survey Respondents

Gender	man	46.6%
	woman	53.4%
Age	18-29	14.8%
	30-45	28.9%
	46-64	36.3%
	over 65	19.9%
Education	Primary education	6.8%
	Secondary education	57.2%
	Higher education	31.8%
	Master's/Doctoral degree	3.8%
	Prefer not to answer	0,3%
Employment status	Employed	58.2%
	Unemployed	12.5%
	Student	3.7%
	Retired	23.8%
	Other	1,2%
	Prefer not to answer	0,7%
Family' monthly incomes	up to 30.000 den	17.8%
	30-50.000 den	30.5%
	50-70.000 den	23.4%
	above 70.000 den	17.4%
	prefer not to answer	10.8%

The distribution of the respondents among the cities was as follows: 33.3% from Skopje and 8,3% from each other city. 78.4% of the respondents are Macedonian, 15,3% Albanian and 6,2% other nationalities.

3. Results and discussion

On the question: Do you select waste for recycling in your household? Only 14,2% of the respondents answer that they always select waste or very often, and unfortunately 30,9% of the respondents answer that they never select the waste in their household. The results are presented in Figure 1.

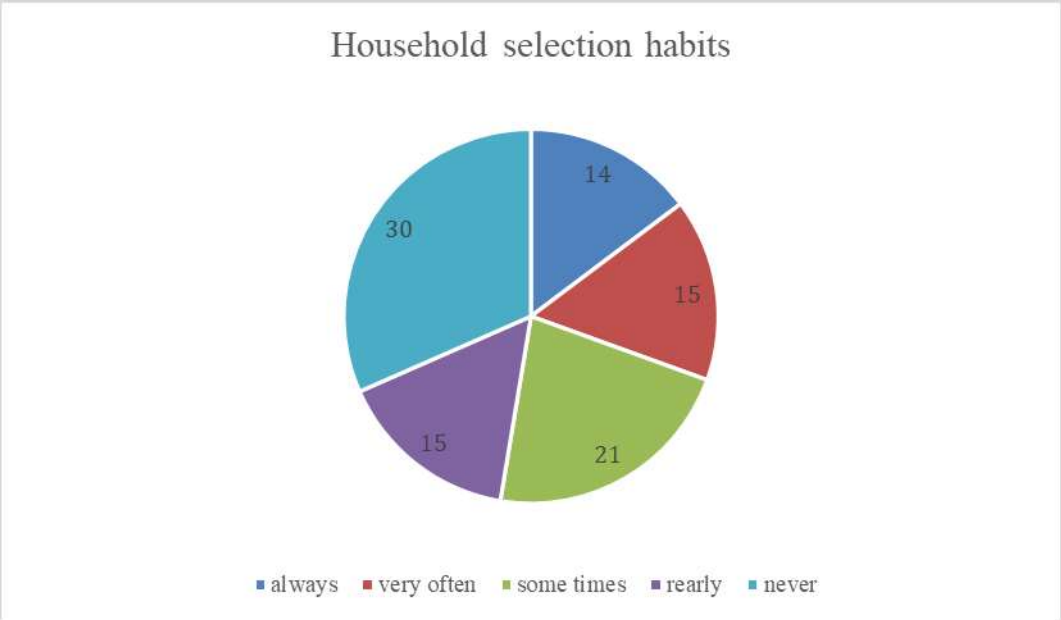


Figure 1. Household waste selection for recycling

Figure 1 shows that the largest share of respondents, 30%, reported that they never separate waste for recycling.

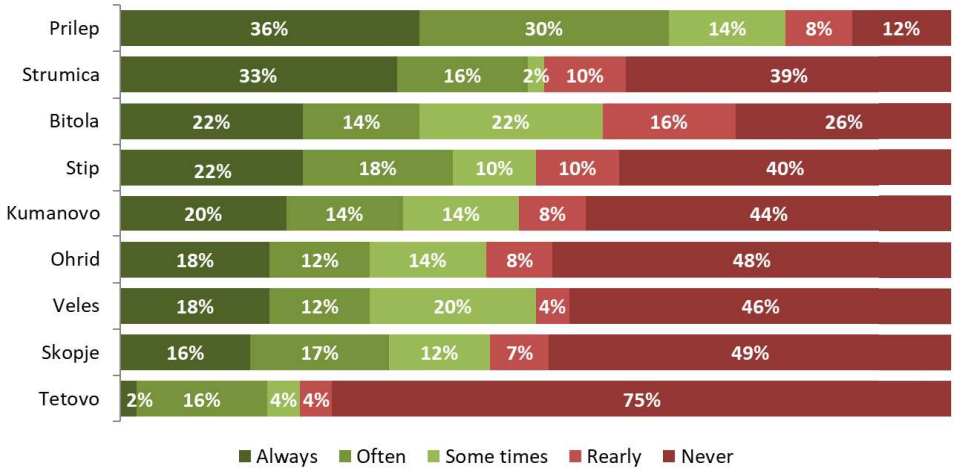


Figure 2: Household waste selection for recycling by city in 2019

Based on the results of the research conducted in 2019, regarding the question "Do you separate waste for recycling in your household?", leading in recycling are respondents from Prilep (with 36% respondents always recycling) and Strumica (with 33% respondents always recycling). Results show that 75% of the respondents from Tetovo have never selected the waste, followed by almost half of the respondents from Skopje, Ohrid and Veles. The lowest percentage of the respondents that said that never select a waste are from Prilep (12%).

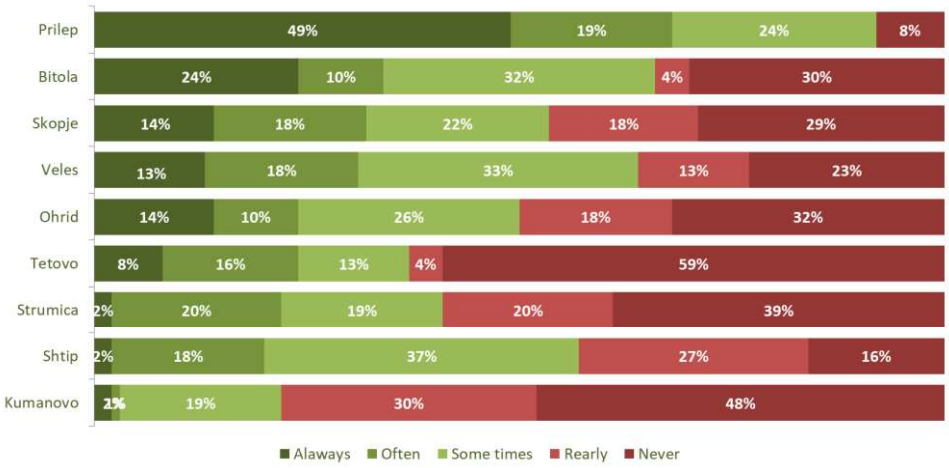


Figure 3. Household waste selection for recycling by city in 2026

In 2026, the results for the same questions show that 49% of respondents from Prilep reported that they always recycle, followed by 24% of respondents from Bitola. In contrast, almost half of the respondents from Kumanovo reported that they never separate waste for recycling, while Prilep recorded the lowest share of respondents who reported never recycling, at only 8%.

Comparing the results presented in Figures 2 and 3, it can be concluded that the share of respondents who always, often, or sometimes separate waste for recycling has increased over the past seven years, while the share of citizens who rarely or never separate waste has decreased. Prilep recorded the highest share of respondents who reported always or often separating waste for recycling in both surveys.

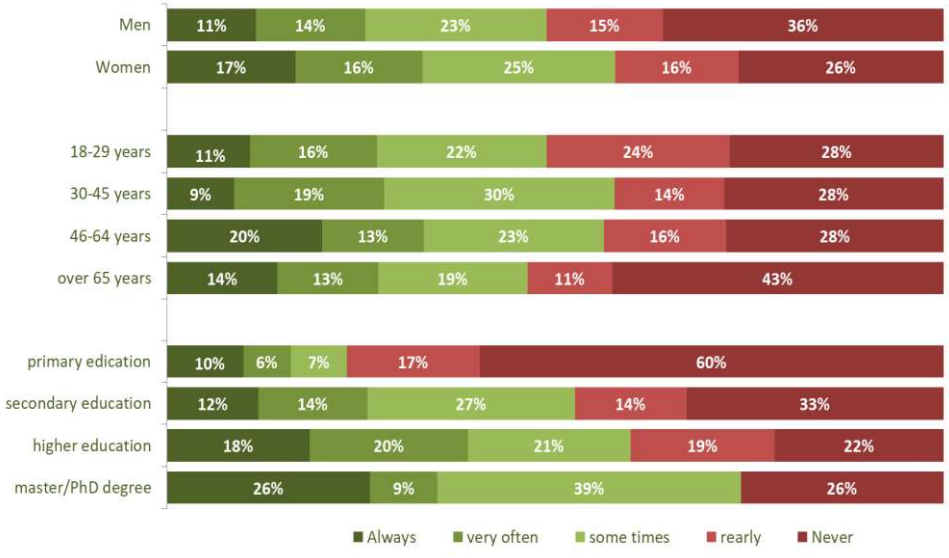


Figure 4. Household Waste Selection for Recycling by gender, age and education status.

From the figure above, it can be concluded that women are more likely to separate waste for recycling than men. This practice is most common among

respondents aged 46–64, while 43% of respondents aged 65 and over reported that they never separate waste. Respondents with higher education, including those with a master's or doctoral degree, are more likely to separate waste than those with primary or secondary education. Notably, 60% of respondents with primary education reported that they never separate waste.

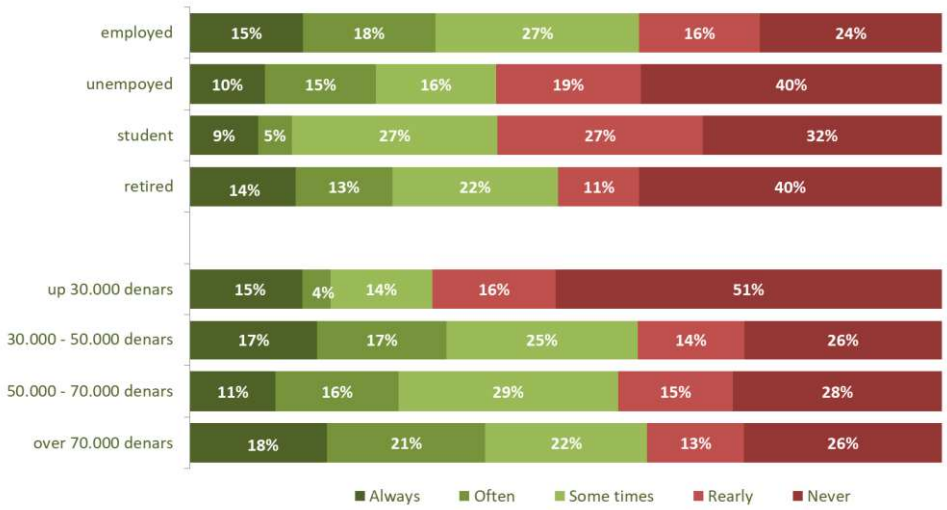


Figure 5. Household Waste Selection for Recycling by employment status and monthly family income.

The results for waste selection cross tabulated with employment status and monthly family incomes show unfortunately that unemployed and students are selecting waste less than employed and retired respondents. 40% of retired and 40% of unemployed answer that they never select waste. Regarding their incomes, the highest percentages of respondents with highest family incomes always select waste, while the most of respondents with lowest monthly incomes never select waste. It may be assumed that higher family income influences proportional on the selection practices and opposite, respondents with lower incomes select the waste less.

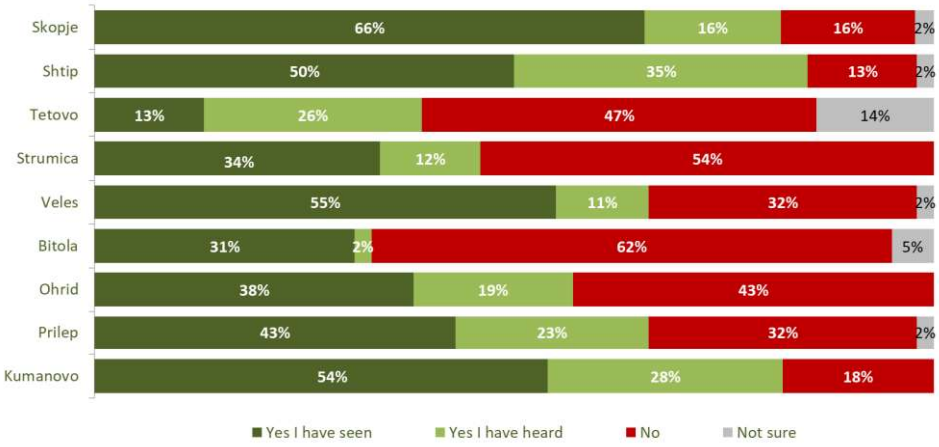


Figure 6. Awareness of reverse vending machines for collecting used plastic bottles and cans by city

Regarding the question: "Have you heard that there are or perhaps you have seen vending machines (machines) installed somewhere for collecting used plastic bottles and cans?" the most respondents from Skopje (66%) and Stip (50%) have seen RVM, an opposite only 13% of the respondents from Tetovo have seen RVM. 85% form the respondents from Stip have seen and heard about RVM, and 82% from Kumanovo and Skopje have seen and heard about RVM, while 62% of the respondents from Bitola and 54% of the respondents from Strumica have not seen or heard about RVM.

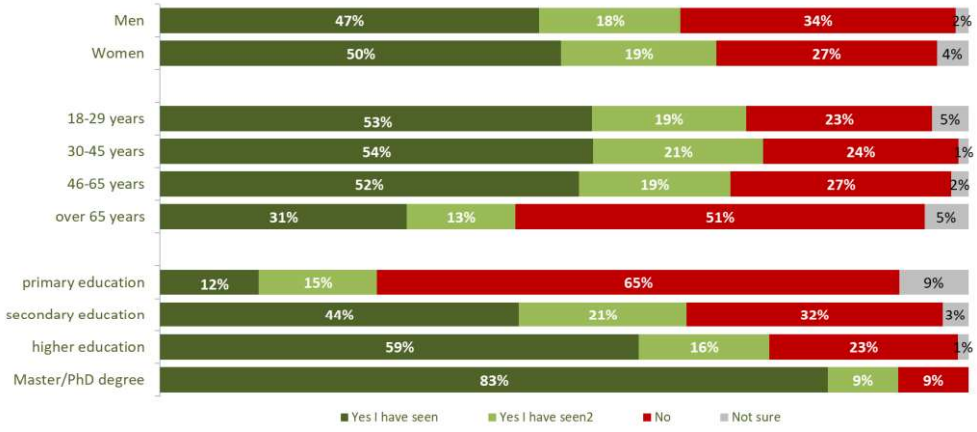


Figure 7. Awareness of reverse vending machines for collecting used plastic bottles and cans by gender, age and education.

Regarding gender, women are more aware about the existence of RVM compared to men, 54% of the respondents from the age group 30-45 years have seen RVM, while 51% of the respondents that are over 65 years have not seen or heard about RSV. The crosstabulation regarding education shows that respondents with primary education have the lowest level of awareness about existence of

RVM (12%), while the greatest level of awareness have shown respondents with master or PhD degree (83% have seen RVM).

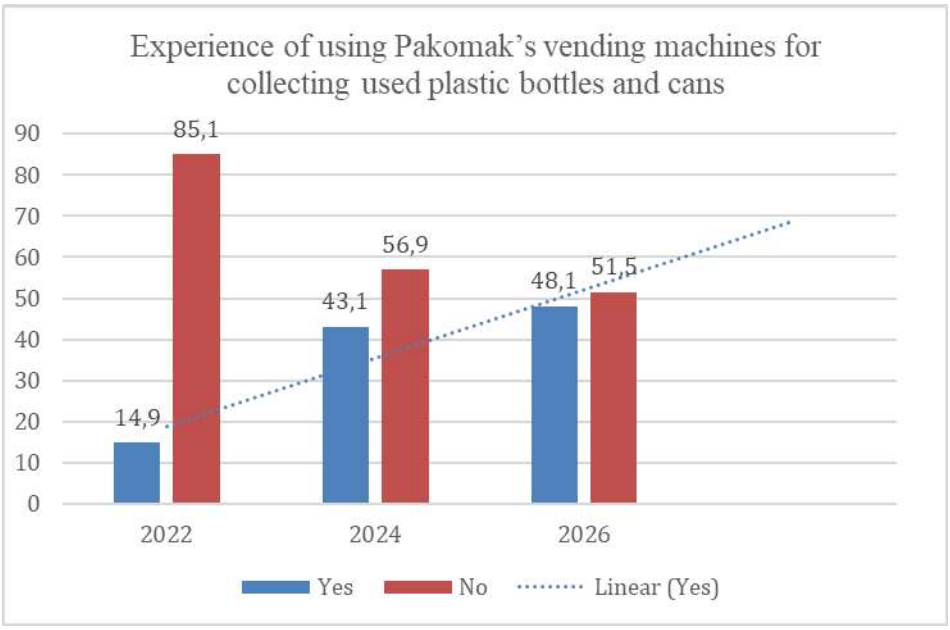


Figure 8. Experience of using Pakomak's vending machines for collecting used plastic bottles and cans in 2022, 2024 and 2026

Regarding the experience of using RVMs, the findings indicate a continuous increase in the number of people using them over the years. While only 14.9% of respondents reported using RVMs in 2022, this share increased substantially to 48.1% in 2026.

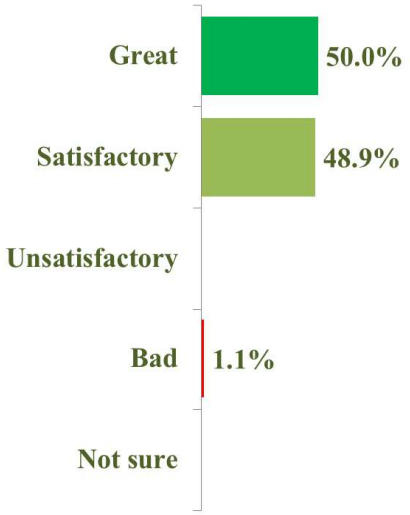


Figure 9. Experience of using Pakomak's vending machines for collecting used plastic bottles and cans

From the respondents who had personal experience using the machines, 98,9% rated it positively (50% excellent and 48,9% satisfactory). Only 1,1% stated that their experience was bad.

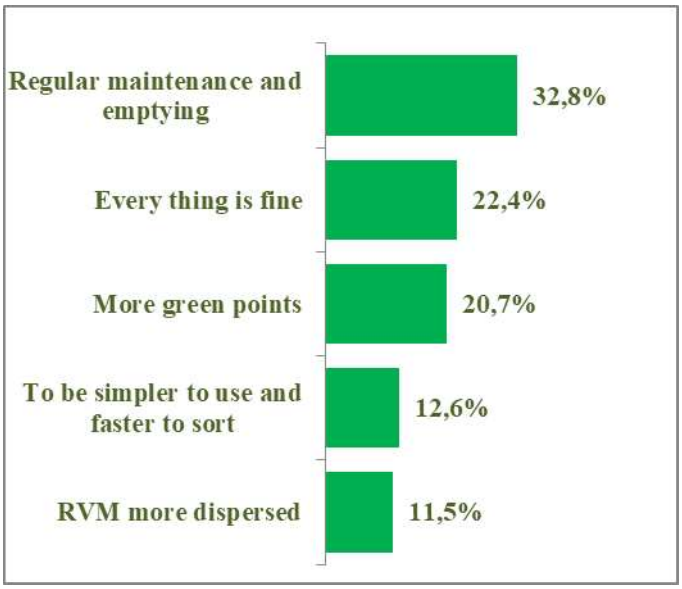


Figure 10. Recommendations for further improvement of Pakomak's reverse vending machines

Despite the high level of user satisfaction, several areas for improvement were identified. The most frequent suggestion was more regular maintenance and emptying of vending machines (33%), followed by increased rewards (21%). Other recommendations included simplifying and speeding up the process (13%) and expanding the number of locations (12%), while 22% of respondents provided no comments.

4. Conclusion

The survey findings indicate that waste separation practices vary considerably according to gender, age, education, employment status, income, and place of residence. Women are more likely to separate waste for recycling than men, while respondents aged 46–64 and those with higher education, particularly master's and doctoral degree holders, demonstrate the highest levels of participation. In contrast, waste separation is less common among respondents with primary education, older respondents, retired and unemployed individuals. Leading in recycling habits are citizens from Prilep (with 49% respondents always recycling) and Bitola (with 24% respondents always recycling). In contrast, almost half of the respondents from Kumanovo never select waste for recycling. Awareness of reverse vending machines (RVMs) also varies significantly among cities and demographic groups, with women and respondents with higher education generally demonstrating greater awareness, while awareness is lowest among respondents with primary education and those over 65 years of age.

Citizens of Stip, Kumanovo and Skopje are most aware of the existence of RVM, while lowest awareness is presented among citizens from Bitola and Strumica.

Regarding actual experience, 48,6% of respondents reported having used an RVM, while 51,4% had no such experience; however, approximately 99% of those who had used Pakomak's RVMs reported a positive experience. The findings reveal a significant upward trend in RVM use, with the proportion of respondents reporting their use increasing from 14.9% in 2022 to 48.1% in 2026.

Overall, the findings indicate a positive shift in citizens' waste separation practices over the observed period, reflected in the increased proportion of respondents who regularly separate waste for recycling and the decline in those who rarely or never do so. Prilep stands out for its consistently favourable results, recording the highest proportion of respondents who regularly separate waste for recycling in both research periods. These results suggest growing awareness and more positive recycling habits among citizens, although further efforts are needed to encourage wider and more consistent participation in waste separation.

These findings suggest that expanding RVM infrastructure, together with targeted awareness campaigns and educational activities, could contribute to increased waste separation and recycling and support the broader adoption of RVMs in North Macedonia. As key enablers, the RVM infrastructure should be improved by increasing the number of machines and ensuring their wider territorial distribution, including better coverage of smaller and less-served areas. The system of green points should also be further developed and consistently implemented to provide citizens with more accessible opportunities for waste separation and recycling. Awareness campaigns and leading-by-example initiatives should be tailored to specific target groups that lag behind in waste separation practices, with particular attention to groups demonstrating lower levels of awareness and participation.

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