
PUBLIC PERCEPTION AND NEED FOR INVESTMENTS TO REDUCE AIR POLLUTION IN KAVADARCI

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Abstract: Air pollution has been one of the biggest environmental and health challenges for modern urban environments, and the Republic of North Macedonia, as a transition country with specific economic and energy structures, is no exception. The city of Kavadarci, known for its wine industry, metallurgical capacities and heavy traffic, is a typical example of an environment where air quality is under constant pressure from multiple sources. Faced with this reality, citizens express increased concern for their health, environmental protection and the future of the local community. The aim of this research was to examine the public perception of air pollution, to identify the main sources of pollution, to analyze the health consequences and to determine the level of awareness and readiness of citizens for the transition to energy-efficient solutions and renewable energy sources. The research used a quantitative methodology using a structured survey conducted on 300 respondents of different ages, education, professional and socio-economic status. This approach enabled a systematic analysis of citizens' attitudes and knowledge about pollution, as well as their willingness to invest in energy efficiency and to use state and local subsidies. The results showed that more than two-thirds of respondents perceive the air pollution situation as a serious problem, and a significant proportion of them already experience health consequences such as cough, asthma or chronic respiratory diseases. Despite the high level of concern, the research revealed that awareness of existing measures and subsidies is limited, and the use of these mechanisms is low. The main barriers relate to lack of information, administrative procedures, as well as the financial situation of households. Even among those citizens who expressed readiness for change, financial insecurity and distrust in institutions remain key factors limiting their engagement. The results further indicate that there is a strong relationship between educational level and willingness to invest in energy efficiency, which highlights the importance of education and promotion. The findings also point to the need to develop local policies that will facilitate the transition to sustainable energy, while increasing trust in institutions through transparent and accessible support programs. The conclusion of this research is that tackling air pollution cannot be achieved with technical measures alone, but requires an integrated approach that unites public awareness, education, institutional support and economic sustainability. Only through such a comprehensive approach can air pollution be reduced and a better quality of life be ensured for current and future generations in urban areas like Kavadarci.

Keywords: Air pollution, public perception, renewable sources, energy efficiency, Kavadarci

1. INTRODUCTION

Air pollution is one of the most serious environmental and health challenges in urban areas, especially in developing countries such as the Republic of North Macedonia. Existing data show that during the winter months, concentrations of harmful particles significantly exceed permissible limits, causing acute and chronic health problems (World Health Organization [WHO], 2005; WHO, 2018). The main sources of emissions are the combustion of fossil fuels for heating, the industrial sector, transport and open burning of waste (Čist vazduh, 2024; Ministry of Environment and Physical Planning, 2025). Energy poverty, which affects a significant part of the population, increases dependence on cheap but polluting fuels, and limits the transition to sustainable solutions (Ministry of Economy of the Republic of North Macedonia, 2007; Municipality of Kavadarci, 2022). Previous research has mainly focused on the technical aspects of pollution, but less is known about public perception and readiness for change, especially in local regions such as Kavadarci (Al-Shidi, Ambusaidi, & Sulaiman, 2021; Salimbene, Baeza-Romero, Pilla, & Čok, 2024; Giri & Nagendra, 2024). Public awareness, access to information, and the use of subsidies are key factors for the effective implementation of pollution reduction measures. In this study, I conducted a quantitative survey with 300 respondents from the municipality of Kavadarci, analyzing their attitudes, level of information, use of energy policies, and openness to renewable energy sources. I used a descriptive statistical approach to analyze the responses, and the results showed a high level of concern about air quality, but also a low level of information and poor use of available measures. These findings indicate the need for integrated policies that include public education, economic support, and the availability of sustainable technologies. The aim of the research was to determine the level of public awareness, barriers, and potential for implementing sustainable solutions to reduce air pollution in the city of Kavadarci.

2. MATERIALS AND METHODS

The research was conducted with a quantitative approach through a structured survey, combining face-to-face interviews and an electronic survey via Google Forms. The sample included 300 respondents from different demographic and socio-economic categories, from high schools, a Pensioner's Home, the City Square, companies and public institutions. The survey questionnaire was structured in three sections: demographic data, perception of air pollution and attitudes towards renewable sources and financial support. The data were collected from December 15, 2024 to January 5, 2025, organized in tables and analyzed to determine trends, perceptions and factors influencing public awareness and readiness for the implementation of sustainable energy solutions.

3. RESULTS

1- Thematic unit- Demographic and socio-economic characteristics In this thematic unit, only one choice was allowed, each respondent could only give one answer, which resulted in a total number of responses equal to the number of respondents (n >300), which is important when interpreting the results.

Table 1. Number and percentage of responses/respondents to the first thematic unit

Table 1.		%	бpoj
Age	16-25	17,7%	53
	26-45	36%	108
	46-64	29%	87
	64+(retired)	15,3%	46
	64+(retired who has no financial income)	2%	6
Education	primary	5%	15
	medium	54%	162
	high	41%	123
Nationality	macedonian	91,3%	274
	roma	6,3%	19
	albanian	0	0
	turkish	2%	6
	serbian	0,3%	1
Employment status	private sector	27%	81
	public sector	24,3%	73
	student	13,3%	40
	company owner	8,3%	25
	institutional manager	4%	12
	retired	17%	51
	unemployed	5,7%	17
	basketball player	0,3%	1
Monthly income	15,000 or less	3,3%	10
	15,000-23,000	13,7%	41
	23,000-30,000	19,3%	58
	30,000-40,000	20,7%	62
	40,000-50,000	11%	33
	50,000-70,000	10,3%	31
	70,000+	3,7%	11
	without income	18%	54

Source: Author

2- Thematic Unit - Public Perception of Air Pollution - This thematic unit allowed multiple choices for health status, multiple choices for air pollutants and type of fuel used, which resulted in a total number of responses greater than the number of respondents (n >300), which is important when interpreting the results.

Table 2. Number and percentage of respondents/opinions for the second thematic unit.

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What do you think about the level of air pollution?	High pollution level	47%	140
	Medium pollution level	42%	127
	Low pollution level	10%	29
	Not polluted at all	1%	4
Have you experienced any health problems from polluted air?	Respiratory diseases	18%	64
	Allergies	7%	27
	Heart diseases	5%	19
	Diabetes	2%	9
	High blood pressure	15%	56
	Asthma	7%	27
	Headache	23%	83
	I haven't felt it	22%	82
	Other (watery eyes, cancer, sinuses)	1%	3
What do you think about potential air pollutants, which pollutes the most?	Industry	32%	143
	Motor Vehicles	27%	123
	Domestic Heating	24%	107
	Waste Incineration	17%	75
	Other	0%	2
What do you think, which type of fuel in the city of Kavadarci pollutes the most?	Wood	27%	119
	Oil	43%	190
	Fuel oil	14%	60
	Coal	15%	67
	Gas	1%	5
	Other	0%	2
How do you heat your home/company/institution?	wood	42%	145
	Pellet	17%	59
	Electricity	29%	103
	Oil	6%	21
	Coal	/	0
	Gas	/	0
	Solar panels	5%	18
	Heat pumps	1%	4
	Other	/	0
If you are a company, what industry do you operate in?	Manufacturing	20%	5
	Wood sawing and scraping	8%	2
	Metal production	8%	2
	Electricity production, transmission and distribution	4%	1
	Waste collection, processing and disposal	/	/
	Construction	16%	4
	Wholesale and retail trade	12%	3
	Transport	20%	5
	Food preparation and serving activities	8%	2
	Monetary intermediation	4%	1
	Other	/	/

Source: Author

From a representative sample of 300 respondents, they were divided into : 263 households, 12 institutions and 25 companies. The analysis included 25 companies from different sectors, examining whether the type of their work activity has an impact on the choice of fuel they use to heat their business premises. Given the work activity of the companies, they use the heating fuel that best suits their needs.

3- Thematic unit- Attitudes towards renewable energy sources and financial support-

This thematic unit allowed multiple choices for use or non-use of measures/subsidies and multiple choices for factors that influence investment in new energy-efficient heating, which resulted in a total number of responses greater than the number of respondents ($n > 300$), which is important when interpreting the results.

Table 3. Number and percentage of respondents surveyed - opinions

Table 3. Number and percentage of respondents surveyed - opinions on the third thematic unit.		%	Number of respondents/ opinions
Are you considering changing the heating source in your home/company to a new energy-efficient heating system?	Yes	66%	198
	No	34%	101
	other	0%	1
Have you taken advantage of any of the measures, i.e. subsidies for purchasing an efficient heating element, in the past years?	Yes, through the Ministry of Economy	10%	32
	Yes, through the Municipality of Kavadarci	9%	29
	I had no information about the measures	17%	55
	I had no need, I invested myself	8%	26
	I have not applied	34%	107
	I would like to	22%	68
If you invest in energy-efficient heating, what will your investment depend on most?	Price	36%	146
	Support subsidies	16%	66
	Does the device pollute the air and how much	7%	29
	How much will it cost per month	20%	81
	Is the device safe	8%	32
	Is it easy to maintain	7%	29
	I would not invest	6%	24
Did you know that there are alternative energy sources that are cheaper and at the same time meet global environmental standards? Solar energy and wind energy are well-known alternative energy sources. However, in recent times, the use of geothermal energy has become popular, which, to be honest, has been used in the world for a long time.	Yes	74%	223
	No	25%	75
	Other / I am not sufficiently informed	1%	2
What do you think? Which type of renewable energy will best meet the needs of households/institutions/companies in the city of Kavadarci?	Solar energy	55%	166
	Wind energy	9%	26
	Geothermal energy	13%	38
	I am not familiar with this	23%	69
	Other/gas	0%	1

Source: Author

An additional analysis was made of the respondents who answered that they did not apply. Out of 107 responses given by the respondents who did not apply, the following answers were given: 96 respondents – did not apply (gave only one answer), 7 respondents – did not apply and would like to take advantage of the measures (1 pensioner, 6 employees,) 2 respondents – did not apply and had no information about the measures (1 student and 1 employee), 2 respondents – did not apply, did not need to invest on their own (2 employees). An analysis was made of those 96 respondents who did not apply (gave only one answer), by category of work / financial status. The following graph shows the results:

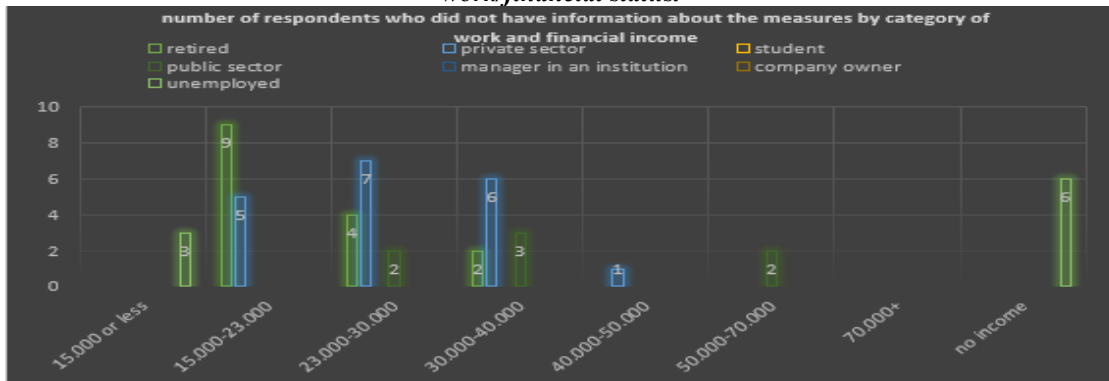
Chart No. 1 Number of respondents who did not apply, by category of work/financial status.



Source: Author

Out of a total of 55 respondents who gave the opinion that they had no information about the measures, 3 answered that they had no information, but wanted to take advantage of the benefits and measures, 2 answered that they had no information and did not apply, and the remaining 50 answered that they simply had no information about the measures. A more detailed analysis was made of these 50 respondents regarding their work/financial status. The results are shown in the following graph:

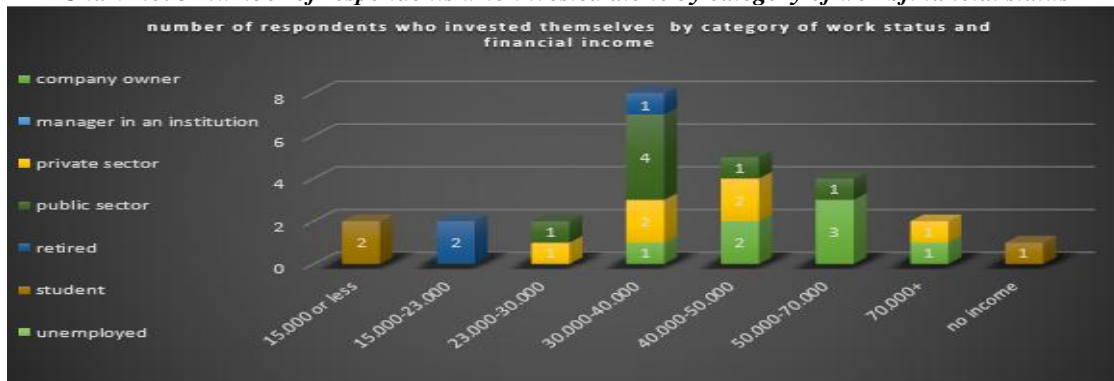
Chart No. 2 Number of respondents who did not have information about the measures by category of work/financial status.



Source: Author

Another additional analysis was conducted on respondents who responded that they did not need to apply for the measures, because they invested on their own. Of the 26 responses given by respondents who did not need to apply, because they invested on their own, their status is as follows:

Chart No. 3 Number of respondents who invested alone by category of work/financial status



Source: Author

4. DISCUSSION

The survey shows that the citizens of Kavadarci are aware of the high level of air pollution, which results in health symptoms such as headache, respiratory diseases and asthma (WHO, 2018; Guarneri & Balmes, 2014). Most of the respondents are from the active working population with secondary and higher education, which increases environmental awareness and readiness for innovation (Al-Shidi, Ambusaidi, & Sulaiman, 2021; Salimbene, Baeza-Romero, Pilla, & Čok, 2024). Despite the knowledge of renewable sources (74%), only 34% are willing to apply them, due to economic and informational barriers, and subsidies are poorly used (Ministry of Environment and Spatial Planning, 2025; Municipality of Kavadarci, 2022). The results indicate the need for policies that will facilitate investments in renewable sources, reduce economic barriers and improve information campaigns (Čist vozduh, 2024; European Environment Agency, 2023).

5. CONCLUSION

Main findings: The research indicated that in Kavadarci there is high public awareness of pollution and its health effects, but the practical application of reduction measures is limited. Demographic and socio-economic factors play a significant role, with education and more economically active groups having a greater willingness to change (Al-Shidi, Ambusaidi, & Sulaiman, 2021; Salimbene, Baeza-Romero, Pilla, & Čok, 2024). Although awareness of renewable sources is significant (74%), only one third of respondents are willing to invest in new systems, with economic barriers and complex administrative procedures being the main limiting factors. Practical implications: These results suggest the need for targeted policies that will combine economic support, subsidies and facilitated procedures for their use, as well as enhanced information campaigns to encourage the public (Čist vozduh, 2024; Municipality of Kavadarci, 2022). Special emphasis should be placed on the development of solar energy, recognized as the most promising source by citizens, which is also in line with the natural potential of the region (Ministry of Economy of the Republic of North Macedonia, 2007). Limitations and recommendations for further research: The research is limited to a sample of 300 respondents and to the local context of Kavadarci, which may reduce its generalizability. Further studies should include larger and more diverse samples, as well as comparative analyses with other cities in Macedonia. Additionally, long-term studies are needed to monitor the impact of public policies and subsidy measures on changing energy habits and air quality (WHO, 2018; European Environment Agency, 2023).

REFERENCES

- Al-Shidi, HK, Ambusaidi, AK, & Sulaiman, H. (2021). Public awareness, perceptions and attitudes on air pollution and its health effects in Muscat, Oman. *Journal of the Air and Waste Management Association*, 71(9), 1159–1174. <https://doi.org/10.1080/10962247.2021.1930287>
- Clean air. (2024). Source Apportionment Study for Kavadarci Urban Area [Report]. <https://cistvozduh.mk/wp-content/uploads/2024/11/SA-report-Kavadarci-FINAL-5.pdf>
- European Environment Agency. Europe's air quality status 2023 <https://www.eea.europa.eu/en/analysis/publications/europes-air-quality-status-2023>
- Giri, A., & Nagendra, SMS (2024). Air pollution perception for air quality management: A systematic review exploring research themes and future perspectives. *Environmental Research Letters*, 19(5), Article 053002. <https://doi.org/10.1088/1748-9326/ad3bd0>
- Guarneri, M., & Balmes, JR (2014). Outdoor air pollution and asthma. *The Lancet*, 383(9928), 1581–1592. [https://doi.org/10.1016/S0140-6736\(14\)60617-6](https://doi.org/10.1016/S0140-6736(14)60617-6)
- Ministry of Economy of the Republic of North Macedonia. (2007). Annual Energy Report 2006. Skopje: Ministry of Economy. <https://www.economy.gov.mk>
- Ministry of Environment and Physical Planning. (2025). Air Quality in the Republic of North Macedonia: Impacts of Air Pollutants on Human Health. https://air.moepp.gov.mk/?page_id=170
- Municipality of Kavadarci. (2022). Local Environmental Action Plan of the Municipality of Kavadarci 2022–2028. <https://kavadarci.gov.mk/public/wp-content/uploads/LEAP.pdf>
- Salimbene, O., Baeza-Romero, MT, Pilla, F., & Čok, G. (2024). Air quality awareness—Empirical evidence from a comparative perspective between two European cities. *Urban Science*, 8(3), Article 133. <https://doi.org/10.3390/urbansci8030133>
- World Health Organisation. (2018). Air pollution and child health: prescribing clean air. <https://www.who.int/publications/i/item/9789241515481>
- World Health Organisation. (2005). WHO air quality guidelines – global update 2005. <https://www.who.int>