

# Citizens' Attitudes and Practices Towards Waste Reduction, Separation, and Recycling: A Systematic Review

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**Abstract:** The aim of this systematic review is to analyze the attitudes and practices adopted by citizens in waste reduction, separation, and recycling, taking into consideration specific socio-demographic factors such as gender, age, income level, and level of education that might have an influence on these practices. The study was based on an extensive review of published articles found in Scopus. In total 27 articles were selected for analysis after filtering and evaluation based on a series of predefined criteria set for the present review, such as time period, geographical coverage, and thematic relevance. Many studies have shown that women, compared to men, in addition to being more aware, adopted more frequently recycling practices. Furthermore, age emerged as a very important factor, as younger citizens were more actively involved and at the same time more willing to recycle waste compared to older citizens. Additionally, education level proved to be a decisive factor, as citizens with higher educational levels possessed greater knowledge regarding recycling and, at the same time, had more environmentally conscious awareness about environmental problems. This resulted in citizens being more involved in various recycling practices. Finally, income proved to be an equally important factor in both shaping recycling attitudes and practices. It turned out that people who received higher incomes had more opportunities and resources for participating in pro-environmental activities. However, some studies have shown opposite results where the effect of income on waste separation practices was either not statistically significant or negative. Finally, from the research, it was clear that there is a need to incorporate environmental issues into educational programs and information campaigns. All these should be tailored to the needs of the socio-demographic groups targeted and at the same time be concerned with promoting best recycling practices as well as waste reduction.

**Keywords:** socio-demographic characteristics; practices and attitudes; reduce and recycle waste; recycling practices



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## 1. Introduction

Urban development in the 21st century is primarily influenced by the growth of cities and the restructuring of the urban economy. Rapid urbanization is one of the most important anthropogenic factors influencing ecosystems and sustainability. Urbanization contributes not only to economic and social development but also impaired environmental issues and challenged social cohesion. Scientists underline the need to explore the relationship between cities and the environment to understand the dynamic interactions associated with problems like climate change, consumption of natural resources, and degradation of the quality of life. Solid waste management is of key importance to both development and environmental protection, being an unavoidable result of human activity because its production has risen dramatically due to population growth. It is important to raise

awareness regarding waste prevention and landfill reduction [1]. In a manner akin to advancements in solid waste management that seek to mitigate ecological repercussions, innovative technologies in construction materials, exemplified by crystalline admixtures in self-healing properties on concrete, contribute significantly to the reduction of carbon emissions while promoting sustainability in urban development [2].

Since the beginning of urbanization, the production of municipal solid waste has been one of the most serious global environmental problems, requiring urgent action by urban managers to find effective management mechanisms [3,4]. Poor waste management remains an increasing challenge to municipalities worldwide and, in particular, the cities of developing countries, where rapid population growth has led to a significant increase in municipal solid waste generation [5]. This issue is intrinsically associated with Sustainable Development Goal 11 (Sustainable Cities and Communities), which advocates for the implementation of sustainable methodologies within urban environments, and Goal 12 (Responsible Consumption and Production), which underscores the importance of sustainable waste management and the efficient utilization of resources.

Total global waste was estimated to be approximately 20 billion tons in 2017 alone, and it is estimated that every individual generates an average of 2.63 tones of municipal solid waste per year. According to the estimates, waste generation is projected to increase to 46 billion tons by 2050. However, municipal solid waste constitutes a smaller portion and ranges from 2.29 to 3.13 billion tons, which is an increase of 30% to 50% within the last 15 years. By 2050, municipal solid waste is projected to increase further to 2.89–4.54 billion tones, a rise from 26% to 45% compared to 2019 [6].

The municipal authorities, in their effort to handle the problem properly, feel that a solution through technology alone is not possible. There is a need for active public participation, which is essential, especially in regard to source separation, reuse, and recycling [7].

Poor management of municipal solid waste, particularly in developing countries, leads to serious environmental pollution. However, principal treatment systems, such as dumping and incineration, are becoming important contributors aggravating the situation. Although composting has been identified as a viable solution for such hazards, the absence of source separation of waste remains a big challenge [8,9].

The solution to the problems associated with solid waste generation largely depends on technological progress, raising public awareness, and infrastructure development. Public awareness and readiness to properly manage households are the key strategies against pollution [10,11].

The reduction of generated waste and enhancement of the recycling rate are the two major challenges for now and the future. Waste reduction at source is the most essential step in the municipal solid waste management process, and recycling is the most environmentally benign option. Yet, worldwide, landfills account for about 70% of municipal solid waste [12].

Major benefits can be acquired from recycling and proper waste management for the environment and the economy [13]. Effective solid waste management reduces pollution, conserves resources and energy, and offers social and economic benefits to the communities. Moreover, recycling reduces the quantity of waste sent to landfills, thus increasing environmental sustainability [14]. Resource management and sustainable development present one case where recycling becomes very critical [15]. Efficient waste management minimizes the cost of waste disposal and creates opportunities for economic growth from recovered and recycled materials [13].

Effective implementation of recycling and sustainable resource management, however, relies on the knowledge and attitudes that citizens possess. Informed and aware citizens knowledgeable about the environmental and economic gains from recycling are likely to take up behaviors that reduce waste volumes and promote sustainable development. Citizens' involvement in environmental activities not only contributes to shaping a more environmentally responsible society, but also contributes to reducing pollution and con-

serving resources. Active participation by citizens can help in efficient waste management and reduction of disposal costs, thus improving opportunities for economic development through resource recovery and reutilization.

In this research, we examined the attitudes and practices of citizens in relation to waste management, with a special emphasis on the role of socio-demographic factors. In contrast to earlier studies focused on specific geographical areas or emphasizing only one aspect of waste management, this review examined a wide range of studies across different social and cultural contexts. The wider approach utilized in this study has allowed us to make comparisons and integrate data from different countries and social strata, hence enabling a comprehensive understanding of the socio-demographic influences on the waste management attitudes and practices of citizens. Moreover, this assured the findings had objectivity and reliability since it followed a systematic methodology. This study is especially useful to help formulate policies targeted at different social groups. Concerning this, it is highly important that the research offers a meaningful contribution to the literature about new perspectives in the context of the effective promotion of sustainable waste management practices in societies with different characteristics and needs. To achieve these objectives, the paper is organized as follows.

Section 2 presents the methodology used during the study for data collection and analysis. Section 3 analyzes citizens' attitudes and practices towards waste reduction, separation and recycling. Section 4 presents conclusions and recommendations.

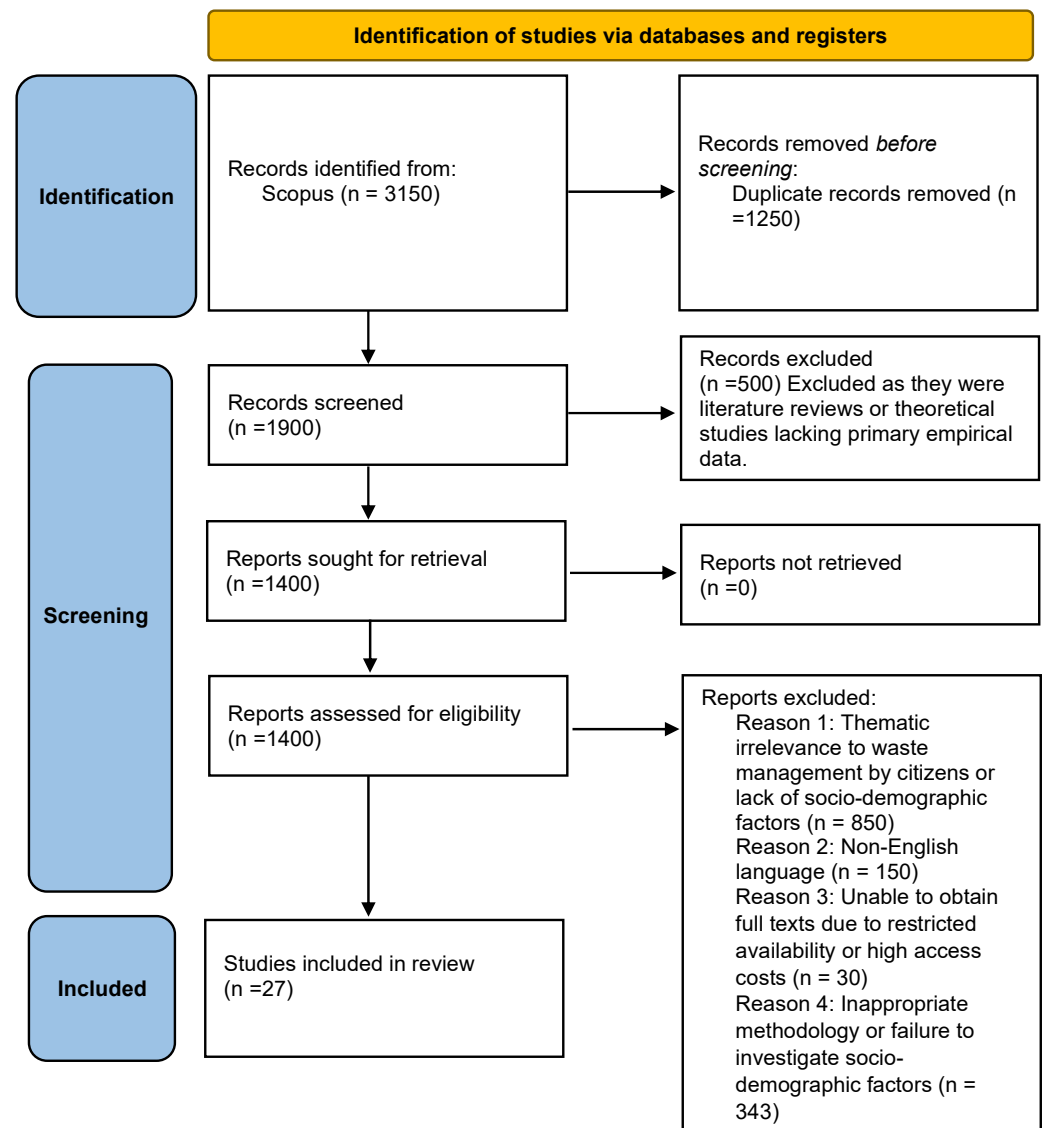
## 2. Materials and Methods

In the framework of this systematic review, the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines were adhered to, as illustrated in Figure 1. Furthermore, theoretical insights were derived from the paradigms established by Randles and Finnegan [16], and by Satriani et al. [17], to enhance the coherence and methodology of the analysis [18]. The process commenced with the identification phase of the studies, during which a comprehensive search was conducted using Scopus, one of the most prominent scientific databases. This database currently contains over 80 million records from more than 25,000 peer-reviewed journals, conference proceedings, and book series across many scientific disciplines. The keywords used for the article search were carefully chosen to be directly relevant to the topic of the research. Some of these keywords were: "Waste Reduction", "Waste Separation", "Recycling Practices", and "Socio-demographic characteristics". The search strategy did not rely on the usage of the above keywords but also employed combinations using Boolean operators. In particular, the following keywords and combinations were used: "Public opinion AND (waste management OR recycling OR waste separation)", "Citizens' attitudes AND (waste reduction OR recycling practices)", "Citizens' behavior AND (waste management OR recycling practices)", "Age AND (recycling behavior OR waste reduction attitudes)", "Gender AND (waste separation OR recycling practices)", "Education AND (public attitudes OR waste management)", "Income AND (recycling behavior OR waste management practices)", "(Public opinion OR citizens' attitudes) AND (waste reduction OR recycling) AND (age OR gender OR education OR income)", "Age OR education AND (public opinion AND waste management)", and "Gender NOT (income) AND (citizens' attitudes AND recycling behavior)". Simultaneously, the search was confined to scholarly articles published from 2018 onward, stipulating that the research dates ranged from 2016 to present, thereby guaranteeing that the analyzed information is contemporary and reflective of prevailing trends. Initially, a total of 3150 articles were identified through the database of Scopus.

From the initial articles identified, 1250 duplicate articles were removed, due to the fact they were repeated entries. After the initial screening of duplicate content, the number of articles that proceeded to the subsequent stage of evaluation was 1900.

The remaining set of 1900 articles underwent a rigorous assessment of their content, with the objective of eliminating those that did not present empirical findings. As a part of this procedure, 500 articles were excluded as they were literature reviews or theoretical

studies lacking primary empirical evidence. Subsequently, the total number of articles was decreased to 1400.



**Figure 1.** Proposed research framework.

Upon the culmination of the identification process, the second phase of screening was applied. During this stage, the remaining records underwent evaluation based on thematic pertinence and publication language. Out of the 1400 records that successfully progressed from the preceding phase, 850 were dismissed on the grounds that their content either lacked direct relevance to the management of waste by citizens or failed to address socio-demographic factors. More precisely, a significant number of these studies concentrated on technical solutions or waste management systems, thus rendering them inconsistent with the primary research focus of this review. After this stage, 550 articles were left that met the basic thematic criteria.

Subsequently, an assessment of the language utilized in the articles was conducted. Out of the 550 articles, 150 were eliminated due to their publication in languages other than English. This criterion was considered essential, as linguistic coherence was important for the precise interpretation and evaluation of the data. Following the completion of this process, a total of 400 articles remained that met the linguistic criteria.

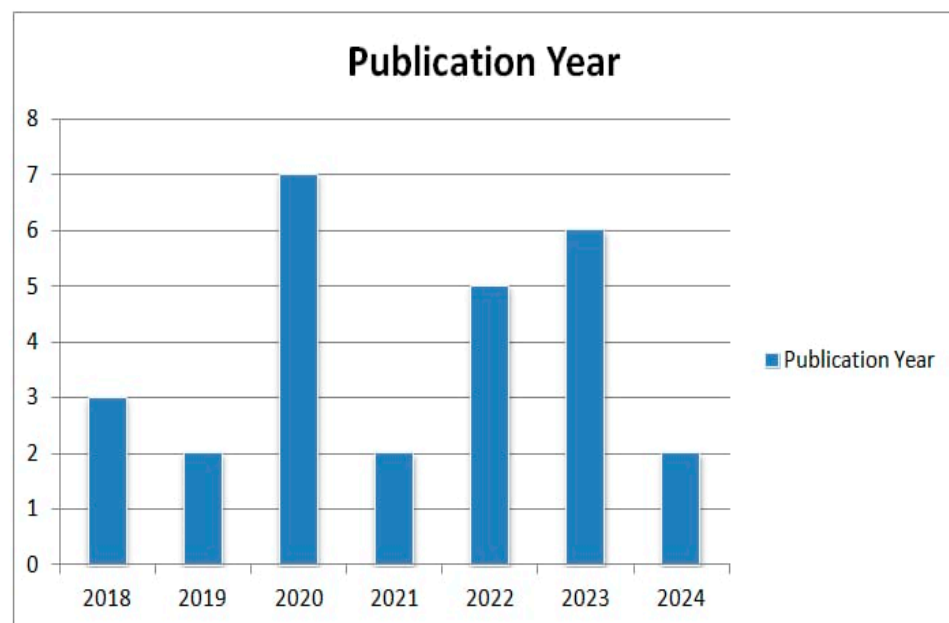
From the 400 studies that satisfied the stipulated criteria and progressed to the subsequent phase, the complete texts were subsequently subjected to analysis. For a total of 30 articles, it was infeasible to obtain the complete texts, attributable either to restricted availability or high access costs. Consequently, a total of 370 studies were submitted for further evaluation.

In the evaluation of the appropriateness of the studies, the complete texts of the 370 studies were scrutinized based on specific criteria, which encompassed the temporal scope, thematic pertinence, and publication language. At this juncture, 343 studies were omitted for a variety of reasons. Notably, 110 of these were discarded as they did not investigate the impact of socio-demographic factors on citizens' attitudes and practices regarding waste management, which constituted the principal focus of the research. An additional 60 studies were omitted from consideration as they pertained to divergent themes, including environmental policy or technological advancements in recycling, whereas 50 studies were deemed unsuitable due to methodological deficiencies, exemplified by inadequate delineation of the data collection procedures or constrained sample sizes.

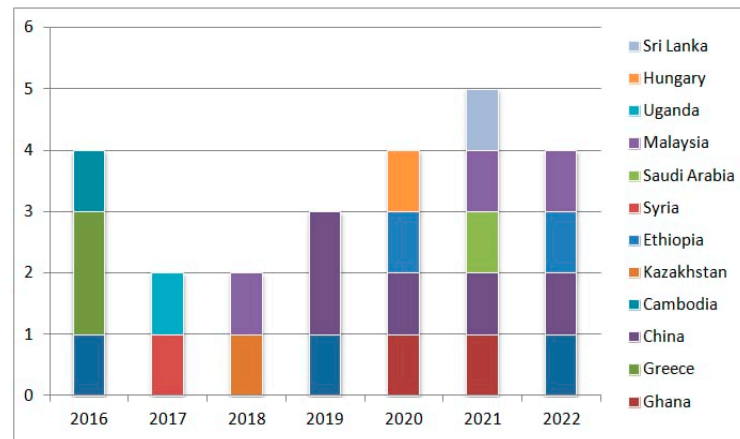
Ultimately, after a rigorous assessment, 27 studies met all inclusion criteria and were included in the systematic review. These studies were deemed suitable to significantly enhance our comprehension of citizens' attitudes and practices in waste management, as well as the impact of socio-demographic factors on these attitudes.

### 3. Results

The systematic review of the available literature on citizens' attitudes and practices for waste reduction, separation, and recycling was conducted in June 2024. The selected articles which are presented in Appendix A highlight the importance of the parameters of socio-demographic characteristics, such as age, gender, education and income, influence of attitudes, and practices in waste management, in shaping citizen's perception of environmentally concerned management. In this framework, Figure 2 illustrates the allocation of scholarly articles in relation to their publication year, thereby providing an insight into progression over the years. Figure 3 depicts the temporal distribution of survey years categorized by nation, thereby offering comparative data regarding the temporal aspects of research activity across diverse countries.



**Figure 2.** Illustration of the allocation of scholarly articles according to their year of publication.



**Figure 3.** Article temporal distribution in survey years categorized by nation.

### 3.1. Citizens' Attitudes and Practices Towards Waste Reduction

The most important objective of environmental management is waste reduction. This goal is mainly based on the attitude and practices of citizens. This chapter is focused on citizens' knowledge and attitudes towards waste reduction, the impact of education on such practices, the actual practices adopted, and the role of gender in waste reduction. These observations and findings can, therefore, be very instrumental in the formulation of policies and actions that can lead to a more sustainable and environmentally conscious society.

#### 3.1.1. Gender and Waste Reduction

Different surveys that have been carried out on waste reduction provided different results regarding the role played by gender in the process. This section presents four studies about the relationship between gender and citizens' participation in reducing waste through composting and 3Rs (Reduce, Reuse, Recycle) practices. More specifically, the study by Drimili et al. [19] aimed to examine the Athenians' point of view and attitudes towards recycling, composting, and the operation of green centers. Collection of data took place at different times of day and days of the week during April and May 2017 in Athens, Greece. The methodology of this research involved individual interviews of the 504 respondents using a structured questionnaire. The results indicated that gender had no statistically significant relationship on residents' participation in composting, which is one of the essential factors for waste reduction. These findings indicated that men and women were both quite willing to become involved with composting-related activities [19].

On the contrary, a study by Alimoradiyan et al. [20] came up with different findings, where it elicited that gender had a significant influence on composting activities. More specifically, the study was conducted in the city of Tehran on August 2022 and focused on investigating socioeconomic factors influencing community participation in the municipal solid waste management system. In particular, this study focused on how socioeconomic characteristics of citizens affected their attitudes and practices toward waste sorting, recycling, and composting. Face-to-face interviews with a questionnaire were conducted with 664 respondents to achieve the objectives of this study. The survey combined both qualitative and quantitative analyses of the citizens' behavior regarding waste management. The study showed that women were three times as likely to be involved in activities related to composting than men. Specifically, the results from this study indicated that apart from composting, gender played an important role in the implementation of the 3Rs (Reduce, Reuse, Recycle). What was specifically noted was that women dominated in waste management [20]. This could mean that women were more aware or willing to take up leading roles on matters involving practices of sustainability.

Similarly, the research conducted by Kunszabó et al. [21] aimed to investigate household composting practices by citizens in Hungary, along with the associated benefits, barriers, and incentives perceived by them. Moreover, the focus of the research was on

composting practices and the attitude of citizens towards the environment and food waste management. It was based on a quantitative analysis of questionnaires from consumers. Data were mainly collected in railway stations in densely populated cities in Hungary between July and September 2020, with a total of 1002 completed questionnaires. The results indicated that, regarding the category of citizens who applied moderate composting practices, 56.54% were women, while the rest, 43.46%, were men. On the other hand, regarding citizens who were indifferent to composting, men dominated the study with 57.03%, while women comprised 42.97%. Finally, for the category of active environmentalists, women made up 58.20% of the participants, with men comprising 41.80% [21].

All these studies had findings that were inconsistent and which showed that the effect of gender participation regarding waste reduction activities was not clear. While some showed no statistical difference between male and female behavior, others showed that women were more willing to be involved and already involved in environmental activities. These results suggested that women probably had a greater awareness of and interest in waste management and sustainability practices.

### 3.1.2. Knowledge and Waste Reduction

One of the major factors in effective waste reduction is citizens' knowledge regarding waste reduction and waste management practices. Understanding the importance of waste reduction can be directly related to practices that citizens apply in their day-to-day lives. However, the results of five pieces of research indicate that there are variations in citizens' knowledge and practices depending on the region and social context.

For instance, the study by Adefris et al. [22] focused on analyzing practices in households and determinants of solid waste segregation in the urban areas of Addis Ababa, the capital city of Ethiopia. The questionnaires were administered to 244 respondents in May 2022, followed by 15 interviews with the heads of agencies responsible for waste collection. The study revealed that most of the respondents, about 76.2%, related the 3Rs (Reuse, Recycle, and Recover) mainly to waste separation. However, the percentage of those who responded that they did not know about the 3Rs was 12.3% while another 11.5% was unsure. Most of the respondents recognized the economic worth of waste and provided examples, like the use of animal manure or any other organic waste which can be composted. Additionally, over 73% of the respondents replied that source separation of solid waste is effective in reducing waste, indicating that a large proportion of people within the community understood that this practice led to a reduction in the quantum of generated solid waste [22].

On the other hand, in the survey by Drimili et al. [19] in which citizens were asked about their knowledge with regard to composting, the majority of the respondents, (77.4%), indicated that they were moderately to extremely familiar with the concept, while the rest, 32.6%, reported little to no knowledge on the subject [19].

This picture of composting knowledge gave the basis for understanding the relationships between knowledge and other waste management practices. In this context, the study by Almasi et al. [23] focused on investigating the knowledge, attitudes, and practices on 1750 women regarding source separation and reduction, recycling, and the harmful effects of poor solid waste management on the environment and human health in Kermanshah City. This survey was conducted within a period from April to September 2016, with structured and semi-structured questions, using face-to-face interviews. The findings showed that citizens' knowledge with respect to waste reduction was at a medium level in Kermanshah. Moreover, it was ascertained that demographic traits were not significantly related to the knowledge and practices of women in relation to composting. These findings helped a great deal in understanding how knowledge and attitudes shape solid waste management practices within the area [23].

On the contrary, the study conducted by Zand et al. [24] during the period from February to May 2019, aimed on identifying women's knowledge, attitudes, and practices towards municipal solid waste management in Tehran. In this study, a questionnaire was

used and 384 women responded to a self-administered open-ended series of questions in written forms. The results from the survey indicated that the respondents had a high level of knowledge but their attitudes toward and practices for waste reduction were found to be weak. In the second phase of the study, the effectiveness of the face-to-face training on waste management knowledge, attitudes, and behavior was evaluated. One-sixth of the women interviewed during the first phase (64 out of the 384) were randomly selected for training. The training course included source separation methods at home and strategies to reduce and reuse waste. After 3 months, the women were re-examined. As a result of training, the knowledge and attitudes of women increased by 18.2% and 8.5%, respectively. The practice regarding waste management increased to about 63.9%. Knowledge, attitudes, and practices for waste management further increased to 82.3%, 79.1%, and 75.4%, respectively. In that respect, training had a very strong influence on their participation in source separation of waste by 93.1%. Additionally, the training of women in source reduction and separation techniques increased the likelihood that they would contribute to projects of this kind by 37.7% [24].

Finally, one major challenge was the lack of reduction and reuse knowledge. More specifically, the survey from Eshete et al. [25] aimed to assess household knowledge, attitudes, and practices about solid waste management and associated factors in Gelemso Town, Ethiopia. The survey was conducted from March to June 2020. A total of 390 respondents participated, who answered a structured questionnaire with open and closed questions. The findings of the survey revealed that citizens' lack of knowledge about reduction and reuse contributed to inappropriate waste management practices [25].

The above surveys demonstrate how citizens' knowledge of practices towards waste management was directly reflected in their daily habits. The surveys' results showed that there were differences in knowledge and waste management practices depending on the region and social context. Moreover, citizens with a stronger knowledge of the concepts of reduction, recycling, and reuse contributed more effectively to the outcome of waste management. Finally, a lack of knowledge about reduction and reuse led to inappropriate practices, highlighting the need for further education and awareness efforts.

### 3.1.3. Education and Waste Reduction

The impact of education on reducing waste has been studied over a long period, and the results vary depending on the form of practice and extent to which people apply knowledge. The relation of education to waste reduction practices was examined in the following four pieces of research.

More specifically, according to Drimili et al. [19], no statistically significant correlation emerged with respect to the level of education and participation of the residents in composting [19]. This means that composting as a practice for waste reduction may not necessarily be dependent on the educational level of a person.

Other studies, however, pointed to education as a factor of influence on practices of waste reduction. Notably, a study by Zand et al. [24], established that there was a significant relationship between the level of education and knowledge, attitudes, and practices of citizens in regard to reducing, reusing, and recycling municipal solid waste. Individuals with a higher level of education generally exhibited greater knowledge regarding the environmental impacts of waste and were more actively involved in adopting waste reduction and recycling practices [24].

Similar results were observed in the study by Ansah et al. [26] in Ghana, Africa, during June of 2021, using an online survey with 1406 respondents through a structured questionnaire. The survey sought to obtain the willingness of Ghanaians to segregate household solid waste for a proper and sustainable waste management system. Therefore, the research focused on satisfaction with the existing system on how waste is managed, preference for the waste collection and disposal system, awareness of the impact of the present waste management system on the environment, the knowledge of separation of waste, and the willingness to separate household waste. The results showed that though



their educational status did not affect awareness of the separation of waste, it was the highly educated who understood that household waste can be reused and recycled to minimize pollution. This indicated that education contributed to the understanding of the chances of reducing waste [26].

Finally, the survey conducted by Alimoradiyan et al. [20] showed that education was one of the factors influencing composting. In fact, respondents who had previously attended training programs that were geared towards the reduction of municipal solid waste were three times more likely to be involved in composting. Additionally, those who reported receiving media information on the practices of the 3Rs (Reduce, Reuse, Recycle) were five times more likely to be involved in composting as compared to others who had reported receiving zero information. In this case, it can be added that educated citizens seemed more aware of the benefits associated with composting and hence showed a greater tendency to take part in such activities [20].

Overall, the relationship between education and waste-reduction practices was varied, according to the findings of the surveys. In some cases, education did not play a decisive role, as in the case of composting, while in others, citizens with higher levels of education showed increased awareness and active participation in practices like recycling and reuse. Education thus plays an important role in waste reduction.

#### 3.1.4. Practices and Waste Reduction

Waste reduction practices from citizens are remarkably different depending on knowledge, attitudes, and information related to waste management. Although there is general awareness about environmental problems, the same is not reflected in citizens' practices. In this section, the results of the remaining seven articles concerning the practices of citizens in waste management and reduction are appraised.

For example, according to Almasi et al. [23], in the conducted survey, practice in waste reduction proved to be lower compared to knowledge and attitudes among the respondents. The results also revealed that the overall awareness of domestic composting was low, with only 16.91% of people being aware, and only 1% of women actually practicing composting [23].

On the same note, the results from Eshete et al. [25], showed that about 80.0% of the households were not managing solid waste accordingly and their experience regarding solid waste reduction and reutilization was not satisfactory [25].

Another study by Zand et al. [24] established that adequate knowledge and a positive attitude of citizens do not guarantee good practice in reducing waste [24]. This reflects that there is a dire need for more effective methods to motivate citizens to apply their knowledge to their lives.

The results from the study conducted by Ismail et al. [27], also revealed that most citizens did not become involved in the composting of organic waste. In this context, 52.05% of the respondents answered that they never performed any composting, equal to 127 from 244 respondents [27].

Moreover, Nuwamanya and Byamukama [28] conducted a study that focused on determining the factors from citizens that impede the effective management of solid waste in Nansana, Uganda. The research was aimed at availing stakeholders with information that could be used in designing appropriate interventions to ensure proper management of solid waste. A total of 272 households responded to structured questionnaires. Quantitative data for this study were gathered through questionnaires and interviews, while qualitative data were obtained via tape and telephone recordings. The findings showed that only 8.5% of the respondents sorted the waste before disposing of it, while 14% were reusing the waste for other purposes. This therefore means that 77.5% of citizens were throwing waste on the streets, which is an indication that very few people put into practice proper waste management [28].

The study by Nsimbe et al. [29] set out to determine the knowledge, perceptions, and practices concerning composting at the household level. The quantitative data for the

current study were collected through a semi-structured questionnaire from 368 residents of Masaka Municipality in Central Uganda in January 2017. The results showed that only a small fraction of the households practiced composting. More specifically, out of 368 respondents, 11.4% practiced composting [29].

On the other hand, despite all these worrisome signs, there stands a more optimistic viewpoint. According to the survey conducted by Drimili et al. [19], most of the respondents showed willingness to be part of future composting projects. In particular, 66.2% of the participants were willing to participate in composting programs, while 23.7% were moderately willing, with others showing reluctance to participate. It was remarkable that these programs were most likely to involve married and working individuals. Also, high environmental concern and perceptions of generating a lot of waste boosted the chance of participating in composting activities [19].

Finally, the results obtained by the survey of Alimoradiyan et al. [20] showed that although only 9% of the surveyed respondents reported they were engaged in composting, and nearly all of them, 97%, did not apply this method of reducing wastage. However, a significant percentage, 30.7%, was willing to start composting; therefore, there was room for developing community initiatives and educational activities promoting the benefits and simple processes of composting [20].

In summary, the results show that, despite an increase in citizens' awareness of environmental issues, low waste reduction practices were maintained, with a limited implementation of composting and solid waste management. The gap, from knowing to actual implementation, makes the demand for having more effective incentives and motivational strategies. Moreover, it was observed that limited recycling and composting practices prevail in many areas that proves the necessity of educational and community initiatives. Lastly, there was scope for development in terms of the creation of community programs and improving citizens' environmental awareness.

### *3.2. Citizens' Attitudes and Practices Towards Waste Separation*

Effective waste management is a precondition for environmental and public health protection. While people are, in general, aware of its necessity, big differences are present in practices regarding waste separation. Parameters relating to a citizen, like age, gender, educational level, and income, may be very important in the adoption of such practices. This section aims to highlight the influence of various social and economic factors on the behavior of citizens regarding waste separation in order to obtain a better understanding of the reasons for waste management.

#### *3.2.1. Age and Waste Separation*

Household waste management and source separation are two of the prominent issues in the context of environmental protection. Citizens' participation in these practices is affected by different factors, one of which is age. This chapter tries to present a review of six studies that have attempted to explore the influence of age on waste management practices in different regions and populations.

Several studies indicated that older people were more willing to participate in practices related to waste segregation. Yuhuan et al. [30] developed research that aimed to examine how different factors—demographic and socio-economic characteristics, local authority involvement, and socio-psychological factors—were influenced by household waste management practices. Specifically, the household's intention for source separation of solid waste and methods of disposal of solid waste was investigated. The survey was conducted from the beginning of October 2021 to the middle of November 2021, covering three districts in the Western Province of Sri Lanka. A total of 428 households were surveyed and responded to a semi-structured questionnaire on Google Forms. According to the findings of the research, age significantly impacted the intention of household heads towards separating domestic solid waste. Older household heads indicated a stronger willingness to sort their waste compared to younger heads [30].

Simultaneously, the research which was conducted by Noufal and Maalla aimed to understand factors that influence the participation of households in source separation programs. In particular, the research focused on the socio-economic characteristics of the households, availability of the collection service for waste, knowledge regarding the benefits acquired from separating the waste, and the citizens' environmental awareness and concern. The study area was the city of Homs, Syria. In the survey, the sample consisted of 300 households which answered the questionnaire. Data collection occurred from July 2017 to February 2019. The results of the survey showed that older age heads of households were reported to have a higher likelihood of participating in waste separation. This may be caused by the fact that elderly and retired citizens have more time at their disposal and can, therefore, engage in waste separation practices. This research adds important insights into the factors that influence household participation in source-separation schemes, underlining the age of heads of households as an influencing socio-economic parameter in structuring environment-related behavior [31].

Similar results were found in the study conducted by Sarbassov et al. [32], which aimed to study the attitudes of the citizens of Nur-Sultan for the disposal and separation of household solid waste at source. Meanwhile, it also aimed to analyze the factors affecting citizens' recycling behavior. This research was conducted in the capital of Kazakhstan, Nur-Sultan (formerly Astana), from April to July 2018. A total of 3281 respondents participated, who completed electronic questionnaires containing open and closed-ended questions. The findings indicated increased willingness towards separating waste among the elderly, with about one third indicating a positive attitude towards source separation [32].

Moreover, the survey of Fadhullah et al. [33], was aimed to assess the attitudes and behaviors of citizens about reducing, separating, and recycling waste. More attention was paid to the influence of socio-demographic variables on waste management. The duration of the survey was from January to May 2018. The location for this study was Panji Sub-district, which includes many districts like Taman Bendahara, Taman Desa Kujid, and Kg Belukar Village. Participation in this study involved 338 households answering a survey questionnaire with open-ended and closed-ended questions. It was revealed in the survey that there was a high correlation between the practice of waste separation and age. More specifically, it transpired that the respondents aged 50–65 years were those who did segregate their waste more, while the 35–49 year-old group segregated less [33].

The findings from Alimoradiyan et al. [20] showed that the age of the respondents had a significant effect on participation in the waste sorting process. More specifically, respondents aged between 31 and 45 years were most likely to participate in municipal solid waste sorting compared to those below the age of 30. Similarly, for the respondents aged 45–60 and over 61, sorting participation was more likely than for those under 31 [20].

In contrast, some studies indicated that waste segregation practices are more likely to be conducted by younger people. The study by Zhang et al. [34], conducted in April 2020, in Yingtan City, Jiangxi Province, China, focused on the waste-sorting behavior of younger Chinese people and which reasons influence such behaviors. This was a survey of 579 students who responded to a semi-structured questionnaire consisting of open and closed questions. The results indicated that more than half of the students were actively participating in separating their waste, with younger students performing better than their older counterparts. This finding suggests that age has a positive effect with respect to the practices of separating waste, indicating that the younger the student, the keener they were to implement such practices. In contrast to this study, the Hao et al. [35] research found that senior students were more likely to participate in waste separation compared with their juniors. This means that older classmen students had developed a higher level of awareness and commitment to environmental practices, probably as a result of increased exposure and awareness of the issues throughout the years of studying [34].

Some studies also exist which have found no significant relationship between age and waste management. The objective of the study by Ssemugabo et al. [36] was to assess household waste management practices and investigate the factors associated with good

waste management practices. Specifically, the study sought to understand the existing condition of solid waste management in one of Kampala City's slums in Uganda. In this study, 395 households responded to the study through a semi-structured questionnaire and an observation checklist. The study's results concluded that there was no significant association between age and solid waste management status regarding the head of the household [36].

In summary, most of the studies indicated that older household heads were more likely to be involved in waste separation practices, although there were some exceptions when younger heads were actively involved under certain circumstances. Some studies, however, have shown there was no relationship at all between age and waste separation, thus pointing to the need for further research.

### 3.2.2. Gender and Waste Separation

Survey analysis of seven studies in relation to the role that gender plays in waste segregation provided varied results, showing that the influence of gender on waste management practices can be due to a plethora of factors.

Several studies indicate that women are more willing to be and are already involved in waste management and waste separation compared to men. The survey conducted by Alhassan et al. [37] carried out in Accra from February to July 2020 assessed factors that influence the behavior of households in source separation of waste and the preferred methods for solid waste disposal. The study focused on the most populous and fully urbanized city of Ghana, usually referred to as the 'millennium city'. Involving 525 respondents who answered structured questionnaires, the results obtained from the survey indicated that male-headed households were likely to be 6.79% less involved in the process of waste separation. This finding reflects the traditional culture of Ghana, wherein reuse is solely considered a woman's affair [37]. Furthermore, according to the survey which conducted by Elmosaad et al. [38] it turned out that female-headed households were 2.35 times more likely to implement practices of source separation compared to male-headed households [38].

A study by Noufal and Maalla [31], also revealed that female heads of households were more likely to segregate waste than men. One possible explanation is that women were more engaged in pro-environmental behaviors and took a more active role in waste-related activities because they managed the household and were responsible for determining what was useful and what was waste [31]. This was also supported by the study conducted by Tang et al. [39], which revealed that women were more likely to participate in household garbage sorting compared to men, a situation that could be attributed to a higher level of taking up chores concerning household management [39]. On the same note, the Sarbassov et al. [32] survey indicated that the gender distribution was 43% male and 57% female, with 21% of the men and 27% of the women responding that they implemented source separation. Gender was proven as a major factor that might affect a citizen's intention to separate waste [32].

Another study carried out by Qu et al. [40], in 2022 aimed to examine the attitudes and behaviors of university students about separating waste and the factors that influence such behavior. The research also studied how socio-demographic student characteristics affected their attitudes and perceptions about waste management. The study was conducted in the Henan Institute of Science and Technology, China. The methodology used was questionnaires, with a total sample size of 1213 students. Together with the questionnaires, there were reviews of previous studies in conjunction with interviews of some experts and representative students. The findings of the study revealed that female students had better attitudes and behaviors toward sorting waste than male students [40].

On the contrary, the study by Adefris et al. [22] found no significant difference in waste separation depending on gender, while similar results were presented by the survey of Hao et al. [35], where the students' participation in waste separation did not statistically depend on their gender [22,35]. Last but not least, a study by Fadhillah et al. [33] established that the variable 'gender factor' had no significant association with waste segregation practices,

while that of Ssemugabo et al. [36] concluded that no significant association was found between gender and solid waste management status [33,36].

Analysis showed that gender had an influence regarding citizens' participation in waste management and segregation, with women being found to be more willing and participating more actively than men. However, some studies did not establish a statistically significant association between gender and waste segregation. Traditional cultures, roles in the household, and environmental awareness were determinant factors in the increased participation of women in environmental practices. In most cases, despite variations, gender turned out to be an important influencing factor while in some other cases it would not show much effect. In general, the findings are varied, thus giving the indication that the relationship between gender and waste segregation is influenced by many factors.

### 3.2.3. Income and Waste Separation

One of the important issues concerning waste management is the effect of income, with many researchers arguing that it is directly or indirectly linked with sustainability and environmental awareness. The following review shows seven different views on the role of income in separation practices related to waste, with some studies being positive, while others question whether income plays a significant role as a determinant on waste management practices. In this respect, the paper reviewed the findings of some studies to shed light on the complexity of the relation between income and waste management practices, showing agreements and contradictions in the relevant studies.

The results from Noufal and Maalla [31], showed that monthly income had a statistically significant effect on the willingness of households toward waste separation. It was established that an increase in household income increased their willingness to practice waste separation. This indicates that rich households were more willing to embrace this practice. This result could be attributed to the fact that high-income households tended to consume more products than low-income households, thus producing more waste. Moreover, citizens with higher incomes had greater access to a wider range of media, allowing them to be better informed about environmental issues compared to those with lower incomes [31].

Furthermore, a study by Seng et al. [41], was conducted to analyze factors influencing the knowledge, attitudes, and practices of residents regarding solid waste management in the city of Phnom Penh. This research was focused on assessing the determinants that shape citizens knowledge, attitudes, and behaviors about waste problems and its management. Interviews of 800 households were conducted with the help of a semi-structured questionnaire. The survey was conducted in the suburban areas of Phnom Penh, running from 6 August to 4 September 2016.

The results of the survey indicated that income turned out to be one of the determining factors of citizens' knowledge and attitudes. The results further showed that respondents with higher incomes were much more aware and satisfied with the services being provided for waste management, perhaps having some bearing on better segregation practices [41].

However, some studies have indicated opposite findings. According to Alhassan et al. [37], the increase of household income reduced the probability of waste separation by 0.004% and is statistically significant at the 5% level. This proved that rich households were less likely to practice waste separation compared to poor households [37]. The study by Kuang and Lin [42] also aimed to identify the determinants affecting residents' willingness and behaviors with respect to sorting municipal waste and further explore the intention-behavior gap. The data were collected by means of an online questionnaire application called "Questionnaire Treasure". In all, 2166 respondents participated. The survey took place in October 2019, covering the four major cities of China: Beijing, Shanghai, Guangzhou, and Shenzhen. The findings of the study showed that income had no significant statistical effects on influencing the willingness and behavior of citizens with respect to waste separation [42].

According to Sarbassov et al. [32], it turned out that income level was not a main factor for household waste source separation behavior [32]. Likewise, Adefris et al. [22], in their study, established that income and waste separation practices were not associated. Lastly, studies by Fadhullah et al. [33] and Elsoaad et al. [38] established that there was no significant association between waste separation practices and monthly income and occupation.

Summarizing the findings of the above studies, opinions on the impact of income on waste separation practices are conflicted. While some studies argue that raising income levels increases the willingness of households to sort their waste, others found there is no significant relationship or even that higher income reduces this willingness. Ultimately, different views brought out the complexity of the relationship between income and waste management and therefore clarified that there was no single or absolute link between the two variables. The findings emphasize the need for further research to clarify the conditions under which income could influence environmental practices.

#### 3.2.4. Knowledge and Environmental Awareness

Waste management requires knowledge and environmental awareness. The following ten studies deal with the aspects of citizens' knowledge and awareness and how that influences their attitude and practices toward waste management.

A study by Seng et al. [41], indicated that citizens with a higher level of education and awareness of the health impacts resulting from waste issues were well-informed about waste problems. This higher knowledge changed their attitude and made them more demanding for waste management services while showing dissatisfaction with the present condition of waste management and collection services [41].

Similarly, Tang et al. [39] confirmed that the attitude of citizens in regard to waste management was directly impacted by knowledge concerning waste. Knowledge about environmental issues had a positive effect on the classification of household waste and emerged as an important factor influencing the behavior of citizens in terms of sorting their waste [13]. Regarding knowledge of laws on solid waste management and the risks of mismanagement, respondents were found to be quite knowledgeable according to Ssemugabo et al. [36], with 50.6% knowing the laws and 69.6% aware of the risks. Members of households who knew the relevant laws were 1.5 times more likely to correctly handle their waste compared with those who did not know the laws. Also, those knowing the risks resulting from bad waste management were 2.2 times likely to implement good practices in waste management [36].

Also, according to Elmosaads et al.'s [38] survey, the majority of the respondents had a low degree of awareness regarding waste segregation. On the other hand, 87.5% were aware that waste segregation at the household level allows for reusing and recycling, while 93.5% were aware that effective waste segregation means less waste goes to landfill. Moreover, it turned out that the odds of implementing waste separation at source were 2.85 times higher in those households with high awareness in comparison to those households with low awareness [38].

In the survey from Eshete et al. [25], which included 390 households, 61.3% of the participants were females, and most of the household members had good knowledge toward solid waste management. The majority of respondents strongly agreed on the risk of improper disposal of solid waste and almost 80% agreed that proper solid waste management was crucial for a healthy environment [25].

Despite the general knowledge available, according to Qu et al. [40], it was shown that although students were generally aware of the importance of waste segregation and their responsibility, they lacked sufficient practical knowledge to implement segregation effectively [40]. Similarly, the study by Noufal and Maalla [31] showed that the odds of practicing source separation by those households (which were aware of the benefits of separating waste) were 38.49 times higher compared to households who did not have such knowledge. Likewise, the results indicated that households aware of the impact of solid

waste on the environment were 39.05 times more likely to practice source separation of waste compared to those not aware [31].

In the work by Zand et al. [24], it was reported that 69.6% of women had an appropriate level of knowledge regarding municipal waste management; however, only 46% implemented average practices [24].

According to the study in Nansana reported by Nuwamanya and Byamukama, a majority of 55.6% had moderate knowledge of solid waste, while 29.6% had high knowledge and 14.8% had low knowledge. One of the main causes of poorly managed solid waste was a lack of knowledge about proper management methods [28].

Finally, in the survey conducted by Hao et al. [35], the results found that 5.5% of those surveyed was familiar with Zhengzhou's waste separation standards, thus indicating that students have a low level of knowledge concerning this aspect. Generally, knowledge about waste separation was low. Nevertheless, the findings showed that there was a considerable relationship between what students know and their behavior [35].

In summary, knowledge of environmental issues and related laws contributed immensely to the formation of the correct approach and behavior towards waste management. Increased knowledge resulted in the potentiality of the right implementation of practices with regard to waste separation and management. Deficiencies in knowledge, on the other hand, limited the potentiality of the right implementation of the practice of waste separation and management.

### 3.2.5. Education and Waste Separation

The relationship between educational attainment and waste management behavior from citizens has been studied several times, and the results largely differ. While some studies have reported that higher education correlates with more responsible waste management practices, others indicated the opposite or non-statistically significant results. The review that follows brings together and compares the findings of seven studies, pointing out the different approaches and conclusions on the impact of education in waste separation behavior.

The research conducted by Yuhuan et al. [30], revealed that household heads with higher levels of education were more likely to adopt good waste disposal practices, including separating waste. Awareness campaigns by the local authorities had positive effects on household solid waste disposal management by enhancing the adoption of similar household practices [30].

Similarly, the study by Tang et al. [39] evaluated the determinants of household waste sorting behavior among residents of Shanghai, China, in 2021. The data in the study were derived from an online survey with 637 respondents. The findings of the study showed that the higher the education level of citizens, the more the environmental knowledge they would have, and hence, the higher the possibility of participation by residents in activities concerning household waste sorting.

Moreover, according to Zhang et al. [34], the environmental education received at school had a positive effect on students' behavior regarding waste separation. Students who had environmental education were 1.766 times likely to follow good practices of waste separation compared to students who did not have this type of education.

What is more, results obtained from the survey conducted by Adefris et al. [22] indicated that the respondents' awareness or education had a significant relationship with regard to the practice of solid waste separation [22]. The analysis showed that increasing public awareness and giving relevant training were significant in promoting and encouraging household-level practices of separating solid waste. In instances where citizens were aware of the importance of separating their waste and had received adequate training on how to do so, they tended to be more active in source separation of their waste.

However, according to Kuang and Lin [42], the influence of education on litter-sorting intention was positive and significant, meaning that the willingness to sort litter was greater for the respondents with higher education. Nevertheless, educational background had no

significant influence on litter-sorting behavior. In other words, although educational level could enhance the willingness of the respondents to sort their garbage, it did not have any statistically significant effect on the actual garbage-sorting behavior [42].

According to Ansah et al. [26], while citizens of a high educational level were aware that household waste could be recycled and put to other uses to reduce pollution, educational status did not affect awareness with respect to separating waste. About 90.5% of the respondents' opinions were that recycling domestic waste would significantly reduce pollution. A total of 67.4% of the respondents had knowledge about separating waste, while 72.1% agreed to do so only if it was made compulsory [26].

Finally, Ssemugabo et al. [36] also found no statistically significant relationship between education level and effectiveness of solid waste management. This contradicts the widespread belief that higher education always leads to better waste management practices [36].

In summary, research has shown conflicting results on the effect of education on litter-picking behavior. Some studies found a positive relationship between educational level and willingness or behavior to separate waste, while others indicate that education does not have a statistically significant effect on actual separation practices. Moreover, environmental education and raising awareness increased citizens' participation in waste separation. There were also cases when willingness to separate waste was higher among citizens with a lower level of education.

### 3.2.6. Practices for Waste Separation

Household solid waste management has been one of the most important issues the modern world's societies face. Despite a growing awareness about the impacts on the environment and the necessity for sustainable waste management, the implementation of proper separation practices and management in many areas has been problematic. The present review brings together findings from ten studies that investigated the status of these practices in a few population samples.

For instance, in the survey conducted by Sarbassov et al. [32] it transpired that about 24% of the respondents already separated household solid waste without any source separation system in place [32]. This percentage represented some basic willingness to separate in the absence of infrastructure. In most cases, however, waste management practices are still inadequate. According to Ssemugabo et al. [36] only 41.3% of households showed good waste management practices, while 78.7% did not separate their waste. Few households separated and paid for their solid waste collection and less than half of the households showed proper solid management practices.

Furthermore, according to Fadhullah et al. [33], from the results of the survey, it was found that roughly 50.3% (which amounts to 170 respondents) practiced source segregation of the waste at source, while the remaining 49.7%, which was represented by 168 respondents, did not follow this practice. From these data, it was concluded that there was no significant difference between the two groups with respect to source separation of waste [33].

The first group was students, who have a wide array of attitudes toward waste separation. The survey conducted by Hao et al. [35] aimed to investigate university students' litter separation behavior in Zhengzhou and to understand the motivation behind student behavior [35]. In fact, it sought to understand knowledge, attitudes, and practices of students on issues relating to the separation of waste and what drives such practices. The survey was conducted on campuses in Zhengzhou City, and data collection was conducted in 2019. In this research, there were 1747 respondents who answered a semi-structured questionnaire that contained closed and open-ended questions, while face-to-face interviews were conducted. The findings revealed that while 92.8% of the surveyed population recognized the positive impact associated with waste separation on the environment and public health, only 17.8% always participated in these practices. The majority participated sometimes, and a small percentage did not at all.



Also, according to the study conducted by Qu et al. [40], it turned out that first-year students showed more positive waste separation attitudes, while senior students revealed a low level of actual implementation [40]. Generally, students could participate in activities encouraging waste separation, but their practice was relatively poor in regard to their efforts toward waste separation.

Moreover, Kuang and Lin's [42], findings manifested significant discrepancies between willingness to sort waste and actual behaviors. Despite the increase of willingness for sorting, the participation was low in practice. In particular, even though the surveyed respondents had accepted the significance of the role of waste sorting in improving urban environmental quality and showed a greater willingness to separate their waste, it turned out that it had no significant influence on waste-sorting behavior. Although citizens who were willing to sort litter did believe that litter sorting could improve the quality of the urban environment, they did not actually participate in litter sorting in their daily lives. Indeed, this reflects a discrepancy between the willingness to sort litter and behaviors regarding this issue. Moreover, citizens who were willing to sort their litter and believed that litter sorting could improve the quality of the urban environment did not participate in litter sorting in their daily lives. Indeed, this has reflected the gap between their willingness to sort litter and their actual behavior [42].

The study by Eshete et al. [25], further showed that although the majority of the households had a positive attitude towards solid waste management, poor practice was noted. A huge percentage of households, around 80%, practiced poor management of solid waste [25].

In this vein, in the survey by Adefris et al., it was reported that 45.5% of the respondents indicated that they separated waste sometimes, while 21.3% reported that they separated waste regularly. On the other hand, 28.7% of the respondents did not separate waste, and 4.5% were not sure about the practice. This indicated that only one-fifth of the sample responded to the practice of proper solid waste separation at the household level, while a greater proportion, 79%, rarely implemented separation or none at all [22].

The situation is further exacerbated by financial constraints, where in a survey conducted by Ansah et al. [26], it was reported that about 17.1% of those households which did not pay for waste disposal services involved themselves in practices such as burning or dumping waste along the roadside [26].

Last of all, in the Nuwamanya and Byamukama [28] survey, about 82.2% of the respondents disposed of waste along roadsides, while 91.5% did not bother to segregate solid waste. The main reasons given were lack of containers for separation, at 42.6%, and finding it a lot of hassle to separate, at 37.8% [28].

According to the researchers it was found that, although there was a positive attitude towards waste separation, practices were inadequate. There were several cases of mismatches between intentions and behaviors, while with a lack of infrastructure and financial constraints, this problem was exacerbated. Overall, it seemed that while there was a general awareness about the importance of segregation, its practice was limited.

### 3.3. Citizens' Attitudes and Practices Towards Recycling

The active involvement of citizens in recycling is indispensable in the face of rising environmental challenges for the sustainability of cities and communities. Some influential factors in the attitudes towards and practice of recycling by citizens include age, gender, educational level, and general perception of responsibility toward the environment. This section will highlight how these factors model citizen practices and attitudes related to waste recycling by showing differences and similarities for different social and demographic groups.

#### 3.3.1. Age and Waste Recycling

Age is one of the factors which determines people's practices and attitude towards waste recycling. The findings of four surveys revealed that there were considerable differ-

ences in the way different age groups approach recycling, regarding the younger and older citizens that maintain different practices and attitudes.

For instance, according to Almasi et al. [23], it was proved that the age of citizens determines the extent of recycling. Although their knowledge was at a moderate level of issues regarding recycling, their related practices were not properly implemented. Those aged less than 40 years old had more knowledge and a relatively more positive attitude toward recycling. However, this relation did not emerge as statistically significant. In addition, from the study, it emerged that there is a significant relationship between age and environmental knowledge, attitudes, and practices [23].

Moreover, the purpose of the survey by Elmosaad et al. [38] was to assess and investigate the level of awareness about waste reuse and recycling, household waste recycling and separation practices, and factors influencing household practices in Al-Ahsa, Saudi Arabia. Data were collected from December 2021 to February 2022. A structured, anonymous, online, self-administered questionnaire was designed by a researcher using Google Forms and filled by 279 households. The results revealed that the younger female participants were more likely to have implemented household waste recycling practices at source. Age group was confirmed through the research as a determinant factor for household waste recycling practices [38].

At the same time, the survey by Tsalis et al. [43] aimed to establish whether the residents of the Greek city of Xanthi in Thrace were willing to change the pre-existing collection system and initiate a recyclable waste collection system [43]. A fully structured questionnaire was designed, and was distributed in hard copy form to a sample of 150 participants. The respondents were selected by random sampling, whereby initial sampling was conducted through telephone calls and afterwards by direct a street survey in central locations of Xanthi. The survey was carried out from March 2016 to May 2017. The findings revealed that the factor of age had a significant effect on recycling frequency. More specifically, those above 30 years of age tended to separate their recyclables at home more often than individuals aged between 20 and 30 years.

Finally, the study by Wang et al. [44] evaluated significant factors that determine public awareness of household waste recycling in urban areas of China (Beijing, Shanghai, Chengdu, Guangzhou, Harbin, Jinan, Lanzhou, Qingdao, Heze, and Weihai). The main tool of research was a questionnaire in the form of multiple-choice sentences, and the data were collected through on-sight face-to-face interviews. A total of 2200 questionnaires were collected from the ten cities. The study examined public awareness of household waste recycling, including what the public thinks and knows about recycling as well as the willingness of the public to engage with it. Further, the study probed the factors influencing such awareness. The results of the survey indicated that age proved to be the most important socio-demographic factor influencing public awareness of household waste recycling. The age groups between 20 and 50 years showed less environmentally-friendly recycling behavior. Older respondents were more likely to recycle their household waste, yet they generally had less knowledge about recycling practices [44].

In summary, age proved to be a strong determinant of the frequency and practices regarding recycling. While the younger-aged groups generally showed to have more knowledge and more positive attitudes towards recycling, they did not put these into practice. Older citizens had less knowledge but were more likely to recycle their household waste. Age, therefore, proved to be a determinant of recycling practices with differences appearing mainly in attitudes and knowledge.

### 3.3.2. Gender and Waste Recycling

Waste recycling is also one of the key environmental practices that is influenced by various socio-demographic variables, and among these, gender holds an important place. Many studies have been carried out around the issue of how attitudes and practices toward recycling differ between men and women, with the result indicating quite clearly different

approaches to recycling for both genders. The following three pieces of research highlight these very important relationships and the effect of gender in recycling practices.

In particular, the study conducted by Elmosaad et al. [38], found that female respondents had a better attitude towards the adoption of household waste recycling at source. The study confirmed that there was a relationship connecting gender to household waste recycling practices. In particular, the 38–47, 48–57, and >58 age groups were shown to be the least likely to be performing source-based recycling in relation to the younger 18–27 age groups [38].

Furthermore, the survey which was conducted by Azmin et al. [45] aimed to assess the attitude and awareness of citizens about the recycling practices in low-cost houses in Klang, Malaysia [45]. The survey was focused on the effect of socio-demographic factors and on the level of knowledge, attitude, and behavior of the residents about proper management of waste in urban areas. This survey, carried out from January to March 2021 included a total of 234 respondents who answered a structured questionnaire. The results of the study showed a significant relationship that existed between gender and recycling practices. This study highlighted the general relationship between gender and recycling practices, indicating that gender may influence both recycling attitudes and behaviors.

Finally, the study by Ismail et al. [27] was conducted to examine the impact of knowledge of and attitude towards waste recycling practices within selected communities in Selangor during the post-pandemic period. The study area was an urban area in Selangor, Malaysia, referred to as Bandar Baru Bangi. Data collection took place from September 2022 to January 2023. A comprehensive waste analysis was conducted in six residential areas within urban Selangor, with a sampling size involving 25 households. Moreover, a sample of 244 respondents who had stayed in the study area for at least one year and who were knowledgeable concerning the programs and facilities for recycling were surveyed. The instrument used to collect the data was questionnaires, and it was distributed both door-to-door and online. The results revealed that there was a significant relationship between knowledge and gender, with women holding better knowledge regarding recycling. The study also revealed that gender influenced recycling practices. Among the major variables found to determine participation and effectiveness in the field of recycling practices was gender [27].

According to the above studies, it transpired that gender had an influence on the attitudes and behaviors of citizens towards recycling, in the manner that women had a more positive attitude towards the adoption of recycling practices. Correspondingly, the results indicated that the younger groups were more likely to recycle in comparison with the older groups. It also established a high correlation between gender and recycling practices, thus proving that gender was an outstanding factor in participation and effectiveness of recycling practices. In relation, the overall findings made gender one of the major variables influencing recycling.

### 3.3.3. Education and Waste Recycling

Education has been shown to have a critical influence on the attitudes and practices of waste recycling among citizens. It clearly emerged from the following six pieces of research that the extent of education level had a significant effect on the extent of recycling.

In this view, environmental knowledge, attitudes, and practices had a strong relation to the level of education of individuals, as noted by Almasi et al. [23]. Citizens with an academic education had a higher level of knowledge about recycling and, at the same time, they had a more positive attitude towards recycling.

Moreover, according to Drimili et al. [19], education was one of the determinants with respect to participation in recycling, where the possibility of participation increased with a respective increasing level of education [19]. This was also reaffirmed by the findings of Tsalis et al. [43], which showed that respondents who had a high school or a lower educational level, were less likely to recycle as compared to the more highly educated. A total of 85% of those holding a college degree and 81% of those who felt that there was

a problem with the current system of recycling eventually agreed to participate in the recyclable waste collection program [43].

In related research, Elmosaad et al. [38] arrived at the conclusion that those of the participants with university and postgraduate education levels were more likely to implement waste recycling at source. At the same time, the bulk of the participants' responses indicated that they had an insufficient level of knowledge related to waste recycling. The research confirmed a hypothesis that educational attainment was one of the factors influencing household waste recycling practices. It was confirmed by the fact that members of those households with a high degree of knowledge about source-based waste recycling were 2.75 times more likely to implement it, compared to household members with a low level of knowledge [38].

Contrarily, the higher the level of education, the less environmentally responsible the behavior was towards household waste recycling, as revealed by the survey of Wang et al. [44]. Citizens with a lower level of education had less knowledge about recycling but were comparatively more willing to participate in it. Those with a higher level of education were less actively participating in recycling and less willing to participate in related activities. These findings implied that knowledge about recycling does not correlate to willingness to participate. Although education was linked to increased awareness of recycling, citizens who had more knowledge were less active and less willing to participate in this process [44].

Results from Azmin et al. [45], indicated that there were significant relationships between education levels and knowledge of residents with regard to recycling. Knowledge had a significant relationship with the attitudes of citizens towards recycling. However, no significant relationship was revealed between knowledge and practice, proving that adopting environmental attitudes cannot be solely based on knowledge [45].

These articles showed that education was related to awareness and knowledge about waste recycling. Citizens with a higher level of education had more knowledge but did not always show willingness to participate in related activities. At the same time, it transpired that there was no direct link between knowledge and the practice of recycling. In summary, the surveys confirmed that although education provided the basis for positive attitudes, actual participation was not related to knowledge level.

#### 3.3.4. Citizens' Attitudes and Practices Towards Waste Recycling

Many studies have been conducted regarding the attitudes and practices of citizens towards waste recycling since recycling is a very important factor in environmental protection and sustainable development. This section will present an analysis of six surveys examining different facets of citizens' attitudes, ranging from general attitudes to specific practices concerning waste recycling.

For instance, Almasi et al. [23], in their survey, showed that citizens' attitudes towards recycling were good for 34% of the sample, moderate for 52%, and weak for 14%. However, real recycling practices continuously remain low, with only a share of 77% participants reporting weak practices, 15% having moderate practices, and only 8% good practices [23].

Similarly, according to a survey conducted by Drimili et al. [19], half of the respondents participated in recycling programs continuously, while 40.8% participated occasionally, and only 9.2% reported they had never done so. It is worth mentioning that 8.8% of the respondents did not know what kind of waste was recycled, 8.3% reported having no time to recycle, and 4% showed no interest in recycling. Moreover, employees were less likely to participate in recycling programs [19].

Religious beliefs also affected practices in recycling. This was especially revealed in the study by Tsalis et al. [43] according to which Orthodox Christians recycled more often than Muslims. The respondents who held positive attitudes towards recycling and related principles reported a higher frequency of recycling than others. It was also observed that those respondents who were satisfied with the distance they had to travel to access recycling facilities tended to recycle more frequently than those who were not satisfied. A total of 79% of the respondents showed a positive attitude towards recycling [43].

According to Elmosaad et al. [38] urban residents were more likely to follow waste recycling practices because urban areas offered more and easier opportunities and better access to recycling programs [38].

On the same note, according to the survey carried out by Azmin et al. [45], 52.6% of the respondents manifested positive attitudes towards recycling, and 39.7% of them engaged in it. One of the questions asked was whether the respondent recycles at home, with the options being “yes” or “no”. The results obtained from this research showed only 39.7% responded in the affirmative, while 60.7% did not [45].

Finally, the study by Ismail et al. [27] found that although the community of Bandar Baru Bangi in Selangor, Malaysia, had relatively high levels of knowledge pertaining to recycling and positive attitudes towards performing these activities, at the same time they did not show sufficient practices in regard to recycling. Most of the respondents did not become involved in any recycling programs or campaigns. Even with pandemic-linked restrictions, high recycling rates occurred at 81%, indicating good attitudes. They had, however, determined the gap between knowledge and the actions needed to bridge this in order to improve recycling practices [27].

The results from the above surveys reveal that people had both positive and weak attitudes towards recycling, whereas the real practices were found to be at a low level. Despite positive views, there were major differences on the basis of social group, region, and religious beliefs in regard to the implementation of practices. Distance to recycling facilities, knowledge, and access to recycling schemes also played an important role in the frequency of recycling. While knowledge was generally high with positive attitudes, theory–practice gaps could be observed, which need to be bridged for improved recycling practices.

#### 4. Discussion

The attitudes and behaviors of the public regarding reduction, separation, and recycling of waste were investigated in this survey. The inconsistent findings highlight the need to investigate these attitudes in a more comprehensive social, cultural, and environmental framework.

More specifically, the findings on citizens’ participation in composting were unclear. In particular, Drimili et al. [19] found that gender did not significantly affect composting since both genders were eager to participate in associated activities. On the contrary, the survey by Alimoradiyan et al. [20] discovered that gender had a significant role in composting, with females making up the majority of those involved. This discrepancy in findings suggested that the willingness to engage in composting may be influenced by cultural and social factors, as well as by perceptions of gender and its roles in diverse communities.

Men were less inclined to participate in environmental activities like composting, according to research by Kunszabó et al. [21], which further validated the assumption that women were more interested in these activities.

Segregation and waste management confirmed the significance of gender in environmental activities. According to studies by Noufal and Maalla [31], Elmosaad et al. [38], and Alhassan et al. [37], women participated in waste segregation processes at a higher percentage than men did. This is likely due to traditional social beliefs and women’s increased awareness of household and environmental issues. Tang et al.’s 2022 [39] study supported this tendency by arguing that women participated more actively in waste management since they were more in charge of managing the home.

It is important to acknowledge, nevertheless, that a few studies, such as those by Adefris et al. [22], Hao et al. [35], and Fadhullah et al. [33] found a statistically significant association between gender and waste segregation, highlighting the fact that the gender effect was correlated with other parameters.

In the context of recycling, it was found that gender had a significant influence on citizens’ participation and attitudes. According to studies conducted by Elmosaad et al. [38]; Azmin et al. [45], and Ismail et al. [27], women possess a greater comprehension of and positive attitude towards recycling practices, thereby indicating that they are more likely to actively

engage in these activities. Furthermore, it was observed that younger age groups were more inclined to adopt recycling practices, indicating that education and awareness among young individuals may be pivotal in enhancing their involvement in environmental practices.

Moreover, the results emphasized the noteworthy correlation noted among citizens' knowledge and the efficiency of waste management strategies in the various localities and areas examined. For instance, the study conducted by Adefris et al. [22] demonstrated that a substantial proportion of respondents attributed the 3Rs to the separation of waste. Even though certain individuals were unaware of the 3Rs or were uncertain about them, the majority of individuals acknowledged the significance of the economic value of waste, particularly through the utilization of organic materials for composting.

Despite the widespread understanding of the 3R principles, several studies have shown that there are still major gaps in the theoretical understanding and application of waste management techniques like composting. In the survey conducted by Drimili et al. [19], a relatively small proportion of respondents reported having limited or no knowledge regarding composting, despite the majority of the respondents indicating their familiarity with the concept. This implies that, although general concepts may be familiar, specialized practices such as composting may need additional training and direction. According to the study by Almasi et al. [23], there was a moderate level of knowledge about waste reduction in Kermanshah, and there was no significant correlation between demographic characteristics and women's composting practices.

Education has a pivotal role in the waste management practices of citizens. For instance, Zand et al. [24] underlined the importance of education, enhanced citizens' knowledge, and positive attitudes towards waste management, whereas Eshete et al. 2023 [25] reported that a lack of knowledge regarding reduction and reuse practices resulted in poor practices. Hence, it is recommended that educational programs and awareness campaigns should be implemented and bolstered for both students and adults. Furthermore, education was associated with the demand for enhanced waste management services. According to Seng et al. [41], individuals with a higher level of education exhibited heightened awareness and demand for enhanced waste management services. Additionally, Tang et al. [39] and Ssemugabo et al. [36] reported that acquiring knowledge of environmental issues and legislation enhanced the likelihood of effective waste management.

Nonetheless, a study conducted by Elmosaad et al. [38] revealed that citizens were generally aware of the fundamental principles of waste management; however, the implementation of this knowledge was frequently inadequate. According to studies conducted by Eshete et al. [25] and Qu et al. [40], while citizens knew of the potential dangers of improper waste disposal, their practical application of their knowledge was limited.

Research by Noufal and Maalla [31] showed that households with greater knowledge about waste separation were more likely to implement this practice. According to Nuwamanya and Byamukama [28], insufficient knowledge was a crucial factor in inadequate waste management.

Meanwhile, the study conducted by Hao et al. [35] revealed a low level of knowledge among students regarding waste segregation. This underscores the importance of community programs and local actions in enhancing the implementation of these practices.

It is noteworthy that Drimili et al. [19] demonstrated that there was no statistically significant correlation between the educational level of citizens and their involvement in composting. This contradicts the notion that educational attainment is always a determinant of the adoption level of environmentally responsible practices. Nonetheless, certain studies, such as Zand et al. [24], have demonstrated that education had a positive impact on individuals' attitudes towards waste reduction and recycling, whereas others, such as Ansah et al. [26], have reported that there was not always a direct correlation between education and waste separation awareness. The study conducted by Alimoradiyan et al. [20] highlighted the significance of education as individuals who had received information through media or educational programs demonstrated greater engagement in this practice.

Simultaneously, the correlation between education and waste separation practices was found to be variable. Yuhuan et al. [30] reported that individuals with higher levels of education adopted more sound segregation practices, primarily due to the awareness of local authorities. According to the studies by Tang et al. [39] and Zhang et al. [34], environmental education increased the participation of citizens in waste sorting.

The findings of the study conducted by Adefris et al. [22] revealed that awareness and education of respondents had a significant correlation between practices on solid waste separation. According to the research conducted by Kuang and Lin [42], despite the fact that a citizen's educational level increased their willingness to participate, it did not have a statistically significant impact on litter picking. According to Ansah et al. [26], despite the citizen's knowledge that household waste could be recycled and utilized for other purposes to mitigate pollution, the level of education did not affect the level of awareness regarding waste segregation. Likewise, the study conducted by Ssemugabo et al. [36] revealed no statistically significant correlation between educational attainment and the efficacy of solid waste management, thereby challenging the general belief that higher education always leads to superior management practices.

In the field of recycling, Almasi et al. [23], Drimili et al. [19], and Tsalis et al. [43] demonstrated that education was associated with enhanced environmental knowledge and positive attitudes. However, it was also demonstrated that individuals with lower educational levels were less likely to engage in recycling practices. The survey by Elmosaad et al. [38] confirmed this correlation, noting that individuals with higher education levels were more inclined to recycle waste. It is noteworthy that the studies conducted by Wang et al. [44] and Azmin et al. [45] revealed that although individuals with a lower education were less knowledgeable about recycling, they were more willing to actively participate when compared to individuals with a higher education.

The findings of this study have revealed significant obstacles in implementing waste reduction practices, despite the existence of knowledge and positive attitudes among citizens. According to Almasi et al. [23], despite citizens being cognizant of waste issues, the implementation of waste reduction practices, such as composting, was remarkably limited. Eshete et al. [25] confirmed similar findings, noting that most households were not managing solid waste effectively, as their experience with reduction and reuse practices was limited.

In the study by Zand et al. [24], it was noted that knowledge alone was not sufficient to promote meaningful action. What is more, Ismail et al., 2023 [27] observed that composting was not widely practiced.

Despite the prevalent negative trends, certain findings were more optimistic. In the survey conducted by Fadhullah et al. [33], it was discovered that approximately half of the respondents separated their waste at the source, while the remaining did not do so. Moreover, the study conducted by Drimili et al. [19] revealed that a significant proportion of citizens were willing to participate in future composting programs. According to the study conducted by Alimoradiyan et al. [20], a significant proportion of respondents were willing to initiate composting, despite a limited number of respondents being actively involved in the process. Simultaneously, Sarbassov et al. [32] demonstrated that a significant number of individuals were already segregating household waste, despite the absence of adequate infrastructure. This indicates that citizens were willing to take action to separate waste, regardless of the circumstances.

Nevertheless, according to the study conducted by Ssemugabo et al. [36], it turned out that a small proportion of households implemented appropriate waste management practices, whereas the majority did not separate waste. Similar findings were also discovered in the studies conducted by Nuwamanya and Byamukama [28] and Adefris et al. [22], indicating that a limited number of households or respondents consistently adhered to waste segregation practices. Despite the recognition of environmental advantages, as reported by Hao et al. [35], their ongoing involvement in segregation practices was limited, with the majority only occasionally participating.

The disparities between attitudes and actual behaviors were especially evident in the study conducted by Qu et al. [40], wherein, despite students expressing positive attitudes towards waste separation, their practical implementation was minimal. This discrepancy between intention and practice was also highlighted in the studies conducted by Kuang and Lin [42] and Eshete et al. [25], indicating that despite respondents' willingness to separate their waste and acknowledgement of the advantages of waste separation, their actual participation remained low.

Financial constraints also emerged as a significant obstacle, as noted by Ansah et al. [26], who observed that a lack of resources to pay for waste disposal services prompted numerous individuals to adopt practices such as burning or disposing of waste along the roadside. Similar practices were also documented in the study conducted by Nuwamanya and Byamukama [28], who pointed out that the absence of waste containers and difficulties in the segregation process impeded the implementation of effective practices.

Additionally, differences in citizens' knowledge, attitudes, and actual recycling practices were identified. Specifically, the surveys conducted by Almasi et al. [23] and Azmin et al. [45] revealed that despite citizens' positive attitudes towards recycling, their participation in practice was limited. Drimili et al. [19] observed that only half of the respondents were consistently involved in recycling programs. It is noteworthy that a significant number of participants were either unaware or uninterested in recycling. According to the survey conducted by Tsalis et al. [43], Orthodox Christian respondents exhibited a higher frequency of recycling compared to Muslims, whereas the close proximity of citizens to recycling facilities encouraged active participation in them.

Similar findings were observed in the study conducted by Elmosaad et al. [38], wherein urban dwellers tended to adopt recycling practices more frequently as a result of improved accessibility to recycling infrastructures. The study conducted by Ismail et al. [27] revealed that despite citizens' awareness of recycling, its implementation in practice remained insufficient.

Moreover, the survey by Elmosaad et al. [38] observed that individuals residing in urban areas were more inclined to adopt recycling practices as a result of having better access to programs and infrastructure. This finding was in accordance with the findings of the survey by Azmin et al., 2022 [45] which demonstrated that despite the positive attitudes of 52.6% of respondents towards recycling, only 39.7% of respondents actually implemented the practice at their residence.

According to the study conducted by Ismail et al. [27], it was revealed that despite the community of Bandar Baru Bangi having a favorable knowledge and attitude towards recycling, the actual practice of recycling remained low. This finding once again underscored the significance of bridging the gap between knowledge and action, particularly during times of pandemic, where restrictions and inadequate awareness campaigns might compound the issue.

Numerous studies have confirmed that age played a significant role in determining waste separation and recycling practices. It appeared that older household heads were more willing to engage in waste separation practices than younger ones. According to the research conducted by Yuhuan et al. [30], age had a significant impact on the intention to separate household solid waste as older individuals exhibited a greater willingness to do so as compared to younger ones. Noufal and Maalla [31] also concluded that elderly household heads were more inclined to engage in waste segregation, which may be attributed to the additional time available for the elderly to engage in such practices.

Simultaneously, Sarbassov et al. [32] confirmed that older individuals exhibited a greater willingness towards waste separation, where a significant proportion exhibited favorable attitudes towards this practice. According to Fadhillah et al. [33], respondents aged 50–65 years were more likely to segregate their waste in comparison to younger age groups, while Alimoradiyan et al. [20] concluded that respondents aged 31–45 years and above 45 years old were more actively involved in waste segregation in comparison to those below 30 years.



Despite these findings, there were studies that presented a divergent picture. Younger students were more engaged in waste separation, according to the studies by Zhang et al. [34]. This indicated that age may have had a favorable impact on certain groups, such as college students. However, Hao et al. [35] concluded that older students were more inclined to engage in waste separation. This implies that the increased awareness and experience acquired during their studies contributed to this behavior.

Regarding the relation between the age of citizens and their attitudes about recycling, the results were equally varied. According to Almasi et al. [23], individuals under the age of 40 demonstrated a higher level of knowledge and positive attitudes towards recycling, despite the lack of a statistically significant correlation. Nonetheless, no statistically significant correlation was seen between knowledge and attitudes. The study conducted by Elmosaad et al. [38] revealed that younger women were more likely to recycle, whereas Tsalis et al. [43] demonstrated that individuals over the age of 30 were more likely to separate recyclable materials at home. According to the survey conducted by Wang et al. [44], age was found to be one of the most significant factors in influencing public awareness of recycling, whereas older respondents recycled their waste despite their limited knowledge of recycling practices.

Numerous studies have highlighted the complex relationship between the monthly income of households and their attitude towards waste disposal. According to the study conducted by Noufal and Maalla [31], it was observed that an increase in household income resulted in an increase in the willingness to separate waste. This can be attributed to the increased consumption and production of waste by affluent households. Similar results were supported by the study of Seng et al. [41], which demonstrated that individuals with higher incomes were more knowledgeable and content with waste management services, likely resulting in improved segregation practices.

Nonetheless, other studies have reached divergent conclusions. Alhassan et al., 2020 [37] discovered that an increase in income led to a decreased implementation of waste separation, whereas Kuang and Lin [42] and Sarbassov et al. [32] concluded that income had no statistically significant impact on citizens' waste separation behaviors. Similar findings were reported by Adefris et al. [22] who found no correlation between income and waste segregation practices. Similarly, Fadhullah et al. [33] and Elmosaad et al. [38] found no significant correlation between income, occupation, and waste segregation practices.

In conclusion, the findings of this study have highlighted the complexity of factors which affect waste management practices of citizens. These include practices like composting, segregation, and recycling. Gender has emerged as a significant factor, with disparities between men and women reflecting broader social and cultural perceptions. The impact of age on environmental attitudes was also clear, although its impact varied based on the demographic context. Education, while enhancing knowledge and awareness, did not always ensure practical application of this knowledge. This highlighted the need for strategies to bridge the gap between knowledge and attitudes.

Simultaneously, the correlation between income and environmental practices yielded contradictory findings, indicating that other factors, such as social awareness and accessibility of infrastructure, may play a decisive role. This level of complexity underscored the necessity for additional research to examine the interdependent socio-economic and cultural factors and the conditions under which they exert an impact on citizens' waste disposal behavior.

Future research should prioritize in a more comprehensive way the factors that facilitate the transition from knowledge to practice, exploring educational and awareness-raising strategies, and scrutinizing gender and age disparities in more specific cultural contexts. These initiatives might have the potential to enhance waste management practices and create more sustainable environments.

## 5. Conclusions and Recommendations

### 5.1. Conclusions

The present survey aimed to investigate citizens' attitudes and practices regarding waste reduction, separation, and recycling, focusing on the role played by socio-

demographic characteristics such as gender, age, educational level and income. Through a systematic review of the existing literature, an attempt was made to highlight the differences and similarities in waste management practices between different social groups and to identify the factors that influenced environmental behaviors.

This survey answered the question regarding how the socio-demographic characteristics of citizens influenced their attitudes and practices toward waste management. The results indicated that these characteristics were significant, but their influence varied based on the social and cultural context, as well as the interacting factors.

The findings of the survey revealed that gender, age, educational level, and income as socio-demographic variables seemed to influence in diverse ways citizens' attitudes and behaviors toward waste management. Specifically, it was observed that women exhibited a higher participation in environmental activities, whereas citizens' knowledge of waste management emerged as a critical factor for the effectiveness of environmental practices. The traditional roles attributed to women, especially those concerning household duties, may be regarded as a significant factor influencing their heightened involvement in waste management and sustainability initiatives. In numerous cultural contexts, the oversight of household matters is predominantly regarded as a responsibility of women, which may elucidate the inclination for women to take a more active role in waste minimization and recycling activities. This underlined the importance of education and raised awareness, although its effectiveness varied depending on the socio-cultural environment.

While the significance of education in waste management was widely acknowledged, the connection between education and waste reduction practices turned out to be variable. In certain instances, education was not a determining factor, particularly in the case of composting. However, in other cases it transpired that those who possessed relatively greater levels of academic qualifications displayed more awareness and involvement in the processes of recycling and reusability, and proved that education played a very integral role in reducing waste.

The influence on the practice of waste segregation of socio-demographic characteristics including age and gender has also proved to be significant. These practices were more common among older citizens and women. Exceptions existed, such as younger citizens, who almost equally participated. This means socio-demographic characteristics were not the only factor determining waste management practices of citizens. Factors such as social influences and citizens' awareness of the environment and the availability of appropriate infrastructure for waste management were also important and all in need of further study.

The role of income in waste management was controversial. According to some research, higher income was linked to an increased ability and desire to separating waste, as wealthier households had better access to information and services. Other surveys showed that income either had no effect on or reduced people's likelihood of separating waste, indicating that the role which income plays in this sphere is extremely complex and needs further study.

In general, a lack of knowledge represented an important barrier for the adoption of environmental practices and financial constraints often limited citizens' options to adopt proper waste management practices. Socio-demographic characteristics, education, and income had an important effect on citizens' attitudes and practices, but on their own were not enough to bridge the gap between theory and practice.

More specifically, despite the significant insights obtained from the present research, certain limitations are evident. More specifically, the sample utilized was constrained both in terms of geographical diversity and socio-demographic representation, which may prevent the possibility of generalizing findings to alternative regions or cultural settings. Moreover, while essential socio-demographic factors such as gender, age, and income were scrutinized, the availability of infrastructure and the impact of social influences were not comprehensively investigated and warrant further exploration. Future research ought to prioritize the examination of the effects of social factors and available infrastructure on waste management practices. Concurrently, the utmost care should be given in evaluating the incentives that have the potential to enhance citizen involvement in environmental ini-

tiatives. Furthermore, research initiatives could strive to analyze and assess the implications within various cultural frameworks.

### 5.2. Recommendations

It is essential to enhance environmental education and public awareness about adopting responsible environmental behaviors. It is therefore essential to develop and implement educational programs at all levels of the school curriculum as well as within communities. Initiatives might involve school programs, adult seminars, and awareness campaigns that stress the importance of practical garbage disposal and recyclable materials.

Meanwhile it is equally essential to develop and upgrade waste management infrastructure. If infrastructure that allows for proper separation of waste does not exist, it makes it almost impossible for citizens to become involved in recycling. Particular attention should be paid to poor-income areas, which tend not to have sufficient infrastructure. Accessibility means recycling bins being installed, collection centers being organized and a compost waste system which will be available for all citizens.

Another important condition to improve citizens' participation in environmental practices is incentives. The government might need to provide some kind of incentive, such as offering tax breaks, cash rewards, or even rewarding people for participation in a recycling and composting program. The establishment of a reward system could be one of the most important motivating factors to make daily life more sustainable for citizens.

Community programs and partnerships should be developed to increase the participation of citizens in waste management. The engagement of environmental stakeholders is vital for the improvement of educational projects centered on the development of solid waste recycling practices. Environmental organizations, in collaboration with educational institutions and municipal authorities, can play a pivotal role in the formulation of educational programs that advocate for waste minimization, segregation, and recycling at every educational level, as well as in community action and awareness campaigns. This synergistic strategy elevates environmental consciousness and effectively fosters civic engagement, thereby augmenting the efficacy of recycling efforts and the incorporation of sustainable practices.

Moreover, educational campaigns should be designed based on their different social and demographic characteristics. Educational approaches, thus, should be geared in a manner that takes into consideration the different influencing factors on environmental attitude in respect of age, gender, and income. For example, through digital media, younger citizens might be effectively approached, whereas older citizens benefit more from information campaigns which take place face-to-face, in the form of educational seminars on the environment.

To sum up the above, urgent action by relevant stakeholders is called for. Policies which take into proper account the variation among socio-demographic characteristics and regional specificities can contribute significantly to easing the gap between knowledge and action. The implementation of these proposals can strengthen environmentally responsible behavior and the sustainable waste management of citizens.

**Supplementary Materials:** The following supporting information can be downloaded at: <https://www.mdpi.com/article/10.3390/su16229969/s1>. Reference [46] cited in Prisma Check List File.

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### Appendix A. Summary of the Articles Selected for Inclusion in the Scoping Review

References	Study Aims	Study Area	Sample Characteristics and Study Design	Main Findings
<b>Almasi et al. (2019) [23]</b>	Determination of the knowledge, attitudes, and practices of 1750 women on source separation and reduction, recycling, and harmful effects of poor solid waste management on the environment and human health	Kermanshah city, Iran	n = 1750 women questionnaire respondents, structure and semi-structure questionnaire with open and closed questions, face-to-face interview at the door of the houses	The level of knowledge of the citizens on recycling was average, and the application of the recycling practices was not appropriate. Environmental knowledge, attitude, and practice were very strongly associated with the level of education. Citizens had the highest level of knowledge with a positive attitude. Although attitudes towards recycling were very positive, actual practice was very weak—77% of those surveyed reported weak practices. In addition, the awareness on household composting stood at a low of 16.91%, with only 1% of women performing the composting.
<b>Alhassan et al. (2020) [37]</b>	Investigation the determinants of household behavior at the source segregation and preferred solid waste disposal options	Accra, city of Ghana, Africa	n = 525 questionnaire respondents, structured questionnaire	Waste separation was less practiced by rich households compared to poor ones. Moreover, the male-headed household was 6.79% less likely to participate in waste separation. This means that the male heads were less likely to be involved in waste management since the activity is typically carried out by women in Ghana.
<b>Drimili et al. (2020) [19]</b>	Examination of the Athens residents' point of view and attitudes to recycling, composting, and operation of green centers	Athens, Greece	n = 504 respondents, structured questionnaire, personal interviews	The level of education was a determining factor for participation in recycling, where the probability of participation increased with the level of education. A total of 50% of the respondents participated continuously in the recycling programs, while 40.8% participated occasionally, with 9.2% having never participated. As many as 77.4% reported having moderate to extreme familiarity with composting, while 66.2% were willing to participate in composting programs. This study showed that higher environmental concern and perception of generating a lot of waste raise the likelihood of participating in composting activities.
<b>Tsalis et al. (2018) [43]</b>	Finding out how much the inhabitants of a Greek city are willing to change the pre-existing collection system and initiate and take part in a recyclable waste collection system	Xanthi, Thrace, Greece	n = 150 questionnaire respondents, fully structured questionnaire, interviews through telephone calls, street inquiries in central locations	Age had a significant effect where the majority of the respondents aged over 30 years categorized their recyclables more regularly than the 20–30-year-old group. Those with a high school education level or lower recycled less often than the more educated respondents. A total of 85% of those with a college degree and 81% of the respondents who believed that there were problems with the collection system of recyclable waste were willing to participate in the recyclable waste collection program. Orthodox Christians recycled more than Muslims.

References	Study Aims	Study Area	Sample Characteristics and Study Design	Main Findings
<b>Kuang and Lin (2021)</b> [42]	Determination of residents' willingness and behavior in municipal waste sorting and further explore the gap between intention and behavior	Beijing, Shanghai, Guangzhou, and Shenzhen, China	n = 2166 respondents, Questionnaire Treasure- online questionnaire app	Age had a greater effect on actual litter-grading behavior. Income showed no significant statistical influence on willingness and behavior about waste sorting. Gender indicated no statistically significant influence on willingness and litter sorting behavior. Willingness to sort litter was high, but actual participation was low.
<b>Seng et al. (2018)</b> [41]	Analysis of the factors that influence the knowledge, attitudes, and practices of residents in regard to solid waste management. Evaluated determinants influencing knowledge and attitude as well as behavior of people in relation to problems with waste and waste management	Phnom Penh City, Cambodia	n = 800 households interview, semi-structured questionnaire	Age was influential to the attitudes of citizens on waste management, where older citizens were more aware and demonstrated better management practices. Higher income ensured better access to educational resources and information on the problems of waste, thus reinforcing positive attitudes among citizens. Better knowledge of health impacts due to waste was found among citizens with higher education levels, who were more informed and aware. It formed their attitudes, and they became more demanding of waste management services and more dissatisfied with their state.
<b>Sarbassov et al. (2019)</b> [32]	Studying the attitudes of the citizens of Nur-Sultan for the disposal and separation of household solid waste at source	Nur-Sultan, Kazakhstan	n = 3281 questionnaire respondents, electronic questionnaires, questionnaires with both open-and closed-ended questions	There was an increased willingness among older people to separate waste, with about a third of the older people willing to separate the waste at source. Income level was not found to be a critical factor for household waste source separation behavior. The gender factor was also not critical for household waste separation behavior, while age played an important role. About 24% of the respondents already separated household solid waste even when there was no source separation system in place.
<b>Eshete et al. (2023)</b> [25]	Assessment of household knowledge, attitude, and practices about solid waste management and associated factors in Gelemso Town	Gelemso Town, Ethiopia	n = 390 questionnaire respondents, questionnaire with both open- and closed-ended questions, structured pretested questionnaire	Although 87.4% of the households agreed to the risk of inappropriate disposal and almost 80% recognized the relevance of good management for a healthy environment, the majority was engaged in inappropriate practices. Inadequate knowledge on reduction and reuse contributed to inappropriate practices, where around 80% of households managed solid waste inappropriately.

References	Study Aims	Study Area	Sample Characteristics and Study Design	Main Findings
<b>Zand et al. (2020)</b> [24]	Determination of women's knowledge attitude, and practices towards municipal solid waste management	Tehran, Iran	n = 384 women questionnaire respondents, trained face-to-face, questionnaire with both open- and closed-ended questions, written forms, self-administered questionnaire, face-to-face training (64 out of 384)	In the survey, 69.6% of the women had adequate knowledge on municipal solid waste management, while only 46% had moderate practice. The knowledge was quite satisfactory, but the attitude and practice were weak. The level of education was significantly associated with the knowledge, attitude, and practice of citizens in reducing, reusing, and recycling waste. Sufficient knowledge and a good attitude towards waste reduction among citizens did not lead to good practice.
<b>Adefris et al. (2023)</b> [22]	Analysis of practices in households and determinants of solid waste segregation	Addis Ababa City, Ethiopia	n = 244 questionnaire respondents, 15 interviews with leaders of waste collectors	The educational level was not associated with the practice of waste separation. Also, no association was established between income and waste separation practice. While a small percentage reported frequent separation of solid waste, about half separated solid waste rarely, and a significant percentage did not separate waste at all. The analysis indicated that the practice of source separation of solid waste in the urban areas of Addis Ababa was low. More than 73% of the respondents perceived the source separation of solid waste to be effective in reducing waste.
<b>Qu et al. (2023)</b> [40]	Analysis of the attitude and behavior of university students about separating waste and the factors that influence such behavior	Henan Institute of Science and Technology, China	n = 1213 questionnaire respondents, review of the previous studies, interviews with some experts and representative students	Female students, in general, exhibited more positive attitudes and behaviors regarding waste separation when compared to the male students. While most of the students had been informed about the essence of waste separation, a practical knowledge shortage was found in realizing this. First-year students were found to had more positive attitudes, while upper-year students had higher attitudes but a lower level of actual implementation. Though they could involve themselves in activities for the promotion of segregation, in practice their attitudes were relatively poor.
<b>Noufal and Maalla (2021)</b> [31]	Understanding factors that influence participation of households in source separation programs	Homs city, Syria	n = 300 households questionnaire respondents,	Older household heads showed a greater tendency to practice separation. Households with a higher income also tended to separate waste more, meaning that wealthier households were more responsive to separation. It was also seen that female household heads separated waste more than men. The knowledge on benefits in waste separation, together with environmental awareness, had a statistically significant effect on the willingness to participate in the process by households.

References	Study Aims	Study Area	Sample Characteristics and Study Design	Main Findings
Hao et al. (2020) [35]	Investigation into university students' litter separation behavior and understanding the motivation behind student behavior	Zhengzhou City, China	n = 1747 questionnaire respondents, semi-structural questionnaire with closed and open-ended questions, face-to-face intercept interviews	Although 92.8% of the surveyed respondents acknowledged the impact of waste separation on the environment and public health, only 17.8% always participated in these practices. The majority participated sometimes, while a small percentage never participated.
Tang et al. (2022) [39]	The purpose of the study was to find out what factors determined household waste sorting by residents	Shanghai, China.	n = 637 questionnaire respondents, online questionnaires	It was clear from the research that involvement in household waste sorting was more likely among residents with tertiary education. Women were more likely to participate in household waste sorting. Knowledge about waste and environmental knowledge positively influenced people's waste sorting behavior.
Ansah et al. (2022) [26]	Investigation into the willingness of Ghanaians in segregating household solid waste for a proper and sustainable waste management system	Ghana, Africa	n = 1406 questionnaire respondents, structured questionnaire through an online survey	Although highly educated citizens were aware that a lot of the household refuse could be reprocessed and recycled to reduce pollution, educational status did not influence awareness on issues of waste separation. Methods such as burning or dumping along the roadside were adopted by about 17.1% of total households that did not pay for solid waste disposal.
Elmosaad et al. (2023) [38]	Assessment of and investigation into the level of awareness about waste reuse and recycling, household waste recycling and separation practices, and factors influencing household practices	AlAhsa, Saudi Arabia	n = 279 households questionnaire respondents, online, self-administered, anonymous, researcher-structured questionnaire (Google Forms)	Younger women and both genders were more likely to implement source household waste recycling practices. This study confirmed the link between gender and age with household waste recycling practices. Respondents with a university and postgraduate level of education, and urban residents, were more likely to follow waste recycling practices. However, the majority of the respondents reported they did not have sufficient knowledge about waste recycling.
Fadhullah et al. (2022) [33]	Studying the attitudes and behaviors of people about reducing, separating, and recycling waste	Panji, East Coast of Malaysia	n = 338 households questionnaire respondents, questionnaire with both open and closed questions	Separating waste was most probable among the age group 50–65 years, while the least probable was among those aged between 35 and 49 years. The monthly income and occupation did not present a significant association with the practice concerning separation of waste. The factor of gender did not have a significant relationship with the separation of waste.

References	Study Aims	Study Area	Sample Characteristics and Study Design	Main Findings
<b>Ssemugabo et al. (2020)</b> [36]	Appraising household waste management practices and probing the factors associated with good waste management practices	Kampala, Uganda	n = 395 households questionnaire respondents, semi-structured questionnaire and observational checklist	The findings showed that age and education level of the head of the household did not have any significant association with solid waste management status, contrary to the common perception that education is the means to better practices. Knowledge on laws and risks of poor management was high. The proportion knowing the laws was 50.6% and the proportion knowing the risks was 69.6%. Households knowing the law were 1.5 times more likely to portray good waste management practice, while those knowing the risks stood at 2.2 times more likelihood of implementation of proper waste management. Only 41.3% had good practice in waste management in relation to separating their waste, while 78.7% of households did not implement the practice.
<b>Zhang et al. (2023)</b> [34]	Investigation into the waste-sorting behavior of the younger Chinese and the reasons that affect such types of behavior which could be better encouraged within the younger generations of the Chinese populace	Yingtian City, Jiangxi Province, China	n = 579 students questionnaire respondents, semi-structured questionnaire, questionnaire with both open and closed questions	More than half of the students participated in waste separation, and of these, the lower-year students performed better compared to the older students. This would suggest that age had a positive influence on litter separation practices in younger age groups. Environmental education was positively related to the influence from family and friends on the behavior of students but knowledge about waste separation did not have a similar effect on behavior.
<b>Nuwamanya and Byamukama (2020)</b> [28]	Finding out the factors affecting solid waste management in Nansana	Nansana Municipal Division, Uganda	n = 272 questionnaire household respondents, structured questionnaires, interview, qualitative data from recording tapes and phone recordings	The knowledge of solid waste for most of the respondents was at a moderate level, 55.6%, followed by 29.6% with high knowledge, and finally, 14.8% had low knowledge. Among the major causes of poor management of solid waste was due to low knowledge on how to manage it properly. As such, 91.5% of the respondents did not bother to segregate waste, while the majority, 82.2%, disposed of it along roadsides. Only 8.5% of the respondents reported sorting the waste before disposing, and 14% of them reused their waste.



References	Study Aims	Study Area	Sample Characteristics and Study Design	Main Findings
<b>Azmin et al. (2022)</b> [45]	Identification of the attitude and awareness of the citizens about the recycling practice context in low-cost houses of Klang	Klang, Selangor, Malaysia	n = 234 questionnaire respondents, structured questionnaire	The results showed that the practice of recycling had a significant relationship with gender, thus influencing recycling attitudes and behavior. The level of education was significantly related to residents' knowledge of recycling. Knowledge showed a significant relationship with attitudes towards recycling. However, knowledge alone could not be sufficient for environmental attitude adoption since no significant relationship existed between knowledge and practice. Of the respondents, 52.6% had a favorable attitude toward recycling, with 39.7% actively involved in recycling.
<b>Alimoradiyan et al. (2024)</b> [20]	Exploration of the socioeconomic factors that influence community participation in the system of municipal solid waste management within the Tehran municipality	Tehran, Iran	n = 664 respondents, in-person interviews, questionnaire	Education emerged as an important factor influencing composting. Those who received information on reduction, re-use, and recycling were more likely to compost than those who had not received such information. Gender had a significant influence with respect to participation in composting activities with women participating more compared to men.
<b>Ismail et al. (2023)</b> [27]	Examination how knowledge and attitude influenced effective waste recycling practices in selected communities in Selangor during the post-pandemic period	Bandar Baru Bangi, Selangor	n = 244 questionnaire respondents, door-to-door survey, online survey, sampling waste from 25 households	Within the community of Bandar Baru Bangi, Selangor, women had better knowledge regarding recycling, and gender played an important role in the practice of recycling. Even with positive attitudes and high knowledge regarding recycling, the practice within the community is not satisfactory. Most respondents had never participated in any programs or campaigns on recycling. Even amidst the pandemic, the communities showed a strong 81% recycling rate, reflecting positive attitudes. Given that, it was felt that some gap needed to be mitigated between knowledge and implementation.
<b>Yuhuan et al. (2024)</b> [30]	Examination of how different factors—demographic and socio-economic characteristics, local authority involvement, and socio-psychological factors—influence household waste management practices	Sri Lanka	n = 428 households respondents, semi-structured questionnaire, Google Forms	Age of the head of the household significantly affected the intention to separate household solid waste. Older household heads showed a greater willingness compared with younger heads. Household heads with higher education levels were likely to follow good disposal practices in waste, including waste separation. The local authority's awareness campaign did yield its positive effect on the disposal of household solid waste and reinforced the adoption of sustainable practices by the households.

References	Study Aims	Study Area	Sample Characteristics and Study Design	Main Findings
Wang et al. (2020) [44]	Evaluation significant factors that determine public awareness of household waste recycling in urban areas of China	China (Beijing, Shanghai, Chengdu, Chengdu, Guangzhou, Harbin, Jinan, Lanzhou, Qingdao, Heze, and Weihai)	n = 2200 questionnaire respondents, questionnaire, multiple-choice sentences, face-to-face interviews	The survey results indicated that age was the most important factor influencing awareness of household waste recycling. Older people recycled more but their knowledge was poor. People who received less education had less knowledge but were more willing to participate in recycling. On the other hand, highly educated people showed less activity and willingness to participate in related activities. The results showed that knowledge did not correlate with willingness to participate in recycling.
Kunszabó et al. (2022) [21]	Investigation into household composting practices by citizens in Hungary	Hungary	n = 1002 questionnaire respondents	The results of the survey indicated that, regarding the category of citizens who applied moderate composting practices, 56.54% were women, while the rest, 43.46%, were men. On the other hand, for the urban citizens who were indifferent to composting, the men dominated with 57.03%, while women had 42.97%. For the category of active environmentalists, the women made up 58.20% of the participants, with men taking 41.80%.
Nsimbe et al. (2018) [29]	Determination of the knowledge, perception, and practice concerning composting at the household level	Masaka Municipality, Central Uganda	n = 368 questionnaire respondents	The results showed that only a small fraction of the households practiced composting. More specifically, out of 368 respondents, 11.4 percent practiced composting.

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