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Assessing the Gap Between Environmental Awareness and Solid Waste Recycling Behavior Across Five Zones of Kabul City

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ABSTRACT

In Afghanistan, solid waste management remains a significant challenge. A major issue is the gap between what people know and what they actually do about recycling. This gap has not been properly studied in post-conflict countries like Afghanistan. To investigate this gap, we conducted a cross-sectional survey across different parts of Kabul city, involving 152 households. The results show that while 71.7% of residents are fully or partially aware of the harms of solid waste, only 21.7% consistently separate recyclable materials, and 26.2% never do so. This highlights a substantial awareness-action gap of nearly 50 percentage points. Chi-square analysis confirmed a statistically significant relationship between awareness and recycling behavior ($\chi^2 = 23.45$, df = 9, $p = 0.005$). Waste disposal methods varied across households: 37.5% relied on private company collection, 27.6% used public bins, 22.4% depended on municipal collection, while 12.5% disposed of waste on roads or drains. Environmental pollution was identified as the most serious problem by 50.7% of respondents, followed by health problems (19.7%) and dirty roads (17.1%). These results indicate that environmental awareness does not automatically lead to recycling due to infrastructural barriers, such as inadequate collection services and lack of separate waste streams. Therefore, interventions should focus on improving collection systems and providing household separation facilities. This study provides empirical evidence to support sustainable waste management policymaking in Kabul and similar post-conflict urban settings.

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INTRODUCTION

Solid waste management in densely populated cities is a pressing issue and poses significant environmental challenges in developing countries. The lack of proper waste collection infrastructure, facilities, and incomplete recycling systems leads to environmental degradation, endangering public health and lowering the standard of urban life (Davis & Cornwell, 2012;

Imran et al., 2025). The scale of these problems is particularly acute in densely populated cities, which reduces the development of essential services and weakens their organizational capacity.

In Afghanistan, these problems are felt much more than in other countries. After two decades of war, roads and highways, residential buildings and services have been significantly damaged. The government cannot properly manage waste, and the city is also growing very quickly (Forouhar & Hristovski, 2012). Recent assessments indicate that waste management remains a significant environmental and public health challenge in Afghanistan. Inadequate waste disposal practices, especially in informal urban settlements, pose considerable risks to community health and environmental quality. Only 40% of health facilities have proper waste segregation and disposal systems, and ongoing weaknesses in waste management infrastructure persist across provinces (UN-Habitat, 2025; UNICEF & World Bank, 2025; Infrastructure Assessment, 2025). Kabul, the capital, shows this clearly. The city has changed a lot since 2001. Its population grew from about 1.9 million to nearly 4.9 million in 2025 (MacroTrends, 2025). This demographic pressure has intensified waste generation while municipal services have struggled to keep pace. The most problematic types of solid waste in Kabul are plastics, food waste, and construction debris. These materials are often illegally dumped because there is no dedicated collection system for them.

The scale of Kabul's waste management challenge is reflected in recent studies examining the city's waste stream. The Department of Sanitation within Kabul Municipality collects only approximately 1,850 tons daily—barely 58 percent of the total waste generated—while the remainder accumulates in streets, drainage systems, and open spaces, creating environmental hazards and public nuisances (Khoshbeen et al., 2020; Hazheer et al., 2023). In this context of inadequate formal services, an informal waste sector has emerged as a significant presence in Kabul's waste management landscape, with informal collectors playing a substantial role in material recovery while operating largely outside municipal oversight (Hazheer et al., 2023; Ullah et al., 2022).

Many studies have looked at the 'awareness-action gap'. This means people know about environmental problems but still do not act in an environmentally friendly way. Research across diverse contexts has demonstrated that awareness of environmental impacts does not automatically translate into recycling action. Shimamoto (2019), analyzing panel data from Japanese prefectures, found that while demographic factors significantly influence waste generation and recycling rates, higher educational attainment paradoxically correlated with increased waste production, suggesting that awareness alone, without supporting infrastructure and incentives, may be insufficient to drive behavioral change. Similarly, Barr (2007) and Saphores et al. (2006) documented that convenience, access to facilities, and institutional support mediate the relationship between environmental attitudes and actual recycling behavior.

In developing country settings, the awareness-action gap manifests differently and often more acutely. Al-Khatib et al. (2010), studying Palestinian districts, documented that despite

residents' reasonable awareness of waste management issues, household separation practices remained limited due to inadequate collection systems and the absence of economic incentives. More recently, Adhikari et al. (2024) conducted a comprehensive waste characterization study in the rural tourist village of Ghandruk, Nepal, and found that while organic waste dominated the waste stream (60%), the proportion of recyclables like glass (12.2%) and plastic (9.4%) had increased significantly. This challenges the perception that rural areas generate little solid waste and highlights the need for integrated waste management strategies even in these settings. These findings collectively suggest that in resource-constrained settings, structural and infrastructural barriers may outweigh individual knowledge in determining recycling outcomes.

Many researchers have studied this gap worldwide. But very few have looked at it in Afghanistan. Existing studies on Kabul's waste management have focused primarily on waste characterization (Forouhar & Hristovski, 2012), generation rates (Ullah et al., 2022), and overall management challenges and strategies (Khoshbeen et al., 2020; Safi et al., 2025). While Hazheer et al. (2023) investigated household solid waste recycling management in Kabul, their study did not systematically examine the relationship between awareness levels and actual recycling behavior across different city districts using statistical tests of association. Furthermore, no published research has quantitatively analyzed the statistical relationship between environmental awareness and waste separation practices among a geographically representative sample of Kabul residents, leaving a critical gap in understanding how to design effective interventions that address both knowledge deficits and practical constraints.

By analyzing empirical data on waste generation and disposal, this research contributes to the natural science understanding of urban ecosystems in post-conflict settings. The findings will help municipal authorities, international donors, and community organizations in Kabul design more effective programs. Instead of focusing only on awareness campaigns, the evidence points toward addressing real infrastructural constraints to improve waste management in cities facing similar challenges.

This research fills the aforementioned gap by studying recycling practices in Kabul City.

The research had four main objectives, which include:

- To establish the degree of awareness of citizens on the effects of improper waste management on their health and environment;
- To examine actual recycling and waste separation practices among households across different districts;
- To analyze the statistical relationship between awareness levels and recycling behavior using chi-square analysis;
- To identify patterns in the awareness-action gap across different population segments to inform targeted interventions.

METHODS AND MATERIALS

The study was conducted in Kabul City, the capital and largest metropolitan area in Afghanistan. Kabul is located in the central-eastern region of Afghanistan at a height of 1,800 meters above sea level, spanning a surface area of 1,023 square kilometers. Kabul is subdivided into 22 districts, with a population of 5 million, accounting for 15 percent of Afghanistan's total population (NSIA, 2022). Over the last two decades, Kabul has undergone rapid urbanization with its population rising from 1.9 million in 2001 to almost 4.9 million in 2025 (MacroTrends, 2025).

For this study, Kabul City was stratified into five geographic zones based on municipal planning divisions and socioeconomic characteristics: North Kabul (including Wazir Akbar Khan, Sherpur, Khair Khana, Paghman, and Arya Project areas); South Kabul (Chehelsitoon, Chahar Asiab, and Rahman Mina); East Kabul (Bagrami, Makroyan, Pul-e-Charkhi, and Qala-e-Zaman Khan); West Kabul (Dasht-e-Barchi, Deh Mazang, Karte Char, Qala-e-Shada, Darulaman, and Afshar); and Central Kabul (Shahr-e-Naw, Chindawol, Karte Parwan, Deh Afghanan, and Shor Bazar).

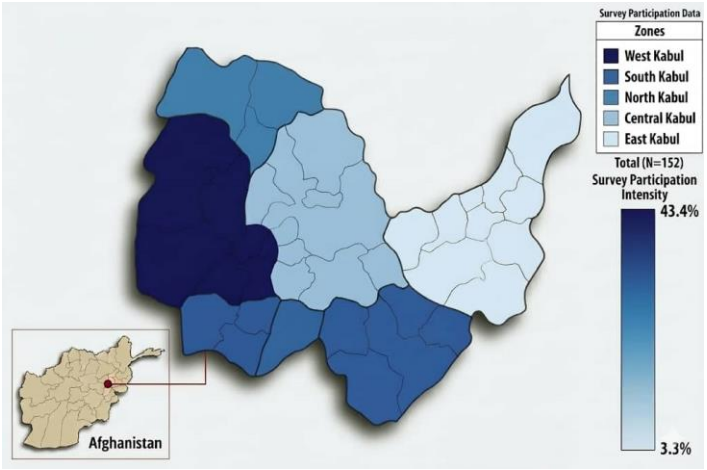

Figure 1. *Spatial distribution of survey respondents across Kabul zones (N=152)*

Note: Color intensity represents the participation rate, ranging from 3.3% (lightest) to 43% (darkest).

A cross-sectional descriptive survey design has been applied in this study to examine the relationship between environmental consciousness and recycling behaviors among citizens of Kabul city. The use of a cross-sectional design has been chosen because it is suitable for studying variables in relation to one another in a single instance.

The target population for this study comprised all households residing in Kabul City. A multi-stage stratified random sampling technique was employed to ensure representative coverage of the city's diverse geographic and socioeconomic areas.

The sample size was calculated using Cochran's formula for cross-sectional studies, yielding a required sample size of 384 households. However, due to logistical constraints and resource limitations inherent to field research, a final sample of 152 households was obtained.

The achieved sample was distributed across zones as follows: North Kabul (32 households), South Kabul (39 households), East Kabul (5 households), West Kabul (66 households), and Central Kabul (10 households).

An environmentally-based sampling method has been used in five zones of Kabul city, in line with environmental science guidelines. This method helps analyze the heterogeneous behavior of waste generation and enables statistical analysis of the determinants of environmental behavior.

Survey Instrument and Questionnaire Design

Data were collected using a structured questionnaire specifically designed for this study. The questionnaire was developed based on an extensive review of relevant literature and adapted to the local context of Kabul City. The instrument was pilot tested with 15 households in District 5 to assess clarity, cultural appropriateness, and comprehensibility.
The final questionnaire comprised eight closed-ended questions organized into three thematic sections:

Section A: Geographic and Demographic Information

- Question 1: District of residence

Section B: Waste Generation and Disposal Practices

- Question 2: Primary type of waste generated
- Question 3: Usual waste disposal location
- Question 4: Satisfaction with current collection system
- Question 5: Frequency of waste collection in the neighborhood

Section C: Awareness and Recycling Behavior

- Question 6: Awareness of the negative impacts of poor waste management
- Question 7: Practice of separating recyclable materials

Question 8: Perception of the most serious problem from poor management

Data Collection Procedures

Data collection was conducted over three weeks in January 2024. Face-to-face interviews were conducted with household heads or primary decision-makers responsible for household waste management. A team of five trained enumerators administered the questionnaires. All enumerators were native Dari and Pashto speakers and graduates of Kabul University's Faculty of Engineering.

Ethical Considerations

Verbal informed consent was obtained from all respondents prior to the commencement of the interview. Anonymity was guaranteed to all participants. Ethical approval for the study protocol was obtained from the Research Ethics Committee of Kabul University, Faculty of Engineering (Approval Number: KU-ENG-2023-042).

Data Processing and Analysis

Data were entered into Microsoft Excel by two independent data entry operators and cross-verified for accuracy. Descriptive statistics, including frequencies and percentages, were calculated for all variables. To examine the association between awareness level and recycling behavior, a chi-square test of independence was conducted. Statistical significance was set at $\alpha = 0.05$.

FINDINGS

This section presents the findings of the cross-sectional survey conducted among 152 households across five geographic zones of Kabul City. The results are organized into several subsections covering demographic distribution, waste generation patterns, disposal practices, collection services, awareness levels, recycling behavior, and the relationship between awareness and action.

Demographic and Geographic Distribution of Respondents

The total number of respondents was 152 households from five geographic zones of Kabul City. The demographic and geographic distribution of respondents by district is provided in Table 1 below. The highest percentage of respondents were from West Kabul (n=66, 43.4%), followed by South Kabul (n=39, 25.7%), North Kabul (n=32, 21.1%), Central Kabul (n=10, 6.6%), and East Kabul (n=5, 3.3%). The distribution above shows that respondents are distributed differently across Kabul's districts, with the western and southern zones experiencing faster rates of urbanization in recent years.

Table 1. *Geographic Distribution of Survey Respondents*

District Zone	Frequency (n)	Percentage (%)
West Kabul	66	43.4
South Kabul	39	25.7
North Kabul	32	21.1
Central Kabul	10	6.6
East Kabul	5	3.3
Total	152	100.0

Waste Generation Patterns

Figure 2 illustrates the types of household waste most commonly generated in Kabul. Mixed non-segregated waste constitutes the largest category (32%), followed closely by plastic waste (30%) and food waste (28%). Paper/cardboard (6%) and metal (4%) represent smaller fractions of household waste. These findings indicate that approximately 70% of households generate significant quantities of potentially recyclable materials (plastics, paper/cardboard, and metals). Yet, these materials are typically combined with other waste rather than separated at source.

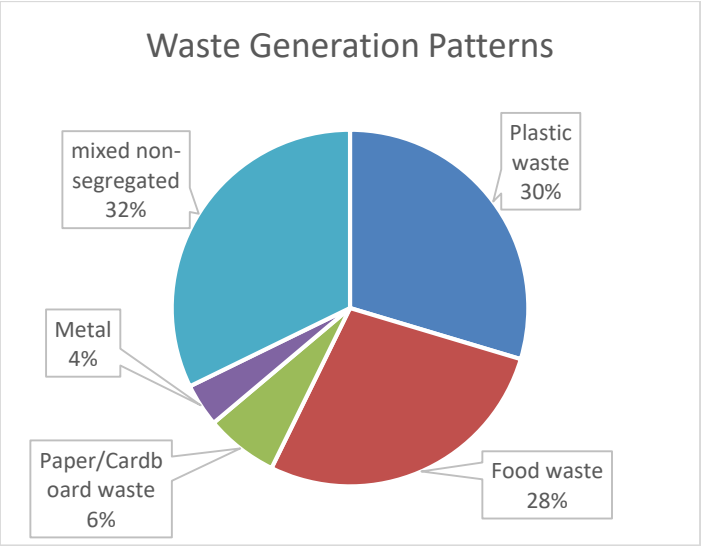

Figure 2. *Types of Waste Generated by Households*

Waste Disposal Practices and Collection Services

Table 2 presents the methods households use to dispose of their waste. Private company collection is the most common method, serving 37.5% of households, followed by public bins (27.6%) and municipal collection (22.4%). Notably, 9.2% of respondents reported disposing of waste on roads or in open spaces, and 3.3% reported disposing of waste in drains or streams. These findings reveal that formal waste collection services—whether municipal or private reach 59.9% of surveyed households. In comparison, 40.1% rely on public bins or resort to open disposal, contributing to environmental pollution and public health risks.

Table 2. *Household Waste Disposal Methods*

Disposal Method	Frequency (n)	Percentage (%)
Private company collection	57	37.5
Public bins	42	27.6
Municipality collection	34	22.4
On roads or open spaces	14	9.2
In drains/streams	5	3.3
Total	152	100.0

Satisfaction with Waste Collection Services

Table 3 summarizes respondents' satisfaction with the current waste collection system. The majority of respondents expressed positive views, with 46.7% reporting being somewhat satisfied and 23.7% very satisfied—together representing 70.4% of households. Conversely, 10.5% were dissatisfied and 7.2% very dissatisfied, while 11.8% remained neutral. These findings indicate that, despite limitations in formal service coverage, the majority of residents who have access to services are satisfied.

Table 3. *Satisfaction with Current Waste Collection System*

Satisfaction Level	Frequency (n)	Percentage (%)
Somewhat satisfied	71	46.7
Very satisfied	36	23.7
Neither satisfied nor dissatisfied	18	11.8
Dissatisfied	16	10.5
Very Dissatisfied	11	7.2
Total	152	100.0

Frequency of Waste Collection

Table 4 shows the frequency of waste collection services in respondents' neighborhoods. Daily collection is reported by 38.8% of households, while weekly collection is reported by 32.9%. However, 14.5% report that collection occurs only "sometimes," 8.6% report "never" receiving collection services, and 5.3% are uncertain. These findings suggest that collection services are irregular or absent for approximately 28% of households, consistent with the disposal methods reported in Table 2.

Table 4. *Frequency of Waste Collection in Neighborhoods*

Collection Frequency	Frequency (n)	Percentage (%)
Daily	59	38.8
Once a week	50	32.9
Sometimes	22	14.5
Never	13	8.6
Not sure	8	5.3
Total	152	100.0

Awareness of Environmental Impacts

Figure 3 illustrates respondents' self-reported awareness of the negative impacts of poor waste management. More than three-quarters of respondents (76.4%) report being fully or somewhat aware of environmental and health consequences, with 42.8% fully aware and 33.6% somewhat aware. Conversely, 15.8% report little awareness and 7.9% are unaware. These findings indicate relatively high public knowledge about waste-related risks in Kabul.

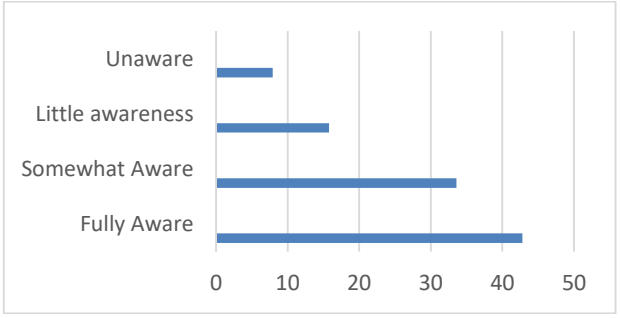

Figure 3. *Awareness Levels of Waste Management Impacts Among Kabul Residents*

Recycling and Waste Separation Behavior

Figure 4 presents respondents' reported practices for separating recyclable materials. Only 22% of respondents consistently practice waste separation ("yes, always"), while 33% separate "sometimes," 23% "rarely," and 22% "never." These findings reveal that only one-fifth of households practice consistent recycling behavior, despite the high levels of awareness documented in Figure 2.

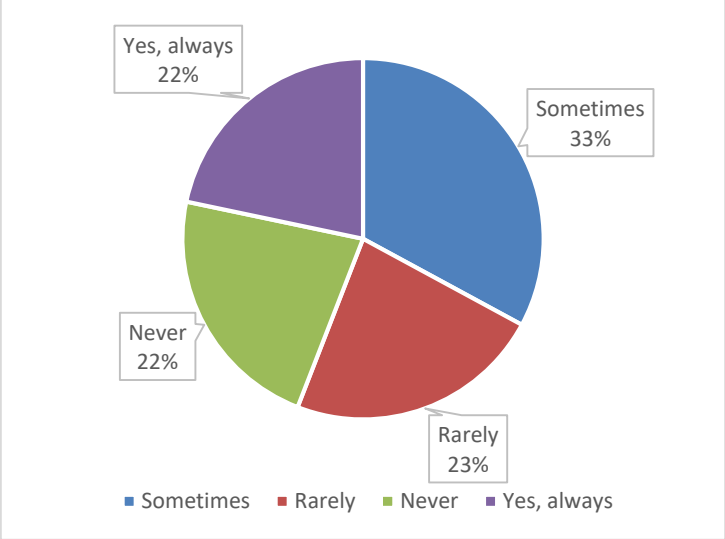

Figure 4. *Recycling and Waste Separation Practices Among Kabul Residents*

Perceived Most Serious Problems

Table 5 presents respondents' perceptions of the most serious problems resulting from inadequate waste management. Environmental pollution is identified as the most serious issue by half of all respondents (50.7%). Health problems are cited by 19.7%, dirty roads by 17.1%, blockage of drains or streams by 9.2%, and all problems combined by 3.3%. These findings indicate that environmental concerns dominate public perception, consistent with the high awareness levels reported, but also reveal significant concern about immediate, visible impacts such as health problems and dirty streets.

Table 5. *Perceived Most Serious Problems from Poor Waste Management*

Perceived Problem	Frequency (n)	Percentage (%)
Environmental Pollution	77	50.7
Health problems	30	19.7
Dirty roads	26	17.1
Blockage of drains/streams	14	9.2
All	5	3.3
Total	152	100.0

The Awareness-Action Gap: Relationship Between Awareness and Recycling Behavior

Figure 5 illustrates the relationship between awareness level and recycling behavior through a cross-tabulation of these two variables. Among respondents who report full awareness of

waste impacts, only 23.1% consistently separate recyclable materials, while a slightly larger proportion—26.2%—reports never separating waste. This finding directly illustrates the awareness-action gap: even among the most environmentally conscious residents, consistent recycling behavior is far from universal, and a substantial minority takes no action despite professed awareness.

Among respondents with little awareness, 12.5% nonetheless report always separating waste, and 50.0% report separating sometimes, suggesting that factors other than awareness—such as habit, convenience, or economic incentives—may independently influence recycling behavior.

The "sometimes" category represents the largest group across most awareness levels, indicating that many residents are willing to separate waste when conditions are favorable but face barriers to consistent practice.

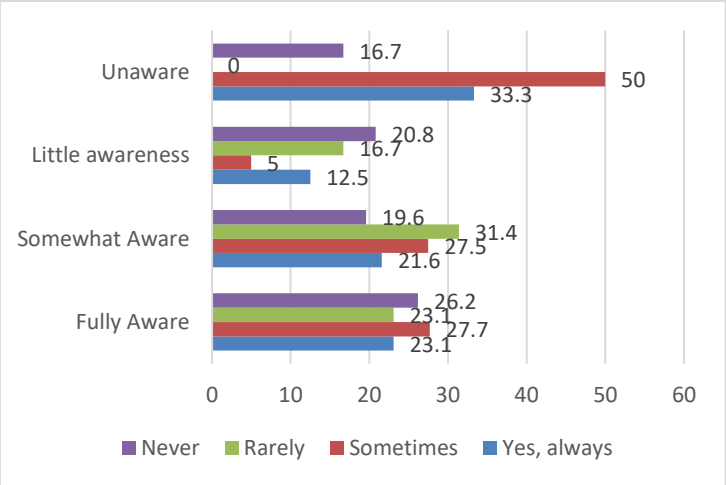

Figure 5. *The Awareness-Action Gap: Recycling Behavior by Awareness Level*

Chi-Square Test Results

We used a chi-square test to determine whether there is a significant relationship between awareness and recycling behavior. Table 6 shows the results. The chi-square value is 23.45 with 9 degrees of freedom, and the p-value is 0.005. This p-value is less than 0.05, which means the relationship is statistically significant. In simple terms, awareness and recycling behavior are related.

But here is the important point: just because they are related does not mean that more awareness always leads to more recycling. As we saw in Figure 5, even people who are fully aware do not always recycle. So the relationship exists, but it is not simple. Other factors, such as infrastructure, convenience, and habits, also play a big role.

Table 6. *Chi-Square Test Results*

Statistic	Value
Pearson Chi-Square	23.45
Degrees of Freedom (df)	9
Asymptotic Significance (p-value)	0.005
Number of Valid Cases	152

The results point to a statistically significant relationship between environmental awareness and recycling behavior in Kabul, although this relationship is not straightforward. While individuals who are more aware tend to show better recycling practices, awareness by itself does not always lead to consistent action. The findings suggest that practical factors, such as the availability of infrastructure and the effectiveness of institutions, play a key role in determining how waste is actually managed in daily life.

DISCUSSION

This study was designed to investigate the relationship between environmental awareness and recycling behavior, and waht we found was a clear gap. About 76% of people know that poor waste management is harmful, but only 22% actually separate their waste. That means more than half of those who know the problem don't act on it. The chi-square test confirmed a relationship between awareness and behavior ($\chi^2 = 23.45$, $p = 0.005$), but the relationship is not simple. The real issue is not lack of knowledge—it is lack of proper services.

First, we looked at public awareness. Most people (76%) are aware of the negative effects of poor waste management, similar to findings from other developing countries (Al-Khatib et al., 2010). People in Kabul see waste everywhere, so it makes sense they know it is a problem. Still, about 16% have little or no awareness, so targeted campaigns are still needed.

Second, we examined recycling behavior. Despite high awareness, only 22% consistently separate waste. Among fully aware people, 23% always separate and 26% never do. This pattern is not unique to Kabul; similar gaps have been found in Kathmandu (Dangi et al., 2011) and Palestine (Al-Khatib et al., 2010). Awareness alone is not enough when infrastructure is missing. A key finding is that 33% separate waste "sometimes." These people are willing to recycle but face barriers. As Barr (2007) noted, convenience and access to facilities are crucial for turning awareness into action.

Third, we tested the statistical relationship. The chi-square test confirmed a significant relationship. However, among fully aware people, the numbers are split almost evenly: 23% always, 28% sometimes, 23% rarely, and 26% never. This shows that awareness alone does not guarantee action. Other factors—what Shimamoto (2019) called "structural and institutional determinants"—play a big role. Interestingly, 33% of unaware people still separate their waste, possibly due to economic reasons. Some households in Kabul sell recyclables to informal collectors (Hazheer et al., 2023), suggesting that financial incentives can sometimes drive recycling more than environmental concern (Saphores et al., 2006)

Fourth, we looked at different groups. The "somewhat aware" group is the best target for interventions—they have some knowledge but no consistent habits. Most people recycle only "sometimes," showing that irregular services are a major problem (Khoshbeen et al., 2020). Some unaware people recycle because they sell materials to informal collectors (Ullah et al., 2022), showing that economic incentives matter.

What does this mean for policymakers? First, invest in infrastructure—only 60% of families have formal collection. Second, target the 33% who recycle "sometimes" and remove barriers they face. Third, work with informal collectors who already recover 9–12% of Kabul's waste. Fourth, focus messages on visible problems like pollution and health.

When we compare our findings with earlier studies, we see both agreement and change. Our results on waste composition match what Hazheer et al. (2023) and Ullah et al. (2022) reported. But unlike older studies that described municipal collection as the main service (Forouhar & Hristovski, 2012), we found that private companies now collect more waste (37%) than municipalities (22%)—a positive change.

We acknowledge our limitations. Our sample size was 152 households, smaller than the ideal 384 due to fieldwork challenges. So our findings should be interpreted with caution and may not fully represent all of Kabul. Larger studies are needed.

Despite these limitations, this study provides useful evidence on the awareness-action gap in a post-conflict city like Kabul. Closing the gap will take more than education—it will need better services, stronger systems, and real support for households.

CONCLUSION

This study examined the gap between environmental awareness and recycling behavior in Kabul. The main contribution is quantifying this gap: while 76% of respondents are aware of waste-related problems, only 22% consistently separate their waste. Even among those who are fully aware, 23% always recycle and 26% never do. The chi-square test confirmed a statistically significant relationship between awareness and behavior ($\chi^2 = 23.45$, $p = 0.005$), but the pattern is complex and non-linear. This clearly suggests that awareness alone is not enough to drive meaningful action.

The study also makes several important contributions to the existing literature. First, it extends research on the awareness-action gap to a post-conflict, fast-growing city context, an area that has received very limited attention in previous studies. Second, it provides valuable baseline data on waste generation patterns, disposal methods, and service satisfaction that can inform future research and policy decisions. Third, it identifies that 33% of respondents recycle "sometimes," highlighting a critical target group—people who are willing to recycle but face real barriers to consistent practice.

The practical implications of these findings are clear and actionable. Awareness campaigns are still needed, especially for the 24% of respondents with little or no awareness, but they cannot solve the problem alone. Interventions must also address structural and infrastructural barriers. The most pressing needs include: expanding collection coverage (only 60% of households have access to formal services), providing separate collection streams, helping "sometimes" recyclers overcome practical barriers, leveraging economic motivations through integration with the informal sector, and framing messages around visible concerns like pollution, health, and dirty streets.

Future research should examine how changes in infrastructure affect recycling behavior over time, study the informal sector in more depth, and compare findings across other Afghan cities to assess whether the patterns observed in Kabul are generalizable.

In short, closing the gap in Kabul requires more than education—it requires better infrastructure, reliable services, and practical support for households. As the city continues to grow and waste generation increases, evidence-based interventions that address both knowledge and structural barriers will be essential for protecting public health and improving environmental quality. This study provides a solid foundation for such efforts.

Authors Contributions

Abdul Matin Muqset: Conceptualized the study, designed the questionnaire, conducted field data collection, performed statistical analysis, and wrote the original manuscript draft.

Ahmad Fawad Ehsas: Supervised the research, guided methodology, reviewed and edited the manuscript, and assisted with the interpretation of findings.

Both authors reviewed and approved the final version of the manuscript.

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Conflict of Interest Statement

The authors declare that they have no conflict of interest. No financial, personal, or professional relationships exist that could be construed as influencing the research or its interpretation.

Data Availability Statement

All data generated and analyzed during this study are included in this published article. The survey questionnaire and raw data tables are presented in the main text. Additional data may be available from the corresponding author upon reasonable request.

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