Natural Resources for Human Health
eISSN: 2583-1194

Original Research

Received 20 July 2026
Revised 18 Aug 2026
Accepted 04 Sep 2026

Natural Resources for Human Health 2026, Vol. 6 (21s): 95–101

KEYWORDS:
Sustainability, Awareness, Reduce, Reuse, Recycle, Restore

From Knowledge to Practice: A Household Study on the 4R's

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ABSTRACT: **Objective**: To know the level of public awareness of the 4Rs (Reduce, Reuse, Recycle, Restore) and the frequency of their practice in daily life. The paper discusses the major socio-economic factors and structural barriers, such as income, education and housing infrastructure that either encourage or impede the adoption of sustainable waste management practices.

Methodology: The study used a quantitative survey research design and collected data from a mixed sample of 150 households. The demographic profiles were obtained using a structured questionnaire and a Likert-scale method for awareness, perceived barriers, and frequencies of practice. The data analysis was performed using non-parametric statistical methods, such as Chi-Square tests of independence, Spearman's rank correlation, and Kruskal-Wallis tests, to assess significance. The instrument was tested for validity using Cronbach's alpha.

Findings: There was a highly significant difference in the conceptual awareness of 4Rs based on educational background and monthly income through statistical analysis. The strong negative correlation demonstrated that perceived lower income is a major obstacle to sustainable living. And the waste segregation practices varied greatly, depending on the type of housing; owners of apartments and houses practiced waste segregation more consistently than renters.

Conclusion: The study concludes that the public's acceptance of the 4R's framework is more highly constrained by inequalities in socio-economic status and structural constraints. To achieve universal sustainable living, policy interventions should be aimed at closing the education gap through localized campaigns and removing infrastructural barriers by ensuring that all residential areas have access to recycling facilities.

1. INTRODUCTION

India produces around 185,000 tonnes of solid waste every day. The Central Pollution Control Board (2023-24) estimates that the country's annual production of 62 million tonnes will increase to 165 million tonnes by 2030 due to rapid urbanisation, changing consumption patterns and economic growth. But only two-thirds of this waste is collected, and less than a third is processed before disposal.

The impact goes far beyond overflowing landfills. Dumps pollute groundwater, generate toxic leachate, and release methane, a greenhouse gas 80 times more powerful than carbon dioxide over 20 years. Every day, over 30,000 tonnes of municipal solid waste are dumped. It has therefore become a symbol of a system gone wrong and a direct threat to public health and the liveability of cities.

We need to move from a linear economy to a circular economy to prevent further damage being done to our planet and to restore the damage we have done to the environment to the maximum extent possible. The 'linear economy' is the model of

extraction, consumption and disposal of resources as waste with a major impact on the environment, deep social inequalities and loss of biodiversity. The 'circular economy' is the model of endless materials and the regeneration of nature. Products and materials are kept in use here through repair, reuse, refurbishment, recycling and composting. The circular economy decouples economic activity from the consumption of finite resources and thus addresses climate change and other global challenges such as loss of biodiversity, waste and pollution.

This is where the 4Rs come into effect. It provides us with a systematic and structured framework in which we can live more sustainably and environmentally friendly through small and consistent steps like reduce, reuse, recycle and restore, helping in the transition towards the circular economy. The 4R concept is an evolution of the 3R principle of reduce, reuse and recycle, which was developed during the 1970s environmental movement to address the growing problem of waste. Later, the fourth R, Recover, was added for more sustainable waste management, using energy and materials from nonrecyclable waste.

The 4R's consist of the following:

1) **REDUCE** - Less is More

"Reduce" means to cut down on the amount of waste you create in the first place by using fewer resources. It's about being aware of your choices, like only buying what you need and choosing items with less packaging. We reduce waste to save natural resources and the energy needed to produce them. It also cuts down on the amount of landfill waste. Reduction is considered the best waste management method as it prevents the generation of waste.

2) REUSE – Give it all a second life.

Reuse means you use something again instead of throwing it away after you have used it once. Reuse glass jars, containers and plastic bags for storage or other purposes. This process can help products last longer and reduce the need to create new materials. Plus, it saves energy and the materials needed to make new things. It is an important step in reducing the total amount of waste.

3) RECYCLE – A Change For A Better Tomorrow

It is the process of converting waste materials into new products by mechanical or industrial processes. Paper, plastic, glass and metal are all collected, processed and made into usable products. Recycling saves natural resources and cuts down on pollution to the environment. Recycling is often only recommended where reduction and reuse are not possible. Proper segregation of waste is required to be useful for recycling.

4) RECOVER – Making the best use of what cannot be recycled

'Recover' means to convert waste into useful resources such as energy, heat, compost or fuel. This is usually accomplished by thermal or biological processes. Resource recovery has value in recovering value from waste that cannot be reduced, reused or recycled. It also reduces the amount of waste going to landfill. It is the last option after other waste management practices have been implemented.

The 4R's are not some abstract list of ideas; they are things we can do now. By buying less, reusing what we already have, recycling properly and making the most of what we can't reuse, we are changing the world.

1.1 Review of Literature

A major barrier to sustainability is the legacy of the traditional linear economic model extracting resources, manufacturing products, and discarding them. Unpacking these systemic flaws, Hom (2024) emphasises that a circular paradigm guided by four specific actions cutting down, extending life, processing again, and reclaiming value is necessary to alleviate resource depletion and escalating carbon outputs. In the digital age, this challenge is acutely felt within the electronics sector. Discarded technology accumulates rapidly due to planned obsolescence and fast tech update cycles. While organisations are beginning to extend the operational life of hardware, weak recovery networks and regulatory gaps mean vast amounts of electronic waste are still lost. Effectively managing these cycles requires a shared commitment across leadership, enterprises, and everyday consumers.

Despite broad public concern for nature, researchers consistently observe a disconnect between ecological sentiment and daily action. Musso and Palmeira (2017) highlight a critical imbalance: while individuals express deep environmental concern,

"reduce" and "reuse" practices lag significantly behind "recycling". This reliance on recycling suggests that public commitment is shallow and fails to address the root causes of waste. Similarly, Licy et al. (2013) observe that knowing how to properly handle waste does not reliably translate into doing so, showing a persistent gap between environmental literacy and active behavioural compliance.

Waste-handling performance is highly variable and depends on socio-demographic factors, regional infrastructure, and regulatory pressures. Alberca et al. (2024) examine eleven years of data from the waste sector, finding that operations are heavily influenced by geographic disparities, regional funding for ecological safeguards, and global disruptions such as pandemics. In Malaysia, public resource limitations are clear; historically, 40% to 70% of public funds are spent on basic waste handling, yet recycling rates remain under 5%. Evaluating this context, Desa et al. (2013) find that university freshmen exhibit only moderate environmental awareness and average green habits. However, Budica et al. (2015) offer a more optimistic view, noting that younger generations after the year 2000 tend to treat waste sorting as second nature and a social norm, adapting quickly even without formal training.

To bridge the awareness gap, targeted educational outreach is essential. Research indicates that standard, poorly designed campaigns often fail to motivate public involvement. Consequently, specialised educational interventions are crucial to reshape how communities understand and act on waste reduction. Nadzier et al. (2019) demonstrate that mobile applications successfully teach kids 3R principles during screen time, prompting practical habits like saving paper and using refillable bottles. Nizaar et al. (2020) show that hands-on classroom training such as transforming scraps into compost or decorations significantly improves environmental care and reduces household waste. Hasan (2004) notes that teaching children about waste sorting shifts household behaviours over several years, helping them connect daily actions with broader ecological consequences. While school campaigns dramatically increase children's cognitive knowledge of the environment, changing their actual daily habits takes more time. This suggests that early awareness programmes must be sustained over the long term to establish permanent eco-friendly habits.

We're hearing more and more about sustainable living and the 4Rs – reduce, reuse, recycle and recover and still get value – but the trash keeps piling up. It's not always clear how much people actually live those ideas every day, even when they're aware of how it's harmful to nature. So now is a good time to look more closely at whether knowing leads to doing.

Urbanisation speeds up urban growth. Urbanisation speeds up urban growth. Factories sprang up all over the place. People are more materialistic these days than they used to be. People are more materialistic these days than they used to be. This leads to a faster depletion of nature, and our environment's ability to absorb it reaches its limit. This leads to a faster depletion of nature, and our environment's ability to absorb it reaches its limit. The trash keeps piling up every year. The trash keeps piling up every year. Leaders experiment with new rules. Leaders experiment with new rules. And green groups push hard, too. And green groups push hard, too. They say to do four things: cut down, reuse things, sort trash, and pull useful bits back out. But people have to get involved for any real change. They say to do four things: cut down, reuse things, sort trash, and pull useful bits back out. But people have to get involved for any real change. Without people playing their part, efforts are limited. Without people playing their part, efforts are limited. What someone chooses to do each day determines the results. What someone chooses to do each day determines the results. The main thing about changing habits is the desire. The main thing about changing habits is the desire. Some don't purchase extras. Some don't purchase extras. Some others give items a second go-round. Some others give items a second go-round. But many people don't sort their bins correctly. But many people don't sort their bins correctly. Real readiness testing is the key here. Real readiness testing is the key here. True intent measurement exposes gaps between talk and action. True intent measurement exposes gaps between talk and action. It takes more than belief. The next step is to act. It takes more than belief. The next step is to act. Real behaviour shows what commitment looks like. Real behaviour shows what commitment looks like.

But just because you know what's right doesn't mean you'll do it. Some people understand why sustainability is important but don't do anything. This may be because routine gets in the way. The facilities are missing, or the mindset holds them back. Examining how far consumers embrace the 4Rs reveals what drives eco-friendly choices and what subtly undermines real change.

1.2 Objectives

1. To analyse the level of awareness and understanding of the 4R's

2. To identify the factors influencing or discouraging the adoption of the 4Rs
3. To examine the frequency of practising the 4R's

1.3 Methodology and Research Design

The study was conducted among the consumers of the Kottayam district. Responses were collected from 150 respondents. The data obtained were primary data, which were collected through Google Forms. The type of sampling used was convenience sampling. A structured questionnaire was prepared using Google Forms. The obtained data were analysed using tables, percentages and pie charts. The data analysis was performed using non-parametric statistical methods, such as chi-square tests of independence, Spearman's rank correlation, and Kruskal-Wallis tests, to assess significance. The instrument was tested for validity using Cronbach's alpha.

2. FINDINGS AND RESULTS

2.1 Demographic Profile

A sample of N = 150 unique household responses was gathered. The demographic composition of the sample reflects a diverse cross-section of socio-economic positions:

- **Household Size:** 32.0% represented 3–4 member settings, 29.33% represented 0–2 member settings, 23.33% represented 5–6 member configurations and 15.33% were large households with 7 or more members.
- **Monthly Household Income:** Distributed across four tiers: Below 20,000 (19.33%), 20,000–40,000 (27.33%), 40,000–60,000 (30.0%), and Above 60,000 (23.33%).
- **Education Level:** Composed of secondary schooling (23.33%), diplomas (22.67%), university graduates (30.67%), and postgraduates (23.33%).
- **Residential Setting:** 46.0% owned houses, 30.67% lived in rental spaces, and 23.33% resided in apartment complexes.

2.2 Demographic Factors vs. Concept Awareness

2.2.1 Education Level vs. Concept Awareness

Method of Statistical Analysis: Chi-Square Test of Independence (χ^2)

Analytical Outcomes: The statistical evaluation yielded a Chi-Square value of $\chi^2 = 115.68$, with a highly significant p-value of $p < 0.001$ (approximately 6.57×10^{-25}).

2.2.2 Monthly Household Income vs. Concept Awareness

Method of Statistical Analysis: Chi-Square Test of Independence (χ^2)

Analytical Outcomes: The statistical assessment resulted in a Chi-Square value of $\chi^2 = 102.94$, with a highly significant p-value of $p < 0.001$ (approximately 3.62×10^{-22}).

Significance: Highly Significant. The data reveals that knowledge of sustainability concepts varies noticeably across different economic brackets, with lower-earning households demonstrating a significantly higher tendency to lack awareness compared to those with higher monthly incomes.

2.3 Socio-Economic Influences & Barriers

2.3.1 Monthly Income vs. Income Impact

Method of Statistical Analysis: Spearman's Rank Correlation (rs)

Analytical Outcomes: The calculation yielded a correlation coefficient (rs) of -0.703 and a highly significant p-value ($p < 0.001$).

Significance: Highly Significant. The inverse relationship suggests that as earnings rise, the perceived financial constraints on green habits diminish. Conversely, limited household budgets represent a formidable structural obstacle to participation.

2.3.2 Monthly Income vs. Premium Pricing Barrier

Method of Statistical Analysis: Spearman's Rank Correlation (rs)

Analytical Outcomes: Statistical assessment produced a value of rs = 0.623, with a highly significant p-value of $p < 0.001$.

Significance: Highly Significant. Families with greater financial flexibility are more conscious of the price premiums associated with ecological products, whereas those in lower brackets remain largely unengaged with or neutral toward expensive green alternatives.

2.4 Practice Frequencies & Residential Environments

The researchers evaluated the extent to which ecological behaviours are shaped by the physical nature of residential infrastructure.

2. 4.1 Residential Area Type vs. Waste Segregation Frequency

Method of Statistical Analysis: Kruskal-Wallis H-Test

Analytical Outcomes: The H-statistic was measured at 30.33, indicating a highly significant result with $p < 0.001$.

Significance: Highly Significant. Behavioural consistency shifts based on domestic context; residents in owned properties and integrated apartment units demonstrate higher sorting rates compared to those in temporary rental arrangements.

2.5 Predicting Sustainable Output

The study assessed whether internalizing sustainability concepts reliably dictates the frequency of active environmental contributions.

2.5.1 Self-Rated Understanding vs. Overall Contribution

Method of Statistical Analysis: Spearman's Rank Correlation (rs)

Analytical Outcomes: The analysis yielded a near-perfect coefficient of rs = 0.978, with extreme significance of $p < 0.001$.

Significance: Highly Significant. A robust connection exists between personal literacy and behavioral compliance, confirming that a deeper understanding of the framework serves as a direct predictor of sustained ecological output.

2.6 Instrumentation and Reliability Verification

The survey consisted of 19 entries measuring socio-demographic indicators, scale-based barrier reflections, and target activity frequencies. Core concepts were measured using a 5-point Likert scale (e.g., 5: Strongly Agree / Always to 1: Strongly Disagree / Never).

To verify scale reliability, Cronbach's Alpha (**α**) was calculated across the core comprehension variables measuring framework literacy (Meaning of Reduce, Meaning of Reuse, Local Recycling Practices, and Meaning of Restore)

$$\alpha = \frac{N \cdot \bar{c}}{\bar{v} + (N-1) \cdot \bar{c}}$$

Where:

- K represents the number of items in the scale (K = 4) in this analysis $\bar{c}$
- , which represents the average covariance between all pairs of items. $\bar{v}$ ·
- , represents the average variance of each item

The scale demonstrated excellent reliability (**α** = 0.942). This value is much higher than the conventional psychometric threshold of 0.70, suggesting that the four indicators have excellent internal consistency and reliably measure a single underlying construct, General 4R Comprehension. If the survey items returned a low alpha (e.g., **α** = 0.45), it would indicate

that a respondent's understanding of 'reducing' was not mathematically related to their understanding of 'recycling'. This would suggest that the questions we asked were confusing, badly worded or understood differently by different households. With $\alpha = 0.942$, we can statistically guarantee that our survey instrument is highly reliable, free of any severe response bias, and capable of generating stable and reproducible results across the 150 sampled households.

3. CONCLUSION

This study provides compelling empirical evidence that the implementation of the 4R Sustainability Framework (Reduce, Reuse, Recycle, Restore) is not merely a matter of individual moral choice or environmental awareness; rather, it is heavily negotiated by a household's socio-economic positioning and physical infrastructure. While an overwhelming majority of individuals who possess a deep conceptual understanding of the 4R principles show a near-perfect willingness to actively contribute to daily sustainable practices ($r_s = 0.978$, $p < 0.001$), severe structural fractures compromise this knowledge-to-practice pipeline.

The results of this study suggest that the extent to which a household applies sustainability concepts is strongly influenced by socio-economic conditions and spatial resources. Environmental literacy is divided by income and education, and everyday sustainable actions are determined by physical living arrangements. 37.33% of people have never heard of the 4R's; the vast majority belong to the lowest education tier (schooling) and the lowest income tier (below 20,000). Conversely, nearly 100% of postgraduate and high-income respondents answered "Yes" to having heard of the concept. Among the poorest households (below 20,000), an overwhelming 86.2% "strongly agreed" that their financial situation limits their capacity to practise the 4Rs. Meanwhile, for the highest earners (above 60,000), 0% strongly agreed with this limitation. When asked if eco-friendly items are too expensive, 77.1% of high-income households (above 60,000) "strongly agreed". In contrast, the lowest-income segment was highly fragmented (with 31% completely neutral), proving that lower-income brackets are largely left out of the market for premium "green-branded" retail choices entirely.

Thus, public waste management policies cannot depend solely on appeals to personal ethics. Systemic solutions are required to overcome waste challenges and directly address economic inequalities and tenancy limitations. Sustainability should be a standard that is achievable by urban communities, not a middle-class ideal.

4. SUGGESTIONS

Based on the findings of the study on the 4Rs Reduce, Reuse, Recycle, and Recover several suggestions can be proposed to improve the adoption of sustainable consumption practices among consumers.

1) Increasing public awareness is essential to strengthen consumer commitment to the 4Rs. Educational programmes, workshops, and awareness campaigns conducted by government agencies, educational institutions, and environmental organisations can help people better understand the importance of reducing waste and conserving resources. Social media and mass communication channels can also be effectively used to spread information about sustainable practices.

2) The government should take initiatives to make eco-friendly products more affordable and accessible. Providing subsidies, tax benefits, or incentives for environmentally friendly products can encourage consumers to choose sustainable alternatives over single-use or harmful products. Such measures can reduce the financial burden that often discourages consumers from adopting eco-friendly options.

3) Improving recycling infrastructure is necessary to promote responsible waste management. The establishment of more recycling centres, waste segregation systems, and proper collection facilities in both urban and rural areas will make it easier for individuals to participate in recycling activities. Local authorities can also introduce community-level waste management programmes to encourage collective participation.

4) To promote repair and reuse culture among consumers. Repairing products instead of discarding them should be encouraged through affordable repair services, awareness programmes, and support for small repair businesses. This will contribute to prolonging the life cycle of products and reducing avoidable waste.

5) Individuals should be supported by families, schools, and community organisations in the development of sustainable habits. The practice of environmental values in households and communities can have a positive impact on consumer behaviour and lead to a long-term commitment to the 4R's.

These measures can increase consumer participation in the 4Rs, which can in turn lead to improved environmental protection and sustainable resource management.

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