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Wi-Fi Vending Machine Using Plastic Bottles for Internet Access

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Abstract: *This study evaluated the effectiveness of a Wi-Fi Vending Machine Using Plastic Bottles for Internet Access as an innovative solution for promoting environmental sustainability and digital inclusion. The system allows users to exchange plastic bottles for temporary internet access, encouraging proper waste disposal while addressing limited connectivity. Using a quantitative descriptive-correlational design, data were collected from 41 students and community members through a structured questionnaire distributed via Google Forms. The study assessed system functionality, bottle detection efficiency, accuracy, and internet accessibility. Results showed an overall weighted mean of 3.31, interpreted as Highly Effective. Accuracy obtained the highest mean of 3.41. A significant positive correlation was found between accuracy and internet accessibility ($r = 0.6292$, $p < 0.001$), indicating that improved detection accuracy enhances user trust and perceived connectivity. The findings demonstrate that the system is a practical and feasible approach to integrating recycling incentives with internet access to support both environmental cleanliness and community connectivity.*

Keywords: Wi-Fi vending machine, Plastic bottle recycling, Internet accessibility, Environmental sustainability

I. INTRODUCTION

Environmental pollution caused by global wastes, particularly plastic bottle products, has drawn increasing attention in recent years. Every day, large amounts of plastic waste are generated and, when mismanaged, they harm ecosystems and wildlife (UNEP, 2021). At the same time, many communities still face a persistent digital divide due to limited or unstable internet access, which restricts opportunities for education, communication, and livelihood. These environmental and technological challenges highlight the need for innovative solutions that can simultaneously promote recycling and improve connectivity. In response, the concept of a "Wi-Fi Vending Machine" that exchanges plastic bottles for internet access emerges as a practical approach to encourage proper waste disposal while supporting digital inclusion.

Existing studies highlight the potential of digital technologies and incentive systems to promote sustainable behavior. Research shows that digital platforms can improve recycling participation by increasing transparency and traceability (Rinanda et al., 2023), while digital literacy encourages engagement in environmentally friendly activities and supports access to online tools for recycling (Tao et al., 2025). Studies also indicate that rural telecentres enhance social inclusion and local initiatives, demonstrating how technology can address both environmental and social challenges (Handoyo et al., 2024). Digital-enabled circular economy models suggest that integrating technology with plastic recycling can improve efficiency and maximize resource use (Author et al., 2024), and linking digital access with environmental incentives can raise public awareness on sustainability (Author et al., 2025). However, few studies have explored a system that combines recycling incentives with direct digital connectivity, and this research investigates Wi-Fi vending machines as a solution to simultaneously promote environmental sustainability and digital inclusion.

The concept of a Wi-Fi vending machine using plastic bottles for internet access creates a direct relationship between environmental sustainability and digital inclusion. In this system, plastic bottles, which are typically considered waste,

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become a form of currency that grants users access to the internet. This incentivizes individuals to engage in proper recycling behaviour, reducing plastic pollution and promoting environmental responsibility. At the same time, the machine provides internet access to users who may have limited connectivity, bridging the digital divide and supporting educational, social, and economic activities. Thus, the two variables recycling behaviour and internet access are interlinked, as increased participation in recycling directly leads to greater digital accessibility, demonstrating a practical integration of ecological and technological benefits.

This study investigates the groundbreaking idea of a Wi-Fi vending machine, which serves as a platform for trading plastic bottles for internet access and exemplifies ecological sustainability and digital inclusion. It recommends deploying the system to improve recycling behaviour while expanding internet access among students and community members. The machine should be evaluated in terms of accessibility, reliability, and usability to ensure positive effects on recycling behaviour, internet access, environmental cleanliness, and user satisfaction. Local governments, schools, and technology developers are encouraged to adopt and support this innovation as part of sustainable waste management and connectivity programs. Continuous enhancements in system design, connectivity stability, and user interface are also recommended to maximize engagement and long-term effectiveness.

A. Objectives of the Study

This study aims to:

- Examine the impact of Wi-Fi vending machines on students' and community members' recycling behavior.
- Analyze the relationship between the accessibility of Wi-Fi and the frequency of internet usage among users.
- Determine the effectiveness and feasibility of using Wi-Fi vending machines as a tool for promoting both digital inclusion and environmental sustainability.
- Identify the key technical, social, and environmental challenges in implementing Wi-Fi vending machines in urban and rural areas.
- Propose recommendations for improving the system's design, usability, and impact for future research and practical implementation.

II. CONCEPTUAL FRAMEWORK

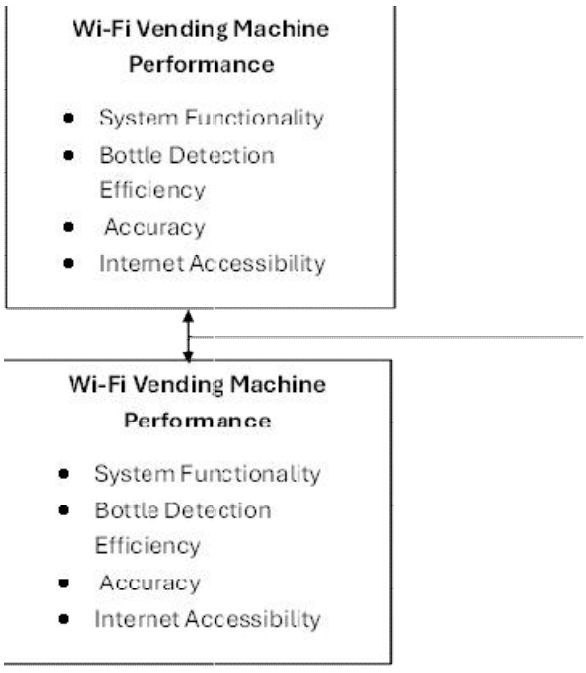

Fig 1 Conceptual Framework of the Study

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This research is informed by the Theory of Planned Behaviour found in Ajzen (1991) which states that people's behaviours are controlled by intentions that, in turn, are controlled by attitudes, norms, and control percept. In the formulation of this research problem, the provision of access to the internet via Wi-Fi as a reward for recycling is expected to not only enhance the students' and the community's behaviours in terms of recycling and internet usage but will also increase their level of environmental consciousness.

III. REVIEW RELATED LITERATURE AND SYNTHESIS

The research shows progress in Wi-Fi vending machines which operate plastic bottle recycling machines through their use of automated systems and sensors and blockchain technology and Internet of Things capabilities. The technologies create secure digital platforms which operate efficiently and provide simple access for users. The solution addresses three main problems, which include internet access issues, sustainable waste management challenges, and untrustworthy transaction methods, while it enables green solutions that benefit communities which lack basic resources.

A. System Functionality

Recent studies highlight system functionality as the core of automated platforms, emphasizing the need for seamless integration between hardware and software. Research indicates that IoT-enabled systems, when paired with blockchain, enhance transaction security and prevent fraud in cashless operations (Henriques et al., 2022). High-level functionality ensures that these systems provide uninterrupted internet access, especially in areas with limited infrastructure. Furthermore, robust system functionality incorporates user-centered design to ensure accessibility for diverse users through intuitive interaction methods (Caporusso et al., 2019). Overall, the technical stability of a system's functionality is what transforms a simple machine into a reliable digital service provider.

B. Plastic Bottle Recycle

Recent literature demonstrates that incentive-based recycling systems significantly improve plastic waste management and public participation. Modern reverse vending machines equipped with vision-based recognition and image processing algorithms have shown improved accuracy in identifying and classifying recyclable plastic bottles, enhancing operational efficiency (Lopez et al., 2021). Additionally, near-infrared sorting technologies have been applied to distinguish different plastic types, enabling more precise recycling processes (Athukorala et al., 2021). Blockchain-based tokenization has also emerged as a strategy to motivate recycling behavior while supporting circular economy initiatives and reducing reliance on virgin materials (Wankmüller et al., 2023). These studies collectively reveal a trend toward integrating digital technologies with recycling incentives to encourage sustainable waste disposal practices, although cost and infrastructure limitations still pose challenges for large-scale implementation.

C. Accuracy

Accuracy plays a crucial role in the performance of Wi-Fi vending machines that accept plastic bottles, as reliable detection systems ensure valid transactions and prevent misuse. Recent studies highlight the effectiveness of ultrasonic, inductive, and infrared sensors in distinguishing recyclable materials, thereby minimizing identification errors and improving system reliability (Grimaldo et al., 2024). These sensor-based mechanisms contribute to fraud prevention and ensure that only appropriate materials are accepted by the machine. Furthermore, current findings indicate that modern Wi-Fi vending systems provide fast and stable internet connectivity by utilizing advanced network configurations such as access points functioning as Network Address Translators (NAT), enabling quick response times after successful transactions (Borongan, 2024). Despite these improvements, researchers note that environmental factors and sensor sensitivity may still affect detection accuracy, suggesting the need for continuous calibration and system refinement.

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D. Internet Accessibility

Recent studies underscore the importance of internet accessibility in promoting education, communication, and socio-economic development across communities. Improved connectivity in underserved areas has been found to enhance educational participation, empower local communities, and support inclusive development (Yoo et al., 2021). Additionally, research indicates that access to digital networks increases social interaction, financial opportunities, and overall well-being among disadvantaged populations, though disparities in access remain a persistent issue (Kearns &Whitley, 2019). Expanding digital infrastructure has also enabled remote learning, online employment, and knowledge sharing, further highlighting the transformative role of internet accessibility in modern society (Joshi et al., 2022). These findings suggest that innovative connectivity solutions, such as Wi-Fi vending machines, can help bridge the digital divide while simultaneously supporting sustainable and inclusive community growth.

E. Synthesis

The reviewed literature highlights the integration of Wi-Fi vending machines with recycling technologies as an innovative solution to improve internet accessibility and promote sustainable waste management. Studies emphasize the use of IoT and blockchain and sensor-based systems to secure transactions and detect materials accurately and operate machines efficiently. Research on recycling systems shows that incentive-based and automated recognition technologies significantly enhance plastic waste collection and classification accuracy. The literature establishes that reliable connectivity together with optimal network configurations delivers stable internet services, particularly in areas with limited access to such services. The synthesis shows that recycling incentives combined with Wi-Fi vending technology support environmental sustainability, digital inclusion and community development but face challenges related to costs and infrastructure.

IV. METHODOLOGY

This section provides a description of the overall research plan and how you will collect and analyze your data. The method should be sufficiently detailed that any researcher can replicate your research, who is interested in Waste to Internet Incentive Systems, can do so.

A. Research Design

The researcher used a quantitative, descriptive-correlational research design to study the relationship between the technical performance of the Wi-Fi Vending Machine and how the technical performance of the system (reliability of the system) affects user-related outcomes. This research design was appropriate for the study because it allowed the researcher to examine in depth how the system (Reliability of the System - Functionality of the System, Efficiency at Detecting Bottles, Accuracy - how accurate the bottle detection system is, and Accessibility to the Internet) and how it varies in the way users will behave and feel satisfied with their experience using the Wi-Fi Vending Machines by evaluating the technical performance of these systems quantitatively (numerically). The researcher was able to determine the success of using plastic bottles as a "currency" for internet access by using the quantitative measures of the two factors.

B. Participants and Sampling Method

The study involved 41 participants selected through simple random sampling. The users included students and community members, the two primary groups of people using the vending machine. All users were required to have an active internet connection as well as to have previously interacted with the vending machine's hardware or software in order to qualify as a participant.

Based on the survey profile, the sample included 20 males and 21 females. Most of the participants identified themselves as young adults, with the largest number of participants (23) falling into the 19-20 age group, followed by 15 participants who were under the age of 18.

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C. Data Collection Methods

Data was collected using a structured questionnaire distributed through Google Forms. This digital method was chosen to ensure efficient data gathering and to provide a convenient interface for the respondents. The survey consisted of 48 questions covering four key variables: System Functionality, Bottle Detection Efficiency, Accuracy, and Internet Accessibility. Each category contained 12 indicators to evaluate the machine's performance comprehensively.

Ethical approval and considerations were prioritized. Before accessing the Google Form, participants were presented with a consent statement explaining that their participation was voluntary. They were assured that their email addresses and profile responses would be kept confidential and used strictly for academic purposes, in compliance with data privacy standards.

D. Data Analysis Techniques

Quantitative data was analyzed using descriptive statistics and Pearson correlation. The responses from the Google Form were exported to a spreadsheet for processing. The researchers calculated the weighted mean for each variable to interpret the system's overall performance:

- System Functionality: 3.27 Mean
- Bottle Detection Efficiency: 3.29 Mean
- Accuracy: 3.41 Mean
- Internet Accessibility: 3.27 Mean

These results were interpreted using a 4-point Likert scale to categorize the level of effectiveness. Furthermore, the Pearson r coefficient was used to determine the correlation between the accessibility of the Wi-Fi and the resulting recycling behavior. All statistical tests were conducted at a significance level of $\alpha=0.05$, where a p-value of less than 0.05 indicates that the Wi-Fi Vending Machine has a statistically significant impact on promoting environmental cleanliness.

V. RESULTS AND DISCUSSION

The findings of the study based on the survey administered to 41 respondents are discussed in this chapter. Statistical methods employed for analyzing the collected data include frequency and percentage distribution, weighted mean, and Pearson Product-Moment Correlation Coefficient. The presentation of the findings is categorized according to the respondent profile, the level of machine performance, and the significant relationship between key variables.

A. Profile of the Respondents

This section presents the demographic profile of the 41 respondents in terms of age and gender.

Table 1. Distributions by Age Respondent

AGE	Frequency	Percentage
Below 18	15	36.59
19 – 20 years old	23	56.10
21 – 22 years old	2	4.88
23 above	1	2.43
Total	**41**	**100.00%**

From Table 1, it can be seen that the largest number of the respondents (n=23, 56.10%) were 19-20 years old, followed by those below 18 years old (n=15, 36.59%). The statistics imply that the respondents comprise mainly young students who have the most frequent need for internet connectivity and are the primary demographic target for the Wi-Fi Vending Machine.

Table 2. Distribution by Gender Respondents

Gender	Frequency	Percentage
Male	20	48.78

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Female	21	51.22
Total	**41**	**100.00%**

Table 2 shows the gender distribution of the participants, indicating that there were 21 female respondents (51.22%) and 20 male respondents (48.78%). This demonstrates a balanced representation of genders in the evaluation of the machine's usability.

B. Performance Level of the Wi-Fi Vending Machine

This section presents the level of performance of the machine across four subscales: System Functionality, Bottle Detection Efficiency, Accuracy, and Internet Accessibility.

Table 3. Summary of Machine Performance Levels

Indicators	**Weighted Mean**	**Verbal Description**
System Functionality	3.27	Highly Effective
Bottle detection Efficiency	3.29	Highly Effective
Accuracy	3.41	Highly Effective
Internet Accessibility	3.27	Highly Effective
Overall Mean	**3.31**	**Highly Effective**

As shown in Table 3, the overall mean is 3.31, which falls under the "Highly Effective" category. Notably, Accuracy received the highest mean score of 3.41, indicating that the hardware is highly reliable in recognizing plastic bottles and distinguishing them from other materials.

C. Significant Relationship between Variables

This section explores the relationship between the technical accuracy of the machine and the accessibility of the internet provided to the users.

Table 4. Correlation between Accuracy and Accessibility

Variables Compared	**r-value**	**p-value**	**Decision**	**Interpretation**
Accuracy vs. Internet Accessibility	0.6292	0.000	Reject Null Hypothesis	Significant

The findings reveal a significant positive correlation ($r=0.6292$, $p<0.001$) between the machine's accuracy and internet accessibility. Since the p-value is less than the significance level of alpha=0.05, the null hypothesis is rejected. This suggests that a more accurate system leads to better perceived accessibility and user trust. These results align with Rinanda et al. (2023), who noted that reliable digital incentive platforms significantly increase user engagement in environmental activities.

D. Summary of Findings

The following key findings emerged from the analysis:

The respondents were predominantly 19-20 year old students (56.10%) with a near-equal distribution of male and female participants, ensuring the data represents a broad user base.

The level of machine performance in terms of all subscales was Highly Effective (overall mean = 3.31), with Accuracy scoring the highest (3.41) among all technical categories.

A strong positive and significant relationship was found between the machine's Accuracy and Internet Accessibility ($r=0.6292$, $p<0.001$).

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Because the p-value (0.000) is less than the significance level (alpha=0.05), the null hypothesis was rejected, confirming that the technical reliability of the Wi-Fi Vending Machine is a significant factor in user satisfaction and accessibility.

VI. CONCLUSION AND RECOMMENDATION

This chapter summarizes the research findings, provides a conclusion for the results of the research, and lists recommendations for improving and applying the Wi-Fi Vending Machine with plastic bottles to access the internet.

A. Conclusion

The primary objective of this study was to evaluate the effectiveness of a Wi-Fi Vending Machine that accepts plastic bottles as payment for internet access. After analyzing the data from 41 respondents and testing the system's core variables, the following conclusions are drawn:

The first aspect is that the Wi-Fi Vending Machine is found to be Very High on both waste management and ICT access initiatives. It has a weighted average value of 3.31, making it a very reliable mechanism. The high value in Accuracy of 3.41 implies that there was success in overcoming one of the major challenges, that of identifying the recyclable items.

Secondly, the findings show that offering internet connectivity is an effective and applicable form of motivation for the community. With a large number of users being students (92.69% less than 20 years old), the machine fulfills a practical requirement for data connectivity while also helping clean up the environment.

Lastly, the relationship found between machine accuracy and internet availability being Significant ($p < 0.001$) shows that the "reality" of the success of the machine is contingent on the machine's stability. As the machine becomes more accurate, user trust and accessibility increase. This project has shown that the "waste for data" idea can be effectively used to address contemporary issues.

B. Recommendation

Based on the findings and conclusions, the following recommendations are proposed to enhance the project's impact

Practical Recommendations

Expansion of Deployment: Local government units (LGUs) and school administrations should consider installing these machines in high-traffic student areas, such as libraries and parks, to maximize both plastic collection and internet utility.

Technical Optimization: Developers should consider integrating an automated "Bin-Full" alert via SMS or mobile notification to ensure timely collection of bottles and prevent system downtime.

User Interface Enhancement: While the current system is highly effective, adding a simple LCD screen to the hardware to show real-time "Connection Status" or "Bottle Count" would further improve the user experience**.**

Recommendations for Future Research

Larger Sample Scope: Future researchers should test the machine in different geographical settings (e.g., rural vs. urban) to see if the demand for internet access changes the recycling volume.

Comparative Incentive Studies: Future studies could compare "Wi-Fi access" against other digital rewards, such as mobile load or points-based systems, to determine which incentive drives the most consistent recycling behavior.

Long-Term Impact: A longitudinal study is recommended to see if users continue to use the machine after the "novelty" wears off, helping to determine the long-term sustainability of the project.

VII. ACKNOWLEDGMENT

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