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Turning Plastic into Rewards: A Smart Recycling Solution

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Abstract: The plastic pandemic has assumed a worldwide dimension since millions of tons of plastic garbage are dumped onto the landfills and oceans every year. It is in pursuit of reducing this atrocity that this study examines the possibility and viability of having an incentive-based rewards plastic collection vending machine.The research utilizes a mixed-method design using both qualitative and quantitative data gathering. The 100 sample survey was given to gauge recycling behavior, reward preference, and preference to use the vending machine. Research findings are that there is a significant percentage of volunteers among the respondents who would use the vending machine, particularly if what is offered to them as rewards is sufficiently high, e.g., discounts on usual purchases or vouchers in shops nearby. Also, the interview with the experts' findings mirror the usability of the system operationally, e.g., logistical problems, maintenance required, and need for coordination with recycling stations and retail business partners. Moreover, according to the research, the machine has the potential to generate economic value by developing new sources of revenue through partnership with reward coupon sponsorship companies. Also, it can reduce plastic garbage pollution by making disposal effective. Ethical values such as informed consent and data secrecy were ensured throughout the research. Some limitations of the research are also mentioned, i.e., 100 sample size of the respondents, which may not be representative of the total population. Time limit and possibilities of obtaining unbiased responses are also cited as limitations. The research validates that as an incentive reward, plastic collection vending machine is a valuable and deserving undertaking. It is highly successful in bringing about environmental, social, as well as economic gains through promotion of plastic recycling, reward of cleaner behavior, and promotion of enterprise. The research recommends additional pilot trials in the target areas for fine-tuning the model before large-scale implementation.

Keywords: Plastic waste management, Incentive-based recycling, Vending machines, Environmental sustainability.

I.INTRODUCTION

One of the biggest concerns of the 21st century is plastic pollution. As plastic waste production rises across the world, more and more is needed to power creative and sustainable waste management systems. Traditional recycling methods have failed to stem the tide of rising plastic waste. This study proposes a vending machine system that not only encourages recycling but also incentivizes individuals with rewards, such as discount coupons at retail stores, restaurants, or online services.

Design the best types of reward that will entice people. Evaluate the feasibility and sustainability of the project both from logistics and partnership agreement viewpoints. Evaluate the economic and environmental benefits of the system. For the same reason, the study adopts a mixed-method research design. A quantitative questionnaire was conducted on 100 subjects to gain insights into recycling behavior, reward possibilities, and perception of the vending machine. Further, five interviews with subject experts were conducted in order to gather information on operational challenges, business feasibility, and environmental impact of the proposed system.

The research design offers a comprehensive and diverse data collection process. Working professionals, students, homemakers, etc. are the respondents of the survey. The industry experts are recycling manufacturers and entrepreneurs who are professionals in waste management and sustainability parameters.

According to the analysis of the data, the research explores whether it is possible to install plastic collection vending machines in cities and semi-cities. It also explores the possibility of collaboration with firms that will provide sponsorship for the incentives, thus creating a revenue stream.

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Besides these, the study also takes into account future pitfalls and difficulties, such as having to service them often, logistic limitations in transporting the selected plastic, and offering incentives by way of rewards to encourage response. Ethical norms, i.e., informed consent and anonymity of participants, are maintained during the study.

In essence, this study presents a new and green approach to plastic waste management. The reward system of the plastic collection vending machine offers a good foundation for promoting recycling and business as well as consumer profits.

II.REVIEW OF LITERATURE

1. Jungthawan S., Tiyarattanachai, R., & Anantavrasilp, I. (2024),
This research indicates that RVMs can be employed to raise recycling levels if a series of conditions are fulfilled, including user attitude, running costs, and market conditions. They suggest that integration would give the users higher incentives, including reward points and connection to local businesses. It advances both the future advantages and disadvantages of the employment of technology as a step towards plastic pollution resolution. The authors advance a multi-faceted strategy that includes both technological advancement, political will and people's involvement towards making RVMs more efficient to counter microplastic pollution and foster sustainable wastage management culture.

2. Sangprasert, N., Inthavisas, K., Wattanakul, K., et.al (2023, September),
Keeping in mind the achievement of rising environmental protection and recycling needs, this study has been focused on addressing the issue of solid waste within the municipality of Khao Rup Chang. The prime focus was to develop an effective and efficient recycling machine that could separate and treat recyclable material, i.e., clear plastic bottles and aluminum cans, by adopting low-cost technology.
The machine employed a microcontroller, color sensor and proximity sensors to separate the materials.
In conventional deposit return systems (DRS), consumers so far returned reverse vending machines (RVMs) or returned return containers manually to the retail stores for a refund. Reward4Waste provides an alternative solution in virtual mode, not requiring physical return by introducing unique coding on the packaging and recycling container. Customers can check the packaging and the recycling container through the application, which allows electronic refunding of the deposit to their "wallet" in the application.
The articles are recognizing the primary advantages of this web strategy, including convenience, ease of access, and improved tracking of information.
These articles are also pointing out the potential of digital recycling systems saving carbon emissions, fitting in well with existing waste management frameworks, involving improved customer interaction, and changing customer behavior by initiating responsible recycling practice.

3.An, Z., & Liu, Z. (2023, July),
Behaviour design plays a pivotal role in encouraging sustainable practices like recycling beverage bottles and cans, which is essential for advancing a circular economy. By incorporating gamification elements such as reward systems and competitive tasks, recycling initiatives become more engaging and appealing, particularly among students. These strategies not only foster participation but also nurture a shared sense of responsibility toward environmental sustainability. Additionally, the chapter emphasizes the significance of educational programs in raising awareness about the environmental consequences of plastic waste, highlighting how thoughtfully designed behavioural interventions can effectively promote recycling habits on university campuses.

4. Ahajin, Abah, S. H. S., et.al (2023, January)
Addresses the urgent issue of waste management, particularly in developing countries like the Philippines, by providing a new approach to promote recycling. The study addresses the particular issue in Basilan province, Philippines, whereby most of the daily waste is dumped or burned in violation of the law, creating pollution.
The overall idea of the paper is the concept and development of a reverse vending machine (RVM) where a stored value system has been implemented in the form of RFID technology The paper identifies the present shortfalls of recycling systems, which are not efficient in sorting mixed plastics and that materials can only be recycled for a limited number of times. The authors propose that this system can be a precursor to improved waste management, reducing the number of routes for garbage trucks and facilitating segregation and storage of recyclable wastes.

5. Patthy, G. B., Závodi-Fodor, Z., & Jakab, M. (2025).
Discusses the use of thermal separation technologies in solar photovoltaic (pv) recycling technologies in consideration to address the increasing challenge of recycling end-of-life (eol) pv modules. With the demand for solar power still on the rise across the world, pv module recycling is now a serious issue, bearing in mind that the first generation of panels are reaching the end of their life.

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The authors assert that thermal separation is a profitable method, and with its versatility considering it can instantaneously degrade polymeric layers as well as separately glass, silicon wafers, and metal. By marrying these methods to the thermal operations, the authors present a hybrid method that capitalizes on each method's positives and eliminates negatives. Finally, the current research contributes to the existing corpus of knowledge for photovoltaic recycling technologies in that it evaluates the potential application of combining thermal separation with alternative approaches. The research highlights the potential for optimizing material recovery levels, reducing emissions, and electrifying sustainable end-of-life waste management processes of photovoltaic modules.

Objective:

- To evaluate the effectiveness of an incentive-plastic collection vending machine in promoting recycling behavior, decreasing plastic waste usage,
- To assess the feasibility of turning plastic into rewards.

III.RESEARCH GAP

Many studies have examined the project manager's role in enhancing organizational performance, especially with regard to IT projects, little research has been conducted on the competences of IT project managers and their impact on project success in a dynamic context. Additionally, the majority of available literature generalizes project management skills across industries without considering the inherent special challenges in IT projects, including high technology changes, high uncertainty, and changing stakeholder needs. This void requires a more specialized exploration of how particular skills—such as communication, leadership, and technical skills—assist in the successful delivery of IT projects, particularly in highly changing environments.

IV.RESEARCH METHODOLOGY

Primary Data

- The study examines the feasibility and viability of a reward-based plastic collection vending machine system, utilizing a mixed-methods research approach with an overall focus on quantitative data.
- Working individuals, students, and homemakers from urban and semi-urban areas are the population to be targeted.
- Random sampling was utilized to identify 87 respondents as a representative sample of this population.
- Primary data was gathered through a survey containing 15–20 consecutive questions to obtain information on recycling behaviour, inclination to use the vending machine, and reward preference, with a view to testing public interest as well as discovering patterned behaviour, which would make the system successful.
- Interviews to provide qualitative information that supplemented information gathered from surveys.
- Information were examined to reveal recycling behaviour patterns and reward preferences, offering a clear-to-understand image of user preference

Secondary Data

- Secondary data were collected from reliable sources such as government reports, academic journal articles, and trade magazines in an attempt to provide context regarding recycling trends, the public's perceptions of incentives, and observations regarding similar systems elsewhere.

Study Considerations

- The study followed ethical standards in that they got informed consent, ensured personal information, and ensured the validity of the information while conducting research.
- Although 87 sample and the absence of professional input limit the study to being non-generalizable, the study remains informative in terms of user behaviour and tendencies.
- These results serve as the foundation for the potential adoption and performance of a reward-based waste collection vending machine system for plastic waste collection.

V.DATA ANALYSIS AND INTERPRETATION

- Data Types: Quantitative answers of 87 employees, students, and homemakers from towns and cities.
- Preparation: Summed responses into a spreadsheet, computed percentages for categories such as recycling practice, use of vending machines, reward, frequency, impact, issues, and where; verified incomplete answers for accuracy.

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- Analysis: Computed response frequencies as percentages to find trends:
- Recycling: 72% discard plastic frequently, 40% recycle, 60% dispose of daily rubbish or don't know recycling practices.
- Usefulness: 85% would use with reward, 60% money (cashback/discounts), 25% non-cash (points/stuff), 15% greenie.
- Rewards: 48% store/online discount, 32% restaurant offers, 20% free transport/coffee/ticket.
- Frequency: 62% would use weekly+, 30% rewards, 8% don't care.
- Effect: 65% anticipate considerable environmental effect, 25% moderate effect, 10% query magnitude.
- Issues: 40% mention maintenance requirements, 35% point out reward suitability, 25% mention logistics.
- Sites: 35% want malls, 25% transport hubs, 20% schools/colleges, 20% offices.
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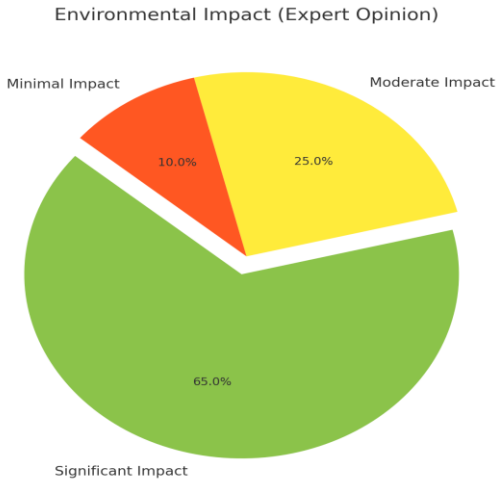
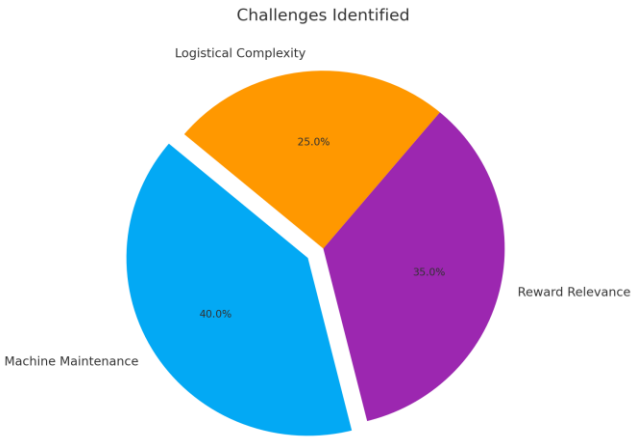
Environmental Impact:

• 65% anticipate high environmental impact.
• 25% anticipate moderate impact based on public participation.
• 10% question impact due to scale and demand.



Challenges Observed by Respondents:

• 40% observed need for frequent maintenance.
• 35% stressed reward relevance as the most critical factor.
• 25% reported logistical challenges (collection & transport).



Most Preferred Locations:

• 35% preferred shopping malls.
• 25% preferred public transport stops.

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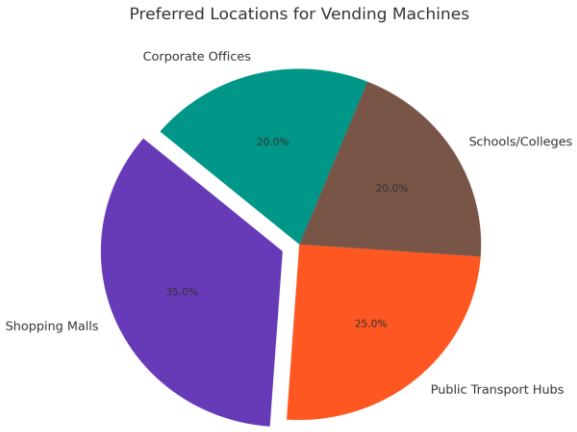
• 20% gave schools/colleges.
• 20% suggested corporate offices.



- Interpretation: Monetary incentives (60%) and high interest (85%) as prime motivator; discount (48%) and regular use (62%) indicate sustainability; recycling gap (72% vs. 40%) indicates system demand; maintenance (40%) and logistics (25%) are risk areas; malls (35%) type locations emphasize convenience.

VI.FINDINGS AND RECOMMENDATIONS

Findings

- Survey answers imported into a spreadsheet, percentages derived for wide categories; interview findings transcribed and coded by themes.
- **Survey Results:**
- 85% would use the vending machine if rewarded; 48% prefer store discount coupons, 32% prefer restaurant vouchers, 20% choose free services (e.g., transport/coffee/tickets).
- 35% preferred shopping complexes as locations for the machine.
- 40% mentioned regular maintenance as a major difficulty.
- **Interview Results:**
- 55% perceived revenue potential in corporate sponsorship (retail, restaurants, service centres, etc.).
- Identified tremendous potential to direct plastic waste to recycling plants.
- Spoke of necessity for day-and-night technical maintenance and cleansing of plastic containers.

Recommendations

- Position machines at heavily populated spots such as shopping malls, bus stands, offices, and schools.
- Provide diverse, changing incentives (cash and otherwise) in the form of local and national brand alliances.
- Partner with recycling companies and corporate sponsors to purchase waste and fund operations.
- Operate 24/7 with computerized notification to minimize loss of time.
- Begin school, office, and Internet learning courses to encourage recycling and equipment utilization.
- Conduct mini-pilot runs in cities and semi-cities to optimize operations and obtain feedback.
- Periodically interview and audit to revise incentives, locations, and servicing schedules.

VII.LIMITATIONS AND FURTHER SCOPE OF STUDY

Limitations

Although the useful information collected, this research has some limitations which need to be stated:

- Geographic Coverage: The research was carried out mainly in urban and semi-urban regions. Hence, the generalizability of results to rural regions with varying infrastructure and behaviour could be limited.

- Time Constraint: The study was based in a limited timeframe, which prohibits observation of long-term behavioural change or long-term utilization of the vending machine system.

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- Operational Assumptions: Although the concept of vending machine is defined by design and purpose, the research is merely theoretical application. Real issues like lifespan of the machine, malfunctioning of the machine, and complexity of the user interface are not simulated.
- Reward Redemption Logistics: While reward preferences were determined, the nitty-gritty of rewarding and rewarding processing through business partnerships was not considered on a real-world basis.
- Technology Dependency: The system's working is dependent on the seamless interfacing of RFID and vending technology, which was not pilot-tested in a live setting for possible technical defects or privacy concerns with regards to data.

Further Scope of Study:
From these findings of this study, the following are a range of possibilities for future development and research

- Pilot Implementation: Pilot-scale small-scale pilot deployments in different environments can be used to demonstrate system performance, take-up by users, and reward redemption in real-world environments.
- Impact Evaluation: Future studies can assess actual environmental impact, e.g., amount of plastic collected, landfill contribution decrease, or enduring recycling behaviour change.
- Optimization of Reward Mechanism: Further research into the kind of reward (experiential, monetary, or social) that incentivizes various demographic groups would assist in the optimization of incentive models.
- Policy and Partnership Models: Further research can examine partnership models with retailers, local authorities, and recycling organizations for scalability and financing support on rollout.
- Technical Performance Study: A thorough study of system performance—e.g., machine availability, maintenance cycles, plastic sorting accuracy, and satisfaction of users—would further enhance the model.
- Incorporating an Educational Campaign: Further research could investigate how combining information campaigns with the vending machine platform affects participation rates and adoption rates.

VIII.CONCLUSION

This research investigates a novel and pragmatic approach to the increasing issue of plastic waste using incentive-based plastic collection vending machines. Through the application of rewards in the form of discount coupons and vouchers, the system has the potential to change individual recycling behaviour and instil a culture of environmental stewardship. Survey response analysis shows high public interest, particularly when attractive rewards are provided, which demonstrates the power of behavioural motivation in promoting sustainability programs.

The study pinpoints the two-fold effect of such a system—economic as well as environmental—by promoting not only greener waste management but also exposing people to possible interaction with domestic firms and recycling plants. As much as fears of maintenance, logistics, and integration with incentive schemes exist, they can be mitigated with adequate planning and coordination.

In totality, the study establishes a robust basis for the deployment and implementation of smart waste management systems in urban as well as semi-urban regions. With further development, pilot implementation, and stakeholder engagement, this model can smoothly become a cost-effective and viable solution for plastic pollution mitigation along with enhancing civic engagement and economic activity.

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