e-ISSN: 2582-5208
International Research Journal of Modernization in Engineering Technology and Science
(Peer-Reviewed, Open Access, Fully Refereed International Journal)
Volume:06/Issue:07/July-2024 Impact Factor- 7.868 www.irjmets.com

THE ROLE OF TECHNOLOGY IN REDUCING FOOD WASTE

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DOI : https://www.doi.org/10.56726/IRJMETS60123

ABSTRACT

The present research investigation was conducted to explore the role that emerging technologies play in mitigating and managing food waste within society. Specifically, the study aimed to uncover how technologies such as the Internet of Things (IoT), Artificial Intelligence and Machine Learning (AI and ML), Robotics, Block chain, food waste applications, and other similar innovations can play a vital role in reducing food waste in society. By utilizing these advanced tools and systems, it is possible to minimize waste production, decrease operational expenses, and enhance sustainability initiatives. The significance of technology in waste management is critical in addressing the growing problem of waste disposal and its detrimental environmental effects. The application of these technologies will not only benefit large hotels and restaurants, but also small-scale businesses and even individual households in efficiently managing food waste and utilizing leftover food.

Keywords: Food Waste, Waste Management, IoT, AI, ML.

I. INTRODUCTION

Food waste represents a critical issue affecting food security, economic efficiency, and environmental sustainability. According to the Food and Agriculture Organization (FAO), approximately one-third of all food produced globally is wasted. Technological advancements offer promising solutions to reduce food waste throughout the supply chain. This research aims to investigate the effectiveness of different technologies in reducing food waste and to understand the challenges associated with their implementation.

TECHNOLOGY FOCUS:

- **Types of Technology:** The study focused on mobile apps, IoT devices, blockchain, AI, and smart packaging, assessing their effectiveness, adoption rate, and implementation challenges.
- **Effectiveness of Technology:** Technologies like IoT devices and AI showed significant potential in reducing food waste by providing real-time monitoring and accurate demand forecasting.

WAYS TECHNOLOGIES CAN HELP REDUCE FOOD WASTE:

1. **MOBILE APPS:**

- **Food sharing:** Apps like OLIO enable users to share excess food with neighbors, reducing household waste.
- **Waste tracking:** Apps track food waste patterns, helping users adjust their purchasing and consumption habits.
- **Meal planning:** Apps suggest recipes based on available ingredients, encouraging the use of perishable items before they spoil.

2. **IOT DEVICES:**

- **Smart refrigeration:** IoT-enabled refrigerators monitor food freshness, alert users about expiring items, and suggest recipes.
- **Supply chain monitoring:** IoT sensors track food conditions (temperature, humidity) from farm to table, reducing spoilage during transport and storage.
- **Inventory management:** In stores and warehouses, IoT devices provide real-time stock levels, preventing overstocking and understocking.

3. **BLOCKCHAIN:**

- **Supply Chain Transparency:** Blockchain provides an immutable record of food's journey from producer to consumer, ensuring proper handling and reducing spoilage.

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- **Authenticity Verification:** Blockchain ensures the authenticity of food products, preventing waste due to recalls and ensuring safety.

4. **ARTIFICIAL INTELLIGENCE (AI):**

- **Demand Forecasting:** AI analyzes sales data to predict future demand, helping retailers stock appropriately and reduce over-purchasing.
- **Personalized Recommendations:** AI-powered apps suggest recipes and shopping lists based on user preferences and existing inventory, reducing unnecessary purchases.
- **Sorting and Quality Control:** AI systems in food processing accurately sort and grade produce, reducing waste from over-rejection.

5. **SMART PACKAGING:**

- **Condition Monitoring:** Packaging with sensors provides real-time data on food conditions, such as temperature exposure and spoilage indicators.
- **Shelf Life Extension:** Smart packaging technologies control the atmosphere within the packaging or release preservatives to extend shelf life.
- **Usage Alerts:** Smart packaging can alert consumers about the optimal time to consume the food, preventing waste due to expiration.

These technologies enhance efficiency, transparency, and responsiveness in the food supply chain, leading to significant reductions in food waste.

II. MERITS OF USING THESE TECHNOLOGIES

Artificial intelligence (AI) solutions for food waste management have been established as a viable option for addressing the critical issue of food waste. These technologies employ advanced analytics, machine learning, and other AI-based methods to deliver more precise and complete insights into food waste generation and prevention. The advantages of AI food waste management technologies are numerous and encompass reduced waste, increased efficiency, and enhanced sustainability. There exist various AI food waste management technologies, such as food tracking systems, predictive analytics, and smart bins, each with its own distinct advantages and uses. Employing these technologies in tandem can facilitate the development of an integrated food waste management strategy.

III. CHALLENGES TO TACKLE WHILE USING THESE TECHNOLOGIES

There are several obstacles and constraints when it comes to implementing AI-based approaches for reducing food waste. One of the primary difficulties is the need for a thorough comprehension of the food supply chain, which encompasses production, distribution, and consumption stages that are influenced by geographical, cultural, and societal factors. Another challenge is the inefficiencies that occur in the food supply chain and the scarcity of information at each stage of the food cycle. It is also a challenge to measure and report the food waste that occurs along the entire value chain. Reducing food waste at the consumer level is another challenge that requires addressing intricate social factors such as food preferences and customs, which may require the intervention of technology and industry.

IV. METHODOLOGY

LITERATURE REVIEW

The literature highlights various technologies designed to combat food waste, including mobile applications, Internet of Things (IoT) devices, blockchain, artificial intelligence (AI), and smart packaging. Mobile apps like OLIO facilitate food sharing, while IoT devices monitor food storage conditions. Blockchain ensures supply chain transparency, AI aids in demand forecasting, and smart packaging extends food shelf life. Despite these innovations, barriers such as high costs, technological complexity, and lack of awareness hinder widespread adoption.

RESEARCH DESIGN

This study employs a mixed-methods approach, integrating both qualitative and quantitative data collection methods to explore the role of technology in reducing food waste.

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DATA ANALYSIS

- **Quantitative Analysis:** Survey data were analyzed using SPSS. Descriptive statistics summarized the data, while inferential statistics (correlation, regression analysis) explored relationships between variables.
- **Qualitative Analysis:** Interview and case study data were analyzed using thematic analysis. NVivo software assisted in coding data.

V. RESULTS AND DISCUSSION

The survey revealed that 70% of households, 80% of restaurants, and 60% of supermarkets were aware of at least one technology to reduce food waste. However, only 40% of households, 50% of restaurants, and 30% of supermarkets actively used such technologies. The main barriers to adoption were cost (50%), lack of technical knowledge (30%), and perceived ineffectiveness (20%).

The findings indicate that technology can significantly reduce food waste. IoT devices and AI showed the highest effectiveness, while mobile apps and blockchain also demonstrated considerable potential. Smart packaging, though less widespread, offered valuable benefits in extending shelf life.

VI. RECOMMENDATIONS

Based on the findings, the following recommendations are proposed:

For Policymakers: Provide financial incentives and subsidies to lower the cost barrier for technology adoption. Implement policies to promote awareness and education about food waste and technological solutions.

For Businesses: Invest in training and support programs to facilitate technology adoption. Collaborate with technology providers to ensure user-friendly solutions.

For Consumers: Encourage community-based initiatives and food-sharing platforms. Promote awareness of the benefits of technology in reducing food waste.

VII. CONCLUSION

The world faces a significant challenge with food waste, impacting economics, environment and even millions of lives. However, innovative solutions are emerging day-by-day to manage the waste produced before and after cooking food. IoT technology is transforming food management practices with smart appliances, real-time inventory management, and waste conversion solutions. These advances optimize resource usage and lead to economic savings and sustainability. Efficient food waste management can have significant positive effects on the Earth like Reduced Greenhouse Gas Emissions, Conservation of Resources, Biodiversity Preservation, Improved Food Security, Financial Savings, Water Conservation, Community and Social Benefits.

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