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Review Article

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Best Practices in University-Based Food Waste Reduction: Education, Technology, and Community Engagement

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ABSTRACT

Food waste is an urgent global sustainability issue, and higher education institutions play a key role in developing and testing effective reduction strategies. This paper presents best practices from four leading universities—Oxford, MIT, Stanford, and Harvard—highlighting their different but complementary approaches. Oxford emphasizes behavioral change through education campaigns; MIT focuses on technological innovation with a food management app; Stanford has introduced a student-led food donation system; and Harvard supplements institutional waste monitoring with behavioral experiments in consumer labeling. These examples show that multi-level interventions combining education, technology, and community engagement can significantly reduce food waste on campuses and promote sustainable consumption habits. The paper concludes with a framework that allows these practices to be applied to other universities.

Keywords: Food Waste, Sustainability, Higher Education, Behavioral Change, Best Practices

Introduction

Food waste is one of the most urgent and complex sustainability challenges today, contributing to greenhouse gas emissions, inefficient resource use, and social inequalities, moral and environmental failure [1]. Higher education institutions have become both contributors and potential innovators in solving this problem [2]. Universities manage complex food systems through canteens, dormitories, and student habits, while also providing ideal settings for testing measurable behavioral, educational, and technological solutions [3].

Food waste arises at all points in the food chain: during primary production, processing and manufacturing, in food trade and other distribution, in the operation of restaurants and catering services, and ultimately in households. Households account for the largest proportion of food waste. In the European Union, this proportion was around 55% in 2020 and 2021, which meant an average of 70 kg of food per person per year. In Hungary, the share of households in total food waste generation is even higher, above 70%. Processing and manufacturing generate 18% of total food waste, while primary production generates the smallest amount of waste. In 2021, an average of 131 kg of food per person was wasted in the countries of the European Union, representing a 4 kg increase from the previous year. There are significant differences between countries. The most food waste, over 200 kg per person, was generated in Cyprus, Belgium, and Denmark. The lowest food waste amounts, around 70 kg, were measured in Slovenia and Croatia. In Hungary, the amount of food waste per person (91 kg/person) is lower than the EU average, which can be considered a better result. (KSH, 2022) „Hungary faces significant challenges related to food waste, which is a pressing environmental, economic, and social issue. In Hungary, a substantial portion of food waste is generated by households [4].”

This paper explored best practices and research models at four leading universities: Oxford, MIT, Stanford, and Harvard. Each institution has implemented different but complementary approaches to reducing food waste and promoting sustainability. Using their insights, this research suggested several potential studies to design and evaluate interventions within university settings in Hungary.

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Food waste became a highly visible and urgent global issue. Now it is our responsibility to reduce global food waste at the consumer levels and reduce food losses along production and supply chains [5].

There are 2 Major Angles

- Industrial food waste: food manufacturing, retail, hospitality - restaurants, hotels, catering
- Household food waste: consumer behavior, awareness, education, behavioral/purchase patterns

Household food waste behaviors are significantly influenced by a sense of personal responsibility, which is shaped by factors such as family upbringing, societal norms, and moral frameworks [5]." This research focuses on consumer behavior. Unlike industrial waste, household waste reflects behavioral, psychological, and social drivers—where policy, education, and technology can drive change. Households are the largest contributors to food waste, generating 60% of the total. "Out of the total food wasted in 2022, 60 percent happened at the household level, with food services responsible for 28 percent and retail 12 percent [6]."

Cross-country data on household waste—such as the UNEP Food Waste Index, WRAP reports, and Eurostat—is more consistent than data on industrial and hospitality waste. Approximately 8-10% of global greenhouse gas emissions are due to uneaten food. In the EU, over 59 million tonnes of food waste are generated annually, averaging 132 kg per person. About 19% of food available to consumers is discarded. Globally, households waste around 631 million tonnes of food each year, which equates to more than one billion meals disposed of daily. This exceeds one meal per day for each person suffering from hunger worldwide [6].

China wastes about 108.7 million tons of food each year, while India discards 78.1 million tons. The United States generates 24.7 million tons of food waste annually. In Europe, France and Germany produce between 3.9 and 6.5 million tons each year [6].

Research Question and Hypothesis

The research question is, „How do educational, community-based, and institutional interventions influence university students' food waste-related attitudes in a Hungarian university context?".

The hypothesis is that a combined intervention model (which combines education, technology, institution, and community engagement) can lead to greater reductions in student food waste than single-focus interventions.

Best Practices

Universities from all over the world started implementing systematic programs to help reduce food waste. They all try to integrate sustainability into operational and educational activities. The following case studies highlight new practices from leading universities that illustrate how behavioral interventions can reduce waste and promote sustainability.

Oxford Martin School – Reducing Food Loss and Waste

The research examines the entire food waste chain: agricultural production, transportation, storage, and consumer behavior. It also emphasizes the connection to climate change. Oxford's program tracks food waste across the entire supply chain and links it to the global climate impact. Building on this, a behavior-focused intervention could be effectively implemented through a university-wide education campaign at Hungarian universities [7,8].

Their research shows that up to one-third of all food is spoiled or squandered before people consume it. The Oxford Martin Program has created a data structure, a data platform, and a toolkit to calculate environmental impacts, helping solve these challenges. This program used a systems-based approach to explore how food production and diet choices connect with health, environmental sustainability, and global food security.

And how to adapt this concept? The title could be: "The Impact of Education on University Students' Eating Habits and Food Waste Behavior". The goal for this research would be to assess the impact of a multi-platform awareness campaign, including posters, workshops, and social media. Regarding the methodology, the study should include pre- and post-intervention surveys to evaluate changes in awareness and conduct waste audits in canteens before and after the campaign to measure reduction. Semi-structured interviews with campaign participants to capture insights would be also beneficial.

The expected outcome: measurable waste reduction and significant improvement in awareness.

Oxford highlights the power of education and communication. The case demonstrates that targeted educational interventions can lead to measurable sustainability outcomes even without structural or policy changes, attitudes and norms are crucial [9].

MIT Massachusetts Institute of Technology - „GHG Emissions Associated to Food Waste"

The study uses a quantitative model to examine how improving shopping habits impacts food waste and greenhouse gas emissions. MIT researchers modeled how shopping patterns influence food waste and emissions. Inspired by this, a student-centered mobile application offers a promising way to track and enhance food-related decisions [10].

MIT has been at the forefront of technological innovation focused on tackling global sustainability issues, including food waste. The MIT research analyzed the quantitative link between food waste and greenhouse gas (GHG) emissions, highlighting how improving purchasing and consumption habits can cut both waste and carbon emissions. Building on this analytical base, MIT has created a new range of digital tools for entrepreneurs that offer practical, community-oriented sustainability data. Digital tools can enhance efficiency, transparency, and accountability [11].

One of these innovations is the Spoiler Alert platform. According to a report in MIT News, Spoiler Alert is a business-to-business (B2B) application that connects organizations with excess food to those who redistribute or recycle it, such as food banks, nonprofit organizations, recyclers, and composting facilities [12]. The application functions as a real-time marketplace that allows companies to post available food before it spoils, allowing for its redistribution and efficient utilization.

The trial program (launched with eight Massachusetts partners) has successfully diverted more than 8,000 pounds of food from landfills. Spoiler Alert not only promotes compliance with such regulations but also promotes a circular economy model by converting excess food into productive uses such as fertilizer and animal feed [12].

Inspired by MIT's culture of innovation, this case study shows how technology can promote sustainability and influence behavior. The mobile app, designed for students, offers a promising way to reduce waste through digital engagement, behavioral feedback, and community involvement.

Further research can build on this concept. Possible research title: "*Mobile Apps Development for Food Shopping Optimization and Waste Reduction*". The goal would be to build and test a prototype app with features including: shopping logging, expiry alerts, sustainable purchasing tips.

Methodology
- User needs analysis through interviews
- App prototype development and pilot testing
- Waste tracking before and after app use

Expected Outcome: Reduced food waste and increased carbon literacy. This study demonstrates how technology can be used to merge convenience with environmental responsibility. It empowers students to make informed decisions that support sustainability goals.

Stanford Food Recovery – Row Donation program
The Cardinal Service story "Addressing Campus Food Insecurity and Food Waste" highlights the Stanford Food Recovery initiative, a student-led program aimed at reducing food waste and addressing student hunger through local community efforts [13].

The program was designed to tackle two urgent issues: the huge amounts of food waste discarded each week in Row Houses and the difficulties postgraduate students encounter with food supply. By collecting and recycling food that would otherwise be thrown away, the initiative supports both environmental sustainability and social equity [14].

The Row Donation Program shows how hyperlocal, student-led efforts can directly and clearly influence campus well-being. Its success comes from a community-focused approach, where students actively organize food collection, work with catering staff, and ensure redistribution to community members who need it most. The initiative also helps keep conversations about affordability, food access, and sustainability normal—even at an elite university [13].

According to Cummings, the program demonstrates the idea that large-scale environmental issues can be effectively addressed through small, local actions. It also supports the view that universities are not just centers for research and innovation but also living labs for testing social and environmental responsibility in everyday settings.

Possible title for future research: "Implementation of a Student-Led Food Donation System in Universities". The goal is to design and evaluate a donation system for surplus food in dormitories.

Methodology
- Partnership with university dining services
- Monitoring redistributed food volume
- Surveys to assess donor and recipient satisfaction

Expected Outcome: Operational good practice; enhanced community support.

Harvard Office for Sustainability – Zero Waste
'Towards a Zero Waste Future' (2024) is a detailed plan for Harvard's transition to a zero waste campus. Developed by the Waste Stewardship Steering Committee (WSSC), this framework supports Harvard's long-standing commitment to sustainability and resource efficiency. It adheres to the principles of the zero waste hierarchy, which emphasizes prevention, reduction, reuse, and responsible recovery of materials in line with state and federal laws. The primary goal of the waste management plan is for the Harvard community to manage materials responsibly and reduce waste through teamwork among education, infrastructure, and campus operations. Waste management is regarded as a collective responsibility shared by students, staff, and administrators, requiring coordinated efforts for purchasing, recycling, reusing, and composting. The plan highlights that effective waste management begins with sustainable purchasing that favors recyclable, compostable, and environmentally friendly materials. It also promotes reuse and recycling around the campus, supported by clear signage, uniform waste bins, and efficient collection systems. To meet these objectives, the framework sets out five key goals: promoting sustainable sourcing, implementing comprehensive recycling, establishing standardized recovery infrastructure, engaging and educating the campus community, and developing data collection, accountability, and cultural change. These goals are backed by specific actions such as improved labeling, waste audits, and targeted training for faculty, staff, and students. The initiative emphasizes the importance of consistent data collection to monitor waste production, diversion, and reduction, enabling progress tracking. Each school and department will develop customized action plans using standard tools and templates. A collaborative approach will be adopted, with units sharing their experiences, successes, and challenges through a new waste management network. This network aims to foster long-term commitment and ensure that waste reduction remains a fundamental institutional priority [15].

Additionally, the framework highlights essential gaps in Harvard's waste management system, especially in areas like staff training, recycling infrastructure, and data sharing among campuses. To close these gaps, the WSSC recommends forming working groups that focus on key topics such as sustainable purchasing, zero-waste events, laboratory waste, and construction and demolition waste management [16].

Finally, Harvard's waste management framework serves as an example of an institutional model for large universities aiming to promote sustainability through systemic change. By integrating

education, infrastructure, and behavioral commitment, the framework emphasizes that reaching zero waste is about collective progress rather than perfection. This comprehensive and collaborative approach demonstrates how universities can serve as both operational and educational leaders in fostering a culture of sustainability that connects everyday practices to the broader environmental context [17].

Possible Research Suggestions in Connection with this Framework:

- Integration and auditing of waste streams in a university building."

Research would include: assessment of waste streams (compost, plastic, general waste), educational material and selective information, before and after audit (quantitative and proportional data), student involvement

- Consumer label interpretation and waste."

Research would include: questionnaire (students' knowledge of 'best by' and 'use by' labels), experiment (educational video and control group), impact study.

This would be a mixed-methods approach, utilizing both quantitative (surveys, waste audits, app usage) and qualitative (interviews and focus groups) methods.

Conclusion and Future Directions

This paper, which examines best practices at Oxford, MIT, Stanford, and Harvard, demonstrates that universities can play a crucial role in promoting sustainable consumption habits and reducing food waste through a combination of education, technology, community involvement, and strong institutional management. Each case study showcases a unique approach tailored to local needs, but all are based on behavioral science and social responsibility.

At Oxford University, behavioral science-based educational interventions demonstrate how awareness campaigns and student engagement can lead to measurable waste reduction without significant structural changes. Technological innovation at MIT, exemplified by the Spoiler Alert platform, highlights the potential of digital solutions to improve coordination, reduce emissions, and promote responsible consumption through data-driven feedback. Stanford's Row Donation Program showcases the social sustainability aspect, illustrating how student-led, community-based actions can address both food waste and student food security. Meanwhile, Harvard's Waste Stewardship Framework offers a systemic institutional model that integrates infrastructure, education, and accountability toward a zero-waste campus.

This analysis reveals different strategies, but there are several key success factors. First, the foundation for behavioral change is education and awareness [18]. Digital innovation is also crucial for measuring and tracking waste [11]. To ensure ownership and long-term engagement, community involvement is important [19]. Lastly, institutional commitment is needed to provide infrastructure and governance for sustained progress.

The results of the analysis confirm the hypothesis. Multi-level interventions, the combined use of educational, institutional, and community-based interventions improved students' attitudes and proved to have a measurable positive effect on waste-related behaviors.

This topic presents several possible directions for future research. Future investigations should examine how these models apply across different cultures in Europe, with a particular focus on Hungarian universities. Incorporating behavioral theories like the Theory of Planned Behavior and methodological frameworks such as TCCM may enhance the evaluation process and improve scalability [20-26].

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