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**NAVIGATING SUSTAINABLE PACKAGING SOLUTIONS FOR FOOD WASTE  
MINIMIZATION IN DOWNSTREAM ACTIVITIES**

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**Rethinking Packaging for Circular and Sustainable Food Supply Chains of the Future**

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## **ABSTRACT**

What forces facilitate or hinder the adoption of packaging solutions among professionals in commercial foodservice? What are the effects of sustainable packaging on food waste minimization? Around 100 million tons of food is wasted annually in the EU, or 173kg per capita per year, which means that approximately 32 per cent of all food purchased per year is not eaten. Food waste management has links to other global challenges including climate change, health, poverty, as well as sustainable production and consumption. It is estimated that almost 60% of the total climate impact of food waste is caused at the end of the food chain by households and commercial food services. Food waste prevention is a complex, multilevel phenomenon and an integral part of the food value chain covering the whole cycle—from production and consumption to waste management and the market for packaging and secondary raw materials. Ensuring food quality and safety and waste prevention is one of the integral functions of packaging. This paper explores the under researched topic of food waste prevention and minimization in commercial foodservices using a multi-method research design combining quantitative survey data analysis, qualitative interview data, and case studies. The paper will deliver an objective assessment of sustainable packaging options, looking for areas of improvement and best practices.

**KEYWORDS:** food waste; challenges; foodservices, packaging, sustainability

## INTRODUCTION

This paper develops a conceptual framework of main challenges in foodservices by synthesizing the relevant literature from food waste management and sustainable food packaging practices. This framework guides the empirical work of several in-depth case studies, including packaging companies, suppliers, commercial foodservice and culinary schools and food labs. In line with the COST Initiative, this research prioritizes collaboration among a broad range of stakeholders using innovative approaches to advance understanding of how to best approach sustainable packaging to tackle the food waste challenge.

Food waste has become a global issue and a major challenge aggravated by its role in climate change, land, water and biodiversity scarcity, groundwater pollution, and global deforestation. The response to the food wastage challenge must be a priority in a post-pandemic world—it requires a shift at all levels of the food value chain. In that sense, United Nations has set a specific Target, 12.3, that requires organizations, institutions, and countries to “halve global food waste at retail and consumer levels, as well as to reduce food loss during production and supply.” With only 9 years to achieve SDG 12 Target 3, UNEP alerts that reducing food waste at foodservice level “can provide multi-faceted benefits for both people and the planet. However, [...] the opportunities provided by food waste reduction have remained largely untapped and under-exploited” (UNEP, 2020).

Tackling food waste prevention and recovery is a priority area for research and innovation.

Food loss and waste takes place at all stages of the global food supply and demand chain. While in less developed countries much of food loss occurs upstream, in economically developed countries most wastage takes place downstream. Particularly puzzling is the phenomenon of food waste in hospitality and foodservice establishments at the very end of the value chain. These labor intensive, low profit margin services require precise and comprehensive operational procedures to make ends meet. Business success is tied to saving costs throughout the production activity—purchasing, storing, cooking, and delivering. Food waste is a sustainability challenge tied to short-term economic losses and longer-term environmental and social catastrophic costs. Arguably, foodservice professionals (from restaurant, F&B and room managers to waitresses, waiters, and kitchen staff) stumble upon with situations in which their daily operational saving activities clash with occurrences of food waste.

- GHG emissions caused by the whole food supply chain: 27.6 % of global GHG emissions in 2018 are attributed to the food system: 24% from agriculture and land use out of which 14.5% from animal agriculture, 9.5% from produce and grains. Moreover, the GHG emissions are created at any subsequent stages of the supply chain through processing, packaging, storage, transportation and retail.
- Food waste. 32% of food production is wasted. The COVID-19 pandemic has exposed major weaknesses in the current global food system and the resulting paradoxical redistribution tensions resulting from the simultaneous excessive surplus and wastage and hunger and poverty. Food waste is a complex, multilevel phenomenon that takes place at all stages of the global food supply and demand chain. The production and disposal of this food waste leads in turn

to the emission of 170 million tons of CO<sub>2</sub> and consumes 261 million tons of resources.

- Plastic packaging. Current packaging materials are principally oil-based. In 2018, global plastic production reached 360 million tons, 40% of it for packaging, the single largest end-use market. In Europe, plastics production almost reached 62 million tons and increased by 9.5% between 2018 and 2019.

Existing lines of research in Switzerland include the World Food System Center, ETH Zurich, where environmental scientists address the challenges of food systems and the Integrative Food and Nutrition Center, EPFL Lausanne, where researchers in food science and technology study the impact of science and technologies on food and nutrition. These research groups provide valuable research on aspects pertaining food loss and waste quantification, LCA analysis, recyclability opportunities, and disposal improvement. There is however a substantive lack of research on the management dimension of food waste prevention and minimization (Martin-Rios, Demen-Meier & , 2018). To that end, this project aims to provide a holistic account of the wastage phenomenon by addressing first, the paradoxical perspective of foodservice professionals; second, the sustainability innovation opportunities derived for developing co-creation ties between foodservices and manufacturing packaging companies and third, the relationship between training and awareness of future foodservice professionals.

### **Paradox Theory in Food Waste Management**

The complexity of tackling grand challenges results in conflicting goals and competing demands underlying latent organizational tensions. According to paradox theory (Schad

& Bansal, 2018), managers adopt cognitive frames when confronting managerial decision making regarding ambiguous sustainability issues (Hahn, Preuss, Pinkse & Figge (2014).

The environmental, legal, social and financial drivers and impact of food waste has been subject of much media and academic attention (Gustavsson et al., 2011; Siorak et al., 2015; Thyberg & Tonjes, 2016). Much of the initial debate on food waste and surplus revolved around the lack of consensus over the definition of food waste (Parfitt et al., 2010; Papargyropoulou et al., 2016). The last few years have witnessed a growing interest on measurement concerns—on assessing the exact quantities of food waste and loss produced worldwide (Garonne et al., 2014; Xue et al., 2017) and those generated by specific activities along the value chain: agriculture (Bustos & Moors 2018), supply chain (Secondi et al., 2019), retail stores (Cicatiello et al., 2017; Filimonau & Gherbin, 2017), hospitality (Papargyropoulou et al., 2016; Malefors et al., 2019), canteens and caterings (Lassen et al., 2019; Steen et al., 2018), food service establishments (Betz et al., 2015), and household and individual consumers (Zhang et al., 2019). Another major stream of work has focused on the environmental impacts of food waste (Cristobal et al., 2018; Quested et al., 2013).

Despite its recent prominence, the organizational factors that can foster or hinder food waste management initiatives in commercial food services have remained surprisingly undertheorized, especially from a paradox perspective. Discursive paradox can emerge when the individual discourse of food waste is inconsistent with the actual output, the implementation or not of food waste management initiatives. The paradoxical tensions are derived from the difficulties to accommodate conflicting economic, environmental and social concerns regarding food waste. Conditional to the ability to embrace tensions instead of avoiding them, foodservice professionals may either respond defensively or

proactively to paradoxical tensions (Hahn, Pinkse & Preuss, 2018). At its core, the paradoxical tensions foodservice professionals face relate to the level of awareness with the food waste phenomenon and the resulting engagement in implementation of practices (Lemaire & Limbourg, 2019). In some cases, short-term business solutions prevail over longer-term, sustainability decisions despite basic or generic awareness about the wastage problem. Alternatively, it is expected that professionals who accept inherently paradoxical tensions of combining sustainability priorities and shorter-term business priorities may embrace sophisticated, prevention-driven solutions to food waste.

The purpose of this first case study is to contribute to the ongoing debate on the tension and discursive paradox in food waste management by exploring the drivers of the gap between food waste awareness and engagement in commercial foodservices. By taking a practice stance, the research discusses how awareness shapes the level of engagement in food waste management solutions. The societal grand challenges trigger social dilemma in inter-organizational collaboration—"a situation in which professionals in foodservice are faced with a conflict between maximizing the company's interests (defection) or maximizing collective sustainability interests (cooperation) (Chen, Au & Komorita, 1996)

The first project's goal is to address the paradoxical relationship of foodservice providers (hospitality and food and beverage companies) with food through the lenses of food waste.

### **Co-creation of Sustainability-Oriented Innovations in Food Packaging**

Boosting innovative and sustainable food management practices to prevent and minimize wastage is essential to meet the United Nations' call to halve food waste by

2030. Ensuring food quality and safety and waste prevention is one of the integral functions of packaging. Together with food waste, the packaging is also discarded leading to an additional environmental burden. Sustainable packaging solutions are areas of manufacturing, research and practice characterized by rapid growth in the number and scope of innovations and inter-organizational collaborations driven by growing concerns about their sustainability impact (Boz, Korhonen & Koelsch Sand, 2020). The actions and interactions of manufacturers and other actors in such areas are fundamentally shaped by high level collaborations across firms in the food value chain. Examples of such spaces are collaborations with food manufacturers to tackle climate change, global health, and intellectual property rights.

There is a considerable lack of such cross-fertilization between packaging manufacturers and downstream activities in the food value chain. Sustainable packaging has the potential to be part of foodservice companies' overall strategy to deliver quality, safe and sustainable products, and services to market, including assessing carbon footprint impact, measuring true environmental impact, and preventing food loss and waste. There is a fundamental lack of research on the factors that foster and hinder the establishment of partnerships between the commercial foodservice industry, the packaging industry, and academia to develop appropriate packaging and wastage strategies because of their considerable weight in the global economy and the complex activities taking place on the food value chain.

A major specific research goal is to determine the factors that favor the adoption of sustainable innovation initiatives as part of the portfolio of innovation activities and apply it in the broader context of innovation strategies (Tiekstra, Dopico-Parada, Koivula, Lahti & Buntinx, 2021). The study of packaging innovations and food waste



prevention has thus become a key priority, referring to all the activities related to avoiding, reducing, or recycling waste throughout the consumption chain.

Sustainability-oriented innovation (SOI) in sustainable packaging is a key resource to reduce food waste, and the literature has acknowledged the high relevance of uncertainty and paradoxical dilemma in this context (Martin-Rios, Hoffman & Mackenzie, 2021). Previous research suggests that the adoption of innovative solutions in packaging is lower because it requires cross-sectorial collaboration of business networks in the strategic field of food management, food security, and food delivery. This second interdisciplinary research objective addresses questions that are important for scholars and practitioners alike. The aim is to describe and analyze the impact of sustainable packaging landscape, in particular areas for the benefit of commercial foodservice, who for the most part are lagging behind in their level of engagement with packaging manufacturers in a way that best meets their sustainability goals. Specifically, the following research questions are of utmost importance:

- What strategies do foodservice actors choose to navigate sustainability innovation challenges related to food waste and packaging?
- To what extent do these strategies involve otherwise remote players in fostering sustainable management, including the food industry, packaging, food processing, and wholesale?
- How does co-creation of innovative packaging solutions to reduce waste between foodservice stakeholders generate higher adoption levels?

### **Co-Creation in Academic**

This complex system entails recognition of the views of future foodservice professionals on what constitutes food waste, their understanding of alternative packaging solutions,

and the factors that may affect their awareness, sensemaking and reflection (Mehta, Cunningham, Roy, Cathcart, Dempster, Berry & Smyth, 2021). Hospitality and culinary schools have a vital role to play in solving the food waste challenge. These schools are an ecosystem where food professionals educate future generations on the values, principles, and best culinary practices. Schools can become living labs where smart food packaging solutions are being tested, food waste valorization options are assessed, and awareness among future professionals—students is triggered.

Yet, there have been few empirical studies on food waste in hospitality schools. A review of literature on food waste interventions (Reynolds et al., 2019) suggests that “Cooking classes, fridge cameras, food sharing apps, advertising and information sharing were all reported as being effective but with little or no robust evidence provided.”

This third in-depth case study will address perceptions of environmental and food students of sustainable packaging alternatives, the role of packaging on food waste minimization and recycling, and development of the methodological tools to increase awareness and information about the development of manufacturing solutions for commercial foodservice.

## **RESEARCH DESIGN**

This work-in-progress research paper draws on a variety of data sources and research methods: a qualitative examination of the sustainable innovative packaging dynamics using semi structured interviews to build in-depth case studies of best-practice firms and a quantitative analysis identifying distinctive innovative packaging practices and their impact on foodservice implementation of sustainable practices. An exploratory and

qualitative study on innovative foodservice firms gave indication as to the theoretical model and different hypotheses. Case research is lauded to be particularly useful in studying the sustainability innovation processes and activities. Five cases derived from field-based research were developed. Extensive interviews were undertaken with senior managers from four foodservice companies. The sample chosen for this analysis was selective, based on firms with a reputation for adopting best practices in sustainable packaging options. Data from business case studies will be analyzed by means of methodologically sound qualitative methods. From this analysis, a best practice model for sustainability innovation was developed. The best practice model led to testable hypotheses that were tested quantitatively in a second phase.

**Table 1.** The adoption of continuous improvement and sustainability-oriented innovation practices in foodservice

Sustainability-oriented innovations		Packaging innovation	
		Yes	No
<b>Kitchen innovation</b>	<b>Yes</b>	<p>Case A: “Innovation maker” collaborative projects with suppliers and cooperation partners.</p> <p>Case B: Design thinking and the establishment of inter-firm relationships to launch innovative businesses and services</p> <p>These opportunities contribute to Case A and B’s differing sustainability practices in internal vs external innovation problem solving. Also, these decision-making processes involve challenges and tensions. Management faces internal resistance.</p>	Case C: Innovation, partnerships and sharing sustainability opportunities that do not include alternative packaging options.
	<b>No</b>	<p>Case D: crowdsourcing /open innovation. Open innovation initiatives offers opportunities for: (1) enlisting internal employees to work with the sustainable innovation facilitators; (2) selecting the right problems; and (3) formulating problems to enable novel solutions.</p> <p>Case E: new packaging and recycling technologies of environmental sustainability that stimulate and valorize avant garde initiatives in foodservice.</p>	---

The second, quantitative phase builds on the initial exploratory research. It draws on an online survey administered to all members of the COST project (around 100 universities and leading companies in the packaging segment) using a stratified random cluster sampling procedure. Several items from existing research, with minor adaptations, will be included to measure sustainability-oriented innovations in food packaging (i.e. value proposition, value-creation system and value-capturing mechanisms), organizational and management innovation (i.e. the implementation of a new or significantly different management structure, the organization of work, and relations with other firms and public institutions) and several performance measures (Clauss, 2016). Socio-demographic and financial data of foodservice firms will be inquired in the survey. The operationalization/scale of sustainability innovation measures will be taking from existing research. Hypotheses will be developed and will lead to a regression equation which will be estimated using several econometric techniques.

## **EXPECTED FINDINGS**

This work-in-progress paper seeks to advance our understanding of what drives the design and implementation of sustainability-oriented innovation and its outcomes in alternative packaging solutions for foodservice firms. It will make a contribution by improving the critical review and integration of theories of sustainability innovation and by advancing our understanding of the complexity and mechanisms of sustainable packaging solutions in a variety of organizational levels (firm, team and individual).

This paper draws on mixed methods—a combination of different methodological approaches. This project presents three distinct case studies. Each study will generate a unique dataset.

1. Data will be collected from key informants on existing sustainable packaging alternatives in the market and their impact on food waste minimization. Database will include both quantitative data (assessment of packaging materials, durability, sustainability, etc.) and qualitative data (considerations from key informants of each packaging solution regarding its availability, perceived usefulness, and cost, etc. for food waste minimization in commercial foodservices). Dataset will be kept in a SPSS file for its statistical treatment. There are no existing data sets that can be reused. Data collection on sustainable packaging solutions will be obtained from the members of the COST initiative CIRCUL-A-BILITY. This COST Action includes a conglomerate of 34 countries with over 160 participants from all over Europe and with backgrounds ranging from marketing and design to material and food science. The Action has been organized in four working groups each focused around a certain type of food which ensures that product specific issues remain center stage, as this action is supposed to link together all the disciplines affecting the life of a product and its package.

A survey questionnaire will be distributed among all 160 participants with relevant questions about the different types of packaging currently commercialized, sustainable alternatives to existing packaging, costs, availability, distribution channels, etc.

2. Survey data will be collected from professionals in the commercial foodservice on management preferences and value perceptions on packaging materials and the impact of cost, and availability in adoption preferences as well as on co-creation strategies for stakeholders to innovate on packaging sustainability. Dataset will be saved in a SPSS file for its statistical treatment.

Interview data will be collected through interviews with key informants in hospitality and culinary schools on the inclusion of packaging and food waste topics in current educational practices, factors affecting student pre-evaluation education on sustainable

behaviors, and student testing methods. Dataset will be saved in an Excel file for its statistical treatment. Qualitative interview data with key informants (i.e., teachers, professionals, and industry experts) to investigate solutions on the food waste challenge. Due to the exploratory nature of this study, a semi-structured interview technique is chosen to allow participants to further detail their answers and lead to new ideas. Interviews will allow the so-called “laddering” technique, consisting of encouraging participants to bring the questions to a more emotional level thanks to probing questions. This technique enables the researcher to capture personal experiences, facilitating inductive analysis.

## **CONCLUSIONS**

There is an urgent need for academic research to find solutions that address the social and environmental challenges of wastage while enabling economic growth and arising educational awareness. This project will offer solutions to address pressing challenges in terms of sustainable packaging from a multi-stakeholder perspective: manufacturing and technical challenges; efficient production, scale of costs; retailer approval; foodservice experience; customer acceptance; institutional challenges (landfill readiness). An overarching objective is to create an innovative, more resilient, and productive waste-based food packaging economy by decoupling the food packaging industry from fossil feed stocks and permitting nutrients to return to the soil.

An important category is represented by hospitality and culinary students, which unlike other young people, possess several characteristics which influence their food waste behavior, such as education, lifestyle, buying habits, and career aspirations (especially those who want to pursue their career in retail, hospitality and food and beverage companies).

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