Redesigning food packaging to prevent rice wastage

Design for Sustainable Behaviour Lens

(Shreya Ravi, John Asp)

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Introduction

1.1. Food waste

Food waste is a pressing global concern, with significant implications for both the environment and society. It's estimated that one-third of all food produced worldwide is wasted, amounting to approximately 1.3 billion tons each year (WFP, 2020). This wastage occurs at various stages of the supply chain, starting from the agricultural production phase to processing, distribution, retail, and consumption. The environmental impact of food waste is substantial, as it contributes to greenhouse gas emissions, deforestation, and water scarcity. Moreover, the resources invested in producing wasted food, such as land, water, energy, and labour, are squandered, exacerbating food insecurity and economic inequality.

It is crucial to understand the crucial connection between consumer behaviour and food waste to devise effective strategies to tackle this widespread issue. By delving into the intricacies of consumer decision-making processes, including attitudes, perceptions, and habits surrounding food consumption and disposal, we can glean valuable insights into the root causes and contributing factors of food wastage. Understanding why and how consumers discard food, whether due to perceived freshness, aesthetic preferences, or expiration concerns, allows us to tailor interventions and solutions that resonate with their needs and preferences. Moreover, by identifying barriers and motivators that influence consumer behaviour, such as social norms, convenience factors, and environmental consciousness, we can develop targeted approaches to mitigate food wastage and foster more sustainable consumption habits.

The project focuses on addressing rice waste through packaging solutions. Later in the report, we will discuss why rice was selected and research findings on limitations, cultural differences, and discrepancies. It will also include the rationale for choosing research methods and reflections about every stage of the process.

1.2. Chosen approach to tackling food wastage: Design for Sustainable Behaviour

We chose to use the 'Design for Sustainable Behaviour' methodology to combat food wastage because it has a straightforward approach and promising avenues for using package design. The objective of this method is to tackle food waste systematically by acknowledging the significant role packaging plays in influencing consumer behaviour and consumption patterns. By integrating principles of sustainable behaviour into package design, we aim to address the root causes of food wastage at the consumer level, fostering more mindful consumption habits and reducing unnecessary disposal of food. The 'Design for Sustainable Behaviour' approach provides a practical strategy for reimagining food packaging as a tool for reducing waste. Through innovative design solutions, such as portion control packaging, resealable containers, and expiration date indicators, consumers can be empowered to make conscious consumption choices and extend the shelf life of perishable items.

1.3. Objective

The primary objective of this study was to utilize the Theory of Planned Behaviour (TPB) as a guiding framework to inform the redesign of rice packaging, with the aim of mitigating rice wastage by influencing consumer behaviour. Leveraging the TPB model, which elucidates the cognitive processes and behavioural intentions underlying individuals' actions, the research sought to gain insights into the factors driving people's decisions to dispose of rice. By applying the TPB model to the specific context of rice consumption and disposal, the study aimed to identify key determinants, such as attitudes, subjective norms, and perceived behavioural control, that shape consumer behaviour regarding rice wastage.

To achieve this objective, data collection was conducted through a combination of a survey and a workshop, allowing for a holistic understanding of attitudes and behaviours related to rice consumption and disposal. Participants were asked to provide insight into their perceptions, attitudes, and past behaviours regarding rice. In addition, the workshop offered a platform for a deeper exploration and discussion of the factors that influence rice disposal decisions. These insights were then used to inform the redesign of rice packaging, with the goal of developing innovative solutions that encourage responsible consumption practices and minimize unnecessary disposal of rice.

Literature Review

2.1. Theories of Behaviour Change

To address complex societal challenges, such as sustainability, public health, and social justice, it is necessary to understand human behaviour. Various theories and models have been created over time to explain and predict behaviour change. These theories give a basis for understanding the factors that influence individual actions and decisions, as well as the ways in which behaviour change can be facilitated.

1. Social Cognitive Theory : Social Cognitive Theory based on the concept that learning is affected by cognitive, behavioral, and environmental factors (Bandura, 1991). In Bandura's theory, people aim to cultivate a sense of agency (Schunk & DiBenedetto, 2020), or the belief that they can make significant changes to important events in their lives. To do this, they employ their mental and self-regulatory abilities (Schunk & DiBenedetto, 2020), which include setting objectives and creating plans to achieve them. They evaluate their progress and adjust their strategies as required. The essence of this perspective is self-efficacy, which is the trust in one's ability to learn and carry out tasks according to specific standards. Self-efficacy, which is achieved through reflective and goal-oriented self-assessment, is a fundamental internal motivation in social cognitive theory (Bandura, 1977a, Bandura, 1997).



Figure 1: Banduras-model-of-Social-Cognitive-Theory-representing-the-triangular-relationship

According to Bandura, observational learning has four main components: attention, retention, reproduction, and motivation. Attention is the act of focusing on and extracting information from observed activities (Wood and Bandura, 1989). The process of retention involves transforming and structuring information into rules and concepts, and then storing it in memory. Reproduction is the act of carrying out the behavior that was observed. Motivation is the fourth component that motivates the learner to engage in attention, practice, and retention.

2.2. Food Wastage and Sustainable Packaging

The broader sustainability paradigm requires consideration of environmental impacts throughout the product life cycle, which includes food waste and sustainable packaging design. Incorporating life cycle assessment (LCA) into packaging design allows for a comprehensive evaluation of environmental impacts from raw material extraction and processing to manufacturing, distribution, use, and disposal.

LCA provides insights into the environmental footprint of different packaging materials and formats, enabling stakeholders to identify opportunities for improvement and innovation. By quantifying factors such as energy consumption, greenhouse gas emissions, water usage, and waste generation at each stage of the product life cycle, LCA facilitates informed decision-making and the development of more sustainable packaging solutions.

Consumer perceptions of sustainable packaging are influenced not only by environmental considerations but also by factors such as convenience, aesthetics, and product performance (Williams, Wikström, & Otterbring, 2014). Sustainable packaging design must strike a balance between reducing environmental impact and meeting consumer expectations.

By combining sustainable packaging design, consumer education, and engagement initiatives, stakeholders can work towards reducing food waste and promoting more sustainable consumption patterns.

The project aimed to integrate various aspects beyond sustainable behaviour, acknowledging the importance of a holistic approach. Life cycle assessment (LCA) is necessary for real-world applicability, even though it wasn't initially required for the project. As a result, we made an attempt to incorporate LCA into our efforts and come up with solutions.

2.3. Consumer Behaviour

Our second-hand research indicates that paper/cardboard packaging elicits positive emotions such as being homey, fresh, and having associations with healthiness and trustworthiness. Plastic packaging is frequently linked to negative emotions such as the cost of unnecessary things and environmental damage (Otto et.al, 2021). The colour of packaging is strongly connected to how consumers perceive flavour, nutritional quality, satisfaction, and brand image (Otto et.al. Environmental colours, which tend to be quiet and natural tones such as brown or green, are frequently linked to sustainability (Magnier et al., 2015).

In various studies (Lindh et al., 2016), the relationship between product and packaging has remained constant. Consumers view sustainable packaging as environmentally friendly when it comes to design (Magnier et al., 2015). Research has shown that the packaging type has a major impact on the product choices of many consumers, with food packaging being particularly important (Magnier et al., 2015). Cultural factors also play a role in shaping consumers' perception of packaging design.

Theoretical Framework

3.1. Theory of Planned Behaviour

Icek Ajzen's Theory of Planned Behaviour (TPB) *Figure 2*, was a widely utilized theoretical framework for understanding and predicting human behaviour in 1985. The Theory of Reasoned Action is expanded upon by incorporating the concept of perceived behavioural control (PBC). The main factors that affect behavioural intentions are attitudes towards behaviour, subjective norms, and perceived behavioural control, as suggested.

Attitudes : An individual's attitude towards a behaviour is determined by their beliefs about its outcomes and subjective importance as well as their overall evaluation. When a person has positive attitudes towards a behaviour, they are more likely to make intentions to engage in that behaviour, but when they have negative attitudes, they are less likely to do so (Ajzen, 1991).

Subjective Norms : An individual's perception of social pressure or influence from significant others influences their behaviour, which is called subjective norms. The behaviours of these important others are influenced by beliefs about their approval or disapproval. An individual's intention to engage in behaviour is influenced by their perception of social approval or disapproval (Ajzen, 1991).

Perceived behavioural control (PBC): Perceived behavioural control is how one perceives the ease or difficulty of performing a behaviour. It encompasses factors like self-efficacy (the belief that one can perform the behaviour) and perceived controllability of the situation. A higher perceived behavioural control results in stronger behavioural intentions (Ajzen, 1991).



Figure 2 : Theory of Planned Behaviour Model

Attitudes, subjective norms, and perceived behavioural control interact to determine an individual's behavioural intentions, which then affect their actual behaviour.

The theory of planned behaviour states that both intentions and perceived control play a role in performing a behaviour. The assessments of intention and perceived control need to be in alignment or compatible with the expected behaviour (Ajzen & Fishbein, 1977; Ajzen, 1988). This means that both intentions and perceptions of control should be evaluated in the context of the behaviour of interest and within the same environment where the behaviour will occur. To accurately predict (Ajzen, 1991), intentions and perceived control must remain stable between their measurement and the observation of behaviour. Changes in circumstances can alter intentions or perceptions of control, making initial assessments less reliable for predicting behaviour. Predictive validity (Ajzen, 1991) also relies on the accuracy of the perceived behavioural control.

3.2. Rationale behind choosing TPB Approach

There was uncertainty about whether to select Social Cognitive Theory or the Theory of Planned Behaviour for this project, as both emphasize similar factors, such as the external environment. Additionally, Bandura's concept of self-efficacy seems quite similar to perceived behavioural control because both aim to trigger self-regulatory behaviour or promote a level of awareness and intentional action. This comparison between self-efficacy and perceived behavioural control has been discussed in research by Ajzen himself.

The current understanding of perceived behavioural control closely aligns with Bandura's (1977, 1982) idea of perceived self-efficacy (Ajzen, 1991), which focuses on individuals' judgments about their ability to perform actions necessary for upcoming situations (Bandura, 1982, p. 122). Much of what we know about perceived behavioural control stems from Bandura and his colleagues' systematic research (e.g., Bandura, Adams, & Beyer, 1977; Bandura, Adams, Hardy, & Howells, 1980). Their studies have demonstrated that individuals' actions are heavily influenced by their confidence in their ability to execute them (Ajzen, 1991), referred to as

perceived behavioural control. Self-efficacy beliefs influence the selection of tasks, preparation, effort exerted, and cognitive and emotional responses (Bandura, 1982, 1991). The theory of planned behaviour situates self-efficacy or perceived behavioural control within a broader framework that connects beliefs, attitudes, intentions, and actions (Ajzen, 1991).

When we compared Bandura's observational learning model, which defines attention, retention, reproduction, and motivation as its core components, with Ajzen's theory of behavioural intentions, encompassing attitudes, intentions, subjective norms, and perceived behavioural control, the latter emerged as being more persuasive. Its main attribute is its capability to establish a direct correlation between perceived behavioural control, intention formation, and subsequent action. Ajzen's framework demonstrates how individuals' perceptions of their ability to enact a behaviour have direct consequences on their intentions and their actual behaviour. The understanding of self-perceived capability's role in shaping behavioural outcomes is crucial for a more nuanced and effective mapping of human behaviours. Ajzen offers a comprehensive perspective that bridges the gap between cognitive processes and behavioural execution by integrating perceived behavioural control into the model, enhancing the theory's ability to predict and apply to various scenarios.

TPB was chosen as the theoretical framework for studying food waste because of its ability to provide a comprehensive understanding of individuals' behaviour and the factors that influence it. TPB incorporates the concept of 'perceived behavioural control' that reveals how individuals perceive their ability to perform behaviours. Understanding the users' awareness levels and control over food waste, including rice disposal, was particularly valuable due to this aspect. By analysing perceived behavioural control, we could determine if individuals were capable of reducing food waste and identify any discrepancies between impulsive actions and deliberate intentions.

In addition, TPB can assist in identifying potential points for intervention in the process of food consumption and waste generation. By pinpointing these intervention points, it is possible to determine the optimal time to implement design interventions in the food consumption lifecycle to have the greatest impact.

For instance, TPB helped identify whether the design intervention should target the pre-cooking phase (such as purchasing, storage, and meal planning) or the post-cooking phase (such as portion control, leftovers management, and disposal). This allowed for a more targeted and effective approach to designing interventions aimed at reducing food waste, specifically focusing on rice waste in this context.

Process

4.1. Miro

The Miro board (*Figure 3*) was utilized to collect and organize information and data, allowing for visual representation and mapping of various elements. A matrix was created to examine the interplay between behaviour, life cycle assessment (LCA), package design, and the technical aspects of food waste and circular economy. This matrix was the foundation that was derived from preliminary research to initiate the research process. It also served as a base to choose our theoretical framework and mapping methods and design strategies with TPB and linking the data.

Further research was carried out on consumer behaviour in relation to sustainable packaging after narrowing it down to the second quadrant, which is behaviour. The board was updated with information about sustainable packaging design to provide an idea of what the solution should consist of.



Figure 3 : The matrix (Technicalities, Behavior, LCA and packaging design)

In the next phase (*Figure 4*), we used the board to enhance our understanding of key concepts and inform our decision-making, we connected various datasets using the board. For example, the Theory of Planned Behavior (TPB) was examined in relation to the dimension of 'Power in Decision Making', and this was a significant example. Examining how these two elements interact helped us identify determine the most suitable framework for our design phase.

The data collected on Miro was instrumental in determining the specific stage of the rice cooking process that requires intervention. This analysis helped clarify whether our efforts should focus on the pre-cooking phase (such as purchasing, storage, and meal planning), the cooking phase itself, or the post-cooking phase (such as portion control, leftovers management, and disposal).



Figure 4 : Connecting data gathered

4.2. Introduction to research Methods

To gather information about the food waste behaviors of respondents, we used an online questionnaire as our primary data collection method. The accessibility of this approach was chosen to reach a wide audience. The survey was distributed online, which resulted in time-efficient data collection and easy completion for participants.

The second approach involved a qualitative workshop session. The objective of this approach was to delve deeper into the participants' thought processes and refine potential solutions. It was hoped that the workshop format would produce naturally, even though the questions posed in the workshop could have been included in the survey.

(1) The survey

Given the broad scope of food wastage, we designed the survey to narrow our focus to a specific item. We included questions aligned with the Theory of Planned Behavior (TPB) model. Additionally, we sought to identify the stage at which people waste the most food, whether it be pre-cooking, during cooking, or post-cooking. There were 14 respondents in the survey, a

smaller number than what would be preferred in a large-scale study. Nevertheless, the answers were useful.

1. Narrowing the Scope:

• What specific food item do you waste the most?

What type of food do you find yourself discarding most frequently?
14 responses
Peels
Rarely fruits, in case they have gone stale
Fresh vegetables
Generally don't discardif it is discarded then it will be usually a morsel of cooked rice which we don't feel like refrigerating
Breads
Stale food
Fresh vegetables and salad
Older leftover food
Products that I opened some time ago, and did not use before they expired. Examples: feta cheese and

Figure 5 : specific food item

This question was essential for refining our focus on a specific item. We received a variety of responses, including vegetable waste, bread, food leftovers, rice, and expired packaged items. These diverse answers highlighted the range of food waste issues but also helped us identify which items were most frequently mentioned by the respondents, allowing us to better target our intervention efforts.

Rice was not an obvious choice based on the survey results. Only 2 respondents mentioned rice, while 5 indicated vegetables, fruits, or a combination of both. However, since fruits and vegetables are typically sold without packaging in Sweden, modifying their packaging to reduce waste was not feasible. As a result, we decided against selecting fruits and vegetables. Given that rice was the only item mentioned by more than one respondent, with a total count of 2, it was chosen as the focus of our intervention.

2. Stages of Food Waste:

• At which stage do you waste the most food: pre-cooking, during cooking, or post-cooking?



Figure 6 : Stages of food waste

10 people (71%) responded that they throw away food after cooking. From this observation, it is probable that most food waste is caused by people preparing too much when cooking. The significance of this finding lies in the identification of a specific stage in the food preparation process where intervention could be most effective. By focusing on this point, strategies can be developed to help individuals better gauge portion sizes,

plan meals more accurately, and reduce the amount of surplus food that gets discarded.

Do you pay attention to expiry dates while shopping for groceries?

3. Packaging and Expiry Awareness:

• Do you notice details or expiry dates on packaging?



Figure 7 : Expiry dates

Our aim was to assess users' awareness of expiry dates, as this information directly influences how they dispose of food. Being attentive to expiry dates is paramount, as it ensures food safety and prevents consumption of expired products, which can pose health risks. By understanding users' habits regarding expiry dates, we can identify

potential areas for improvement in food management practices and promote safer consumption habits.

• Have you encountered packaging that makes it difficult to extract all contents?

Have you encountered packaging that makes it challenging to extract all the contents? If so, please describe shortly. 14 responses





This inquiry seeks to determine if stale food due to packaging limitations leads to food waste. Our goal was to identify potential issues with packaging design that contribute to food spoilage and waste, by exploring this aspect. Understanding how packaging

inadequacies impact food preservation can assist in improving packaging solutions, which can effectively maintain product freshness and prolong shelf life.

Some participants mentioned difficulties with coffee packets and mayonnaise sachets, while others highlighted challenges with squeezing products from tubes.

4. Food Discarding Habits:

• Does the frequency of your grocery shopping impact the amount of food you throw away?

Do you find that your grocery shopping frequency impacts the amount of food you dispose of? If so, please describe shortly. 14 responses



Figure 9 : Frequency of grocery shopping

Some participants highlighted that wastage, particularly with fresh vegetables, can be exacerbated by discounts that tempt bulk buying, leading to impulse purchases and subsequent waste. However, the prevailing sentiment among most respondents was that the frequency of grocery shopping influences the amount of food discarded.

It is possible for smaller and more manageable purchases to be made on more frequent shopping trips, which may reduce the likelihood of excess food ending up unused and wasted. Interestingly, only a small minority of respondents mentioned freezing food or purchasing frozen items as a strategy to mitigate waste, indicating potential opportunities for education or promotion of alternative storage methods to prevent spoilage and extend the lifespan of perishable items. The complex interplay between shopping habits, consumption behaviors, and food waste is highlighted in these insights, which provide opportunities for intervention and behavior change.

• How do you determine the quantity of food you purchase?

How do you determine the quantity of food you purchase?	
14 responses	
Yes	
Ore-selected recipes / experience	
Buy the minimum available	
I don't have any specific "measurements" but I know quite well what amount of food I consume.	
Determination of quantity of food purchased depends on our eating habits, lifestyle,appetite and how calculative we are about our timely spending, number of times we prefer eating out etc	
Based on number of people at home.	
Recipes I/we have in mind.	
According to the members in the family	
Storage capacity and consumption pattern	

Figure 10 : Quantity of food purchase

The range of factors, including family size, can affect the diversity of responses, adherence to pre-selected recipes, individual eating habits, lifestyle considerations, appetite variations, and the practice of calculating calorie needs. Portion sizes and meal planning strategies may be affected by family size, while adhering to specific recipes may determine ingredient quantities. Furthermore, individuals' eating habits, such as snacking preferences or dietary restrictions, can impact their food purchasing and consumption patterns. Lifestyle factors, such as work schedules or travel commitments, can also impact meal preparation and food waste. Also, changes in appetite levels and the practice of calculating calorie needs could affect portion control and food purchasing decisions.

5. Unused Products and Environmental Considerations:

• Are there specific products that consistently go unused or remain on your shelf?

Are there particular products that consistently go unused or remain on your shelf? 14 responses



Figure 11 : Unused products on shelf

The responses covered a vast array of items, including jam bottles, sauces, canned products, fruits, and bread. However, it is challenging to identify consistent patterns among these items, as the availability of products on store shelves can vary.

Consequently, it becomes challenging to identify specific products that consistently remain unused or on the shelf.

• Do you consider the environmental impact of different food products when making purchasing decisions?

Do you consider the environmental impact of different food products when making purchasing decisions? - Scale 14 responses



Figure 12: Environmental impact in purchase decisions

This question is a crucial indicator of individuals' awareness levels about the environmental impact of food products and their receptiveness to eco-feedback. However, it's essential to acknowledge the potential presence of biases in respondents' answers. An interesting trend emerged from the data, with half of the respondents selecting a mid-range score of 3 out of 5 on the scale, which may be considered a neutral or safe response. It's possible that some respondents chose lower scores because of feelings of guilt, shame, or other factors that influence their perception of environmental responsibility.

Despite this, it's worth noting that most respondents did not rate their consideration of environmental impact highly, as only three rated it as a 4 or 5 on the scale. The survey results suggest that there may be a prevailing lack of awareness or consideration regarding the environmental consequences of food choices among the surveyed individuals. By acknowledging these nuances and potential biases in respondents' answers, we can better interpret the data and tailor interventions to address gaps in environmental consciousness.

(2) Limitations of the survey

The online survey was accessible to a wide audience without any targeted demographic, which resulted in a majority of vegetarian respondents, mostly from Indian backgrounds, as demonstrated by the limited responses given to frozen food. However, cultural differences were not considered before sending out the survey. It's important to note that food habits vary greatly between Asian and European cultures, with rice being a staple in Southern Asia but not as

common in Sweden or other Scandinavian regions. Our choice to focus on rice in the survey was based on general factors, without considering cultural influences.

We acknowledge that our redesign solution may not have adequately addressed cultural differences, considering this limitation. However, we proceeded with rice as it provided a practical avenue to explore the application of the theory of planned behavior during the post-cooking stage. It would have been beneficial to explore how cultural factors interact with behavioral theories before distributing the survey. By adopting this method, we could have gained a better understanding of the impact of cultural differences on food-related behaviors and adjusted our survey accordingly.

(3) Workshop methods

Following the survey, we organized a workshop to further explore rice waste, the focal point identified through the survey results. The workshop had six participants, all of whom were students from Linköping University, and was split into two separate parts. The initial segment consisted of a brainwriting session, which allowed participants to generate and share ideas collaboratively. This was followed by a segment dedicated to exploring 'Worst Possible Ideas,' fostering creative thinking by encouraging participants to propose unconventional solutions without fear of judgment.

The workshop's objective was to explore the behaviours of individuals when disposing of rice after cooking, with a focus on understanding their underlying motivations and intentions. Through participant feedback on the worst-case scenarios, the workshop aimed to uncover deep-seated beliefs and attitudes about rice disposal. Additionally, the discussion about the possible societal consequences of throwing away rice was meant to shed light on subjective norms by exploring how individuals perceive societal expectations and norms regarding food waste behaviour.

 Brainwriting: Brainwriting ensures that everyone's input is considered equally in comparison to traditional brainstorming, which often has the loudest voices dominate. It reduces pressure, motivates less active members to contribute, and enables ideas to develop naturally. At the start of the session, participants receive a prompt or question. They jot down their ideas on sticky notes or paper and either pass them to the next participant for elaboration or post them directly on the board. These ideas are then discussed collaboratively as a group.

We opted for brainwriting because we believed it would facilitate the collection of personal experiences or nostalgic moments that participants could share, helping us

understand perceived behavioural control concerning rice disposal. The participants had to note down and discuss the following;

- Their most recent food disposal occasion and reflect on their emotional response during the process.
- The decision on when it's appropriate to throw away leftover rice.
- The way they measure rice before cooking



Figure 13: Brainwriting session from the workshop

Participants were asked to consider their general food disposal habits in the first prompt. Participants across the board reported discarding leftovers mostly because they thought they were unnecessary, without feeling any significant emotional responses or guilt. When the discussion focused on rice disposal specifically, participants expressed that cooked rice rarely requires disposal. They observed that rice remains fresh for several days, which makes it convenient to consume as leftovers, which reduces the likelihood of wastage.

Moreover, the participants revealed that they were lacking precise methods for measuring rice before cooking. Most used informal methods, like using their hands to estimate quantities or relying on guesswork, instead of using specific measuring tools or standard measurements. By measuring rice, this approach highlights a common practice that could lead to overcooking and food waste, even though people tend to avoid wasting rice.

2. Worst possible ideas: The 'Worst Possible Idea' ideation technique engages participants in brainstorming sessions to identify the most ineffective or counterproductive solutions. Our purpose for choosing this method was to gain insight into the unfavorable behaviors or actions that participants may take when reusing rice and to understand how these actions would be perceived by those around them. This

technique is typically used to generate creative ideas, but we attempted to adapt it to explore behavioral insights indirectly.

Our goal was to gain a deeper understanding of the attitudes and behaviors of participants towards rice reuse by examining the worst-case scenarios and their impact on social perceptions. Through our unconventional approach, we hoped to gain insights into the challenges and obstacles that arise when promoting better rice reuse practices.

• When asked to come up with the most extreme reactions to throwing away food, participants expressed feelings of guilt, shame, and regret. This exercise revealed that the social and emotional consequences of food waste are heavily weighed on people's minds. The participants imagined situations where they were harshly judged by others for wasting food, causing them to feel more guilty and ashamed. One of the participants shared a scenario where her parent instructed her to throw away rotten food because they were worried about food poisoning. Additionally, some participants mentioned that they would likely receive unsolicited advice on how to avoid wasting food. They emphasized that these reactions would not only cause them to regret their actions but also cause them to become more conscious of their food waste behaviors in the future.



Figure 14: Worst Possible Idea session from the workshop

• Participants were encouraged to come up with suggestions for reusing rice that had been cooked, and many shared creative ideas for re-cooking or transforming it into different products. Their innovative approach was notable, as they saw



cooked rice not just as a food item but as a resource that could be reused for everyday use.

Figure 15: Worst Possible Idea session from the workshop

• This perspective gave rise to possibilities beyond conventional culinary applications, suggesting that cooked rice could be incorporated into various products. This insight underscores the potential for thinking outside the box when it comes to reducing food waste, highlighting opportunities to innovate and repurpose resources in unexpected ways.

(4) Limitations of the workshop

The brainwriting session produced limited results, possibly because rice consumption is low in Sweden. The survey findings and workshop discussions did not coincide, especially since participants came from diverse cultural backgrounds with different rice consumption habits. During the 'Worst Possible Ideas' phase, participants, primarily engineering students, generated many ideas for reusing cooked rice. It's probable that their background was a factor in proposing technical solutions. But the discussion on social perceptions of rice disposal, such as guilt or shame, seemed to be predictable.

Despite this, the discussions revealed two significant limitations. Firstly, the demographic and cultural diversity of the participants impacted the depth of insights obtained, highlighting the need for a more diverse sample. Secondly, the methods employed, particularly the 'Worst Possible Ideas' exercise, did not align well with the goal of uncovering deep-seated beliefs and attitudes regarding rice disposal. The primary research objective could not be achieved because of this methodological mismatch, which limited the depth of insights obtained.

While the insights obtained were satisfactory, these limitations highlight the importance of selecting research methods that align with research goals with care. and considering the cultural diversity of the participants to ensure more comprehensive insights.

4.3. Synthesis of findings based on the TPB model

Despite the constraints posed by the survey and workshop methods, we decided to map the insights onto the model (*Figure 16*) using our existing understanding.

- Attitude: In terms of attitude, observations from the workshop revealed that participants viewed the act of discarding rice as unnecessary, particularly when there was an excess amount. Perhaps the reason for this perception is their belief that they have the autonomy to dispose of the rice as they see fit as there are no rules or obligations that dictate its post-cooking usage.
- Subjective norms-Intention-Behaviour: The participants' reactions within the context of the worst possible ideas revealed their intention to ensure the freshness of the rice or avoid discarding it altogether to prevent feelings of guilt, shame, and negative social reactions. For instance, the scenario involving food poisoning caused anxiety and served as a compelling reason to discard the food. However, it also motivates them to cook only the necessary amount of food to avoid the risk of food poisoning in the first place, thus acting as a form of positive reinforcement for mindful cooking practices. The workshop also highlighted that there was a lack of awareness about proper rice measurement, which could lead to unintentional overcooking and the subsequent disposal of excess rice.



Figure 16: Synthesis of findings based on TPB Model

• **Perceived behavioral control:** The participants were aware of their ability to change their behavior, but it's unclear if they view it as easy or hard. It was clear from their responses and discussions during the workshop that they acknowledge the potential to move from unconscious to conscious actions. By acknowledging the need for more mindful practices, they indicate their willingness to move towards more deliberate and informed decision-making processes regarding rice disposal. This implies that despite the challenges they may face when implementing these changes, they are aware of the possibility and significance of doing so.

The challenge was to come up with a packaging design that could increase awareness about food disposal when it's most needed. Our aim was to create packaging that aids consumers in

measuring the correct amount of rice before cooking, thus minimizing waste after cooking. Recognizing that both stages are interconnected, we aimed to address the issue at its source.

Furthermore, we decided to focus on Behavior Steering (Lilley, 2009) by enhancing users' decision-making power (*Figure 17*). Our approach centered on empowering users with the knowledge and tools to make informed decisions about portion control, ultimately promoting more sustainable practices without imposing restrictive measures. The purpose of this strategy is to gently direct behavior through awareness and convenience, rather than using coercion.



Figure 17: Dimension of 'power in decision making'

The redesign

The concept solution's inspiration is derived from the Sous vide cooking technique, where food is vacuum-sealed in a bag and cooked in a precise water bath. This concept is in line with traditional methods in southern Asian countries, where rice items are cooked using banana leaves in boiling water. Our solution revolves around a cook-in-bag rice package that is based on portion size and intended to promote smaller and more appropriate portion sizes.

The portion-based system is designed to disrupt current behavior patterns, urging users to adopt more durable portion control habits. The approach consists of three innovative packaging solutions that are both eco-friendly and practical for cooking.

1. **Biodegradable Materials:** Innovative biodegradable materials made from natural sources like cornstarch or sugarcane could be explored for use in packaging rice for cooking. These materials are eco-friendly and can be designed to be heat-resistant.



Figure 18: Al generated image (gencraft)

2. **Edible Packagin**g: Edible packaging made from materials like seaweed or edible films could be a novel solution for cooking rice directly in its packaging. These materials are safe for consumption and would eliminate the need to remove the rice from the packaging before serving.



Figure 19: AI generated image (gencraft)

3. **Mushroom Packaging:** Mycelium, the root structure of mushrooms, can be grown into custom shapes to create biodegradable packaging materials. These materials are heat-resistant and compostable, making them suitable for cooking applications.



Figure 20: Al generated image (gencraft)

Final reflections

Packaging Solution Inspired by Asian Culture

The proposed packaging solution gets its inspiration from Asian culture, where it is widely accepted to use natural materials to package food. Traditional methods are aligned with this approach and sustainability is emphasized. However, our initial survey, workshop, and resulting solution revealed a mismatch. Studying rice consumption from an Asian perspective would have been more insightful, given its cultural relevance. The workshop participants were Swedish, leading to less diverse responses than the broader survey. As a result, the redesign solution we developed may not be as effective in European cultures.

Cultural Considerations and Behavioral Control

Designing the package in a cylindrical form was an idea that emerged when considering behavioral control. Users could potentially regulate their intake by feeling that there is more content in the package using the perception of depth. To validate this hypothesis, further testing is necessary. The shape, structure, and overall design of the container will vary between cultures. What works in one culture might not work in another, influencing behaviors and norms around food consumption.

The way people perceive and interact with food packaging is greatly influenced by cultural attitudes. Many Asian cultures place a high value on minimizing food waste and utilizing every part of the food product. The use of banana leaves for cooking and serving food is a traditional practice that reflects a deep-seated cultural value of sustainability and resourcefulness. The acceptance and effectiveness of biodegradable or edible packaging solutions can be positively impacted by these cultural attitudes.

In contrast, European cultures may not have the same historical practices or cultural norms regarding food packaging and waste. The introduction of biodegradable packaging in these scenarios may require more effort to shift consumer attitudes.

Those cultures that have a tradition of using natural materials for packaging, like many Asian cultures, may find the transition to biodegradable packaging to be simple. Due to their familiarity with the concept and practice, these individuals have a high perception of behavioral control. It is probable that they will consider biodegradable packaging as an extension of their current practices.

In cultures where plastic and other synthetic materials have taken over packaging, there may be less perceived behavioral control over switching to biodegradable options. People might perceive such packaging as inconvenient or unfamiliar.

Life-Cycle Analysis (LCA) and Sustainability Concerns

Another factor we wanted to consider is the Life Cycle Analysis (LCA) of the packaging solution. Questions remain about whether cultivating plant materials for biodegradable packaging is more carbon-efficient than producing plastic. Additionally, we need to consider how the value of the product and packaging can be retained if the entire package is made of biodegradable materials. The complexity of developing a sustainable packaging solution is highlighted by these questions and the need for thorough analysis and testing.

Conclusion

In summary, although the packaging solution is innovative and culturally inspired, its effectiveness may vary across different cultural contexts. To comprehend the full impact of the packaging design on consumers' behavior and its environmental footprint, more research and testing is required.

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