Empowering Designers in a Circular Approach to Organic Waste Management: Sustainability for Food Retail Sectors

by

Derika Elizabeth Taylor

A thesis submitted to the Graduate Faculty of
Auburn University
in partial fulfillment of the
requirements for the Degree of
Master of Industrial Design

Auburn, Alabama
December 14, 2024

Co-design; collaborative; holistic; implementation; management; strategies; sustainability; systems.

Approved by

Joyce Thomas, Associate Professor, School of Industrial and Graphic Design
Christopher Arnold, Associate Professor, School of Industrial and Graphic Design
Jerrod Windham, Associate Professor, School of Industrial and Graphic Design

Abstract

In the United States, approximately 120 billion pounds of food are wasted per year, which equates to about 40% of all total food produced (Recycle Track Systems, 2023). When considering the impacts of the current business model, negative and harmful effects can be seen throughout communities and the environment. Therefore, this paper aims to explore the implications of the U.S. food system post-industrialization to first understand how that system's conditions came to be and how it not only impacts other countries but the planet as well. Then the paper analyzes societal pressures towards improving economic, environmental, and social responsibility through a global and national case study. This aids in validating current methods used and identifying opportunities for circularity within the food system. Finally, it presents a comprehensive framework for addressing organic waste management in food retail sectors through a circular and systematic approach. This provides actionable steps for designers to improve the sectors' environmental responsibility in an adaptable and scalable manner that encourages systemic collaboration between key stakeholders in the U.S. food system.

Acknowledgements

I would like to express my appreciation to the members of the Industrial Designers Society of America (IDSA) and fellow student designers for their insights throughout the development of this thesis. Their passion for sustainable design and innovation have shaped the direction of this research and continue to inspire my career aspirations and applications for the future.

I am deeply grateful to the many individuals I had the privilege of interviewing as the different perspectives offered a rich understanding of the complexities that surround organic waste management. Your contributions have made it possible to develop a comprehensive foundation and meaningful design interventions to achieve true green potential. This potential grew from the diverse information you provided.

Last but most importantly, I want to extend my heartfelt gratitude towards Professor Megan Strickfaden of University of Alberta who spent a significant portion of her business trip to converse with me. Her thoughtful engagement of nearly two months occurred at a pivotal point in this research and opened up new ways of thinking about design in policy and empathy driven service innovations. I am deeply honored to have benefited from her expertise and hope to have more opportunities to share these contributions for the betterment of the design profession.

Dedication

Dedicated to my pillars of support,

To my dearest cousin,

Who constantly motivated and served as an inspiration through her journey to becoming a doctor to pursue graduate studies

To my loving parents and Perrywinkle,

Who provided the love and strength needed to persevere and the moral inspiration for the social problems I dream of improving

To my esteemed professors of the CADC,

To whom I owe my refined design background through diverse, engaging curriculum where they always lifted me up and never hindered my creative scope.

I strive to become the elevated designer you all have nurtured and output good into the world.

Table of Contents

Table of Figures

1 Introduction

When reflecting on food waste dynamics, it is evident that the challenge goes far beyond simply addressing leftover food. By unpacking the food system, one can see how deeply intertwined organic waste is- between production, distribution, and consumption- revealing its complexity and scale. Policies and practices significantly shape how waste is managed, and their impact can either perpetuate wasteful habits or support more sustainable, circular solutions. While both can be seen as catalysts towards a true green future, if industry is working beneath linear economic policies that antagonize this idea, then the presented interventions in practice can serve as the protagonist. This is a glimpse of how the food system presents itself as a wicked problem with a variety of interconnected factors creating a unique problem with multiple solutions.

There are existing strategies that, though promising, still require substantial support to close the loops effectively and that is where this project is beneficial to the cause. A comprehensive approach illuminates the importance of viewing organic waste not merely as a problem, but as an opportunity for systemic change. Although there are more emerging forward-looking businesses that aim to operate with a lower carbon impact, this research helps support the stance of Papanek (1972) where large consuming entities that provide for the masses have an ethical responsibility to manage their operations. By shifting away from linear models of consumption and disposal, industry can integrate innovative waste diversion techniques that not only reduce environmental impact but also create a regenerative cycle that sees the potential in organic waste. Through the implementation of sustainable and circular principles, designers play an essential role in rethinking how waste is managed and viewed holistically.

Therefore, this paper proposes a comprehensive framework for addressing the issue of organic waste management within industry through a circular and systematic approach. This approach provides actionable steps for designers to reduce waste, optimize recycling and composting processes, and enhance overall environmental performance of their clients' operations. Additionally, the implementation strategies are designed to be both adaptable and scalable, while also being formatted for seamless integration into existing systems to encourage collaboration between stakeholders. Overall, the developed tools and resources will allow designers to pitch sustainability as a business case and/or value proposition in their respective sectors. This can start with something as small as a vision statement to engage dynamic thinking to reflect on during a design's development stages (Robertson, 2014). This research was fueled by the early sentiment:

Bringing the food back to the table, serving the community, and replenishing the commons.

This reflects the personal goal of wanting to reducing food insecurity in the United States having seen firsthand the impacts of a complex social problem. The commons represent the environmental conditions of the U.S, where the demand to feed the population leads to a general food surplus that is inevitably wasted. This waste ends up in landfills where the environmental impacts are compounded and negatively impact global conditions. The vision statement allows for this research to consider the human factors that support the food retail industry and strategize for more circular economy applications within their operations. It refocuses design interventions towards the real problem that exists for the U.S. population and work towards building regenerative systems that can adapt to necessary changes.

Every day new conversations and policies swarm around topics of improving human development, but only 37 years ago the idea of sustainability been taken into serious consideration. Despite the campaigns and methods to combat environmental degradation and lower carbon footprints, there are still many opportunities to improve and integrate more sustainable systems. This can be supported through investigation of the intricate dynamics of food waste management in sectors that share overlooked yet similar characteristics. Currently, the ratio of waste output and high ecological footprints between high spenders (industry) and low spenders (general population) serve as a clear example of a disconnect between providing and receiving ends of consumerism. Therefore, this paper argues for reciprocity in waste management in which beneficiaries of resources hold inherent responsibility to contribute back to the systems they benefit from which apply to both high and low spenders.

However, with end users bearing most if not all the disposal burden, industry has an ethical responsibility to users and the environment companies source from to be more informed on improving circularity. While many organizations have come together to protect our finite resources and enforce a level of ethicality, there are more ways to take advantage of sustainable opportunities. The post-pandemic era offers a unique window to reimagine U.S. operations in food retail and advocate for more collaborative approaches in resource management. Drawing inspiration from the earlier vision statement, the Earth is seen not as an unlimited resource but as a shared storefront with finite materials and degrees of repercussions for laxity.

There is this notion that industrial designers are confined to purely aesthetic realms, but this thesis argues that designers can bridge the gap in building sustainable systems as a business case. This research will bridge gaps between design interventions and socioeconomic impacts, thus introducing a new realm to use design thinking to elevate and execute insightful changes within services for the masses. Design can already be considered political through design decisions directly impacting how the intended users will interact with a product or service, and through expanding on this topic this paper aims to culminate greener ideas food retail sectors.

1.1 Problem Statement

The physical and mental barriers between production and consumption have led to excessive waste of usable food and wasted energy potential, especially in a technologically developed country like the United States. This disconnect in resource management is not only detrimental to the sustainability of our collective biosphere, but also to the longevity of modern society. Continued environmental degradation could lead to mass migration, further stressing the current food system. With industry being the common denominator, the research aims to develop an approach to help designers implement sustainable and circular principles into organic waste management. This will allow for material destined for landfills and wasted energy potential to be revalorized for the greater cause of limiting our environmental strain and providing back to the Earth. These methods will also allow designers to make it possible for businesses to achieve its *true green* potential that will further improve community spirit through engagement and interaction opportunities.

1.2 Need for Study

Validating the purpose of study through gaps in literary research.

- *Global alignment to responsible consumption and production*
- *Linear food production models generate massive amounts of organic waste*
- *Organic waste in landfills generate methane emissions*

1.3 Purpose of Study

Finding opportunities within organic waste management to define system that serves community. Overall, to empower designers in sustainable and circular design interventions for their respective industry.

- Create carbon sink networks to replenish local environments
- Create more waste stream diversions to decrease volume sent to landfills
- Create the framework for collaborative, regenerative systems

- Develop approach to empower designers to improve industry environmental responsibility
- Foster interdisciplinary collaboration across industry sectors
- Identify industry demand for sustainable management operations
- Leverage AI applications in resource monitoring and management for streamlined transparency
- Provide actionable insights and strategies to further promote circularity and sustainability
- Understand the psychological factors that contribute to organic waste

1.4 Assumptions

- Designers have the expertise and tools to influence complex system
- Feasibility and priority of interventions will be supported across social hierarchy
- Food retail stakeholders are willing to adopt circular and sustainable interventions
- Stricter government mandates for improved industry environmental responsibility will be applied

1.5 Scope and Limits

- Focused on solutions in food retail sector
- Framework to provide tools for analyzing food waste reduction strategies
- Limited by lack of transparency in operational knowledge and inability to collaborate fully
- Limited by length of research and accessibility to spaces for further R&D

1.6 Anticipated Outcomes

- Creation of more waste stream diversions that will decrease volume sent to landfills
- Composting output of saleable organic fertilizer and biogas applications.
- Developing a system that communicates collaborative efforts towards sustainable consumption and true green models

1.7 Definitions of Terms

Altruistic: seeing the benefits of resources at a cost to oneself (Chakraborty, 2021, p. 98)

Beneficiaries: a person who derives advantage from something; recipient, inheritor (Merriam-Webster, 2024)

Biosphere: seeing the collective whole or the earth, its atmosphere, and living organisms as one entity (Chakraborty, 2021, p. 98)

Commons: a public, shared resource at constant risk due to personal interests (Spiliakos, 2019)

Demand-side waste management: prices whereby consumers use purchasing decisions to communicate to product manufacturers that they prefer environmentally sound products packaged with the least amount of waste, made from recycled or recyclable materials, and containing no hazardous substances (Connecticut Department of Energy & Environmental Protection, 2014)

Ecosystem services: value to society provided by healthy, functioning ecosystems, recognized since 2005 publication of the UN's Millenium Ecosystem Assessment (citation). The four categories of services include:

Cultural: providing spiritual and recreational benefits

Provisioning: providing food, medicine, water, and habitat

Regulating: controlling climate, erosion, flooding, disease, etc.

Supporting: enabling nature to work via nutrient cycles, pollination, etc.

Egoistic: motivated by self-interest (Chakraborty, 2021, p. 98)

Floorscape: a graphic representation of the floorplan where organic waste interactions occur, helps to detail the flows of energy within the environment and visualize potential bottlenecks in operation

Food security: "the all-time access to certain amount of food required to lead a healthy life" and key components include availability, accessibility, acceptability, and adequacy (Chakraborty, 2021, p. 42)

Hedonic: motivated by immediate pleasure and avoiding long-term gratification (Chakraborty, 2021, p. 98)

Life Cycle Analysis: sometimes referred to as fuel cycle or well-to-wheel analysis, is used to assess the overall greenhouse gas (GHG) impacts of a fuel, including each stage of its production and use (EPA, 2024)

Lobbying: seek to influence (a politician or public official) on an issue (Oxford English Dictionary, 2024)

Sector: a sociological, economic, or political subdivision of society (Merriam-Webster, 2024)

Sustainability: "as an idea and as a professional discipline…refers to humanity's rapidly-evolving response to the urgent planetary challenges we all face, a response that includes emerging professional opportunities" (Robertson, 2014, p. 3)

Sustainable Systems Engineering: the interdisciplinary field focusing on how to design and manage complex systems over their life cycles, with a goal of environmental, economic, and social sustainability (University of Calgary, 2024)

Taskscape: crucial analysis of workflows better understand the interactions that lead to organic waste, helps to identify target areas for intervention

Triple Bottom Line (TBL): "three E's sometimes also referred to at the three pillars of sustainability or as planet, people, profit…can stand for environment, economics, and equity" (Robertson, 2014, p. 5)

True green: characterizes an establishment or operation that consider system factors holistically to create practices that are undeniably sustainable and circular

Urban ecology: studying the relationship and interactions between a society and its environment (Charter, 2001, p. 152)

Valorization: the act of increasing the value or importance of something, or the process of making something valuable or useful (Cambridge, 2024)

Weltanschauung: identifies the intellectual perspective of the designer as an integral part of the design process (Buchanan, 1992, p. 16)

2 Exploring Implications of the Food System in the Post-Industrial Era

In our modern society, there is no longer a question of whether humans are negatively impacting our environment, but rather a question of how to quantify the effects of our impacts and find middle ground to counteract change. While there has been considerable progress in implementing eco-friendly initiatives to optimize processing and create a sense of global responsibility, these solutions may not be right for every organization and thus not maximizing the full potential of sustainable strategies. The unique position of an Industrial Designer allows us to carefully evaluate the considerations and constraints of a business to align its goals to the designed end vision. This literature review seeks to explore aspects of organic waste management within various sectors to find the best opportunities for designers to help industry be more circular (both in design and economy). By studying existing literature, design initiatives, and technology applications, consideration factors can be identified and evaluated that will aid in the design approach development through emphasizing a sustainable model for a circular economy.

The following section, Exploring Global Perspectives on Organic Waste Management, will use the Literature Review as a foundation to understand how the successful components of regional studies work together and gain insight on outlining practical implementation strategies. By integrating these findings, the complex challenges of waste management can be more fully comprehended, which allows the final approach to be more empowering to designers. The topics developed in the following sections take a holistic and systematic approach to support the research process and validate the need for sustainable design interventions within the food system.

2.1 Historical Figures in Conservation and Sustainability

When reflecting on historical contexts and perspectives, there are a series of trends that became more prevalent over time. As outlined by Robertson (2014) there were many important figures throughout the emergence of sustainability as a response to modern development and its complex relationship with the natural environment. In 1798, Thoms Malthus predicted inevitable population growth that would cause premature deaths, while Henry David Thoreau was one of the first Americans to consider and question our natural resource exhaustibility. Ultimately this sentiment was affirmed in 1864 by diplomat and historian George Perkins Marsh, who used scientific reasoning and statistics to illustrate the rise and fall of past civilizations due to over consumption of resources. Finally, in 1890, naturalist John Muir argued the intrinsic value of national parks and the need to save the diminishing wilderness. This led to the formation of the Sierra Club and Muir is considered the founding father of the national parks system.

Following this, U.S. President Theodore Roosevelt emerged as a 'passionate conservationist' and took many initiatives to the cause within his terms (FWS, 2024). Regarding the natural environment, he held a personal appreciation for the land he hunted and fished on. This led to the first National Wildlife Refuge to protect endangered pelicans and the passing of the Antiquities Act protecting the Grand Canyon and land that later became national parks, and vast additions of land to the federal forest reserves. This is an influential resolution where the top-down example of understanding longevity led to the long-term impact of the Theodore Roosevelt Conservation Partnership. This exemplifies his post-term actions in 1912, saying "There can be no greater issue than that of conservation in this country" (TRCP, 2022) which stresses the importance of federal regulations and individual responsibilities of protecting these spaces for future generations.

Later in Robertson's (2014) timeline, the Brundtland Commission was formed as an urgent call by the United Nations General Assembly to acknowledge the growing concerns of human impacts on the environment and ultimately enforce "a global agenda for change" (UN World Commission, 1987, p. 5). Their main objective was to become more unified in "updating the environmental dimensions by focusing on global environmental systems and their absorptive and carrying capacities and by embarking on a globalist view concentrating on the interdependencies of North and South" (Charter, 2001, p. 24). This is an interesting point to observe the industrial and cultural differences between the north and south U.S. or east and west coasts, where the fast-paced cosmopolitan views parallel the traditional agriculturally based ones. Although the commission only operated from October to December of that year, their efforts were communicated throughout the goals later implemented by the UN.

The members ended this milestone meeting with the final report, *Our Common Future*, defining sustainable development as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (UN, p. 41). This was the first time the phrase was introduced into international policy debate and established a new global paradigm. Even today, this is the commonly known characterization of sustainability, yet the disconnect between sentiment and visible action is becoming increasingly more noticeable as operational differences in countries' management are compared.

Since then, a variety of regulations and powerful organizations have come together to combat human impacts on the environment; however, the general U.S. population still has a disdain for how our resources are managed. This is visualized, see *Figure 2.1*, through the 67% of Americans that think large corporations are doing too little in reducing climate change effects. Additionally, 56% of them say that the federal government is doing too little (Tyson, 2023). At first glance, these statistics undeniably validate the need for sustainable measures across the economic and social realms.

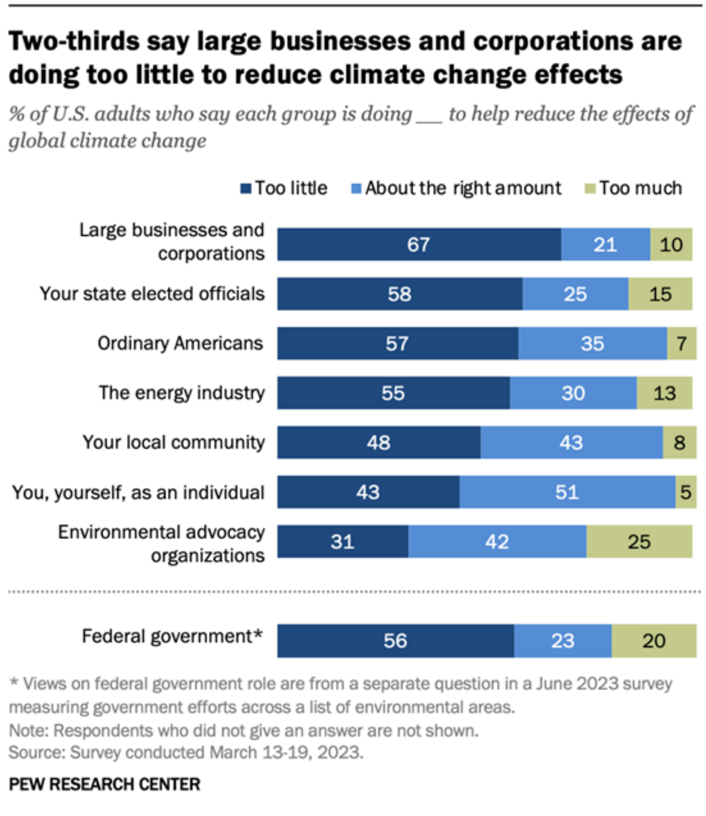


Figure 2.1 Survey attitudes towards industry and their effort to reduce climate change (Tyson, 2023)

Before blindly taking these statistics as absolute, it is important to engage in empathy for the people and where they are coming from. In their defense, there is little consensus about what corporations or governments say they are doing when the effects are not prominent and it is very difficult for a normal person to extract this information, thus making it even more apparent our efforts are minimal in comparison to other economic powers. However, it is essential to bridge the disconnect between perception and reality within the aspects of sustainable food waste management to improve a business' ethical responsibility. This begins by highlighting what users currently know and how before determining what they need to know about industry practices to advocate for greater transparency and accountability through design.

2.2 Conditions of the United States

Forty percent of the total food supply is wasted per year between stages of production to retailers, which equates to about 60 million tons/ 120 billion lbs. or about 325 lbs. per person. Additionally, 30% or about 16 billion lbs. per year of food in grocery stores is thrown away. In total, food makes up 22% of municipal solid waste (Recycle Track Systems, 2023). These statistics are staggering with the amount of food insecurity the U.S. alone faces (see figure 2-2), where in 2023 the U.S. Department of Agriculture measured 18 million households throughout the year (USDA ERS, 2023). Visualizing the environmental and social problems within the food system provides a different perception of a broken system to help support a shift.

Could these conditions be the result of consumer marketing and store layout with influential suggestions leading individuals to buy more than they need? Could it be due to the inventory management system and demand leading to mass waste? Could it be caused by dining contexts that enforce no takeaways? The topic of food waste begins to highlight the shortcomings industry has in the grander food system, but also the many trends and tendencies within the population to combat an inherently wasteful systems. Therefore, the current research begins by investigating the current conditions of waste management to see where organic waste comes into processing and ultimately answer for how to support designers in reducing food waste in the post-industrial era.

Starting with the population, this research must understand the wants and needs from their providing food retailers as well as behavior over time to see how those actions directly and indirectly contribute to the issue of food waste. The 1950's can be seen as the start of relevant trend fluctuations in the United States due to major cultural and societal changes during wartime. There was a big push to maximize U.S. resources and minimize consumption for the greater cause, the war efforts, and the nation collectively supported these sentiments through conscious behaviors. Ultimately during this time, the agricultural sectors were able to boost production through newly discovered chemical compounds and synthetic fertilizers (Robertson, 2014). Most notably, this led to the publication of the 1962 *Silent Spring* by biologist Rachel Carson who eloquently and scientifically broke down the possible negative outcomes of these newfound compounds. The reason it was so influential was due to how she decoded these complex concepts for the average person to understand the true negative effects of poor environmental practices. This was only further supported by other environmental crises, such as the Cuyahoga River fire in Ohio and seeing Earth from space leading to the official creation of Earth Day and the U.S. Environmental Protection

Agency in 1970 (IISD, 2012). From here, not just the United States but all of humanity had a new perspective about our place and impact on this finite planet.

This was the first major paradigm shift in reevaluating personal consumption and footprints as well as general resource management. Relating this shift back to the topic of food waste, there was a following movement in the mid 1990's called freeganism of communities of people who refused to engage with the typical consumer economy and instead find sustenance from discarded usable items (Cooks, 2017). This concept was highly unconventional as these individuals were perceived as typical hard-working Americans and not 'dumpster divers', yet it began to further bring visibility to the issue of sustainability and showcase the excessive and unethical practices of capitalism. This also begins to highlight the socioeconomic consequences of linear management methods in food retailers and outline responsibility towards the commercial industry.

It is also essential to consider where families choose to live and why, as location is a major influence on how they consume and interact with their suppliers. In short, people in the U.S. went from mostly providing for own and bartering with the community to the occasional outsourcing of meals at a restaurant due to costs, to it becoming normal to frequent food retailers due to the efficiency of services. This is seen during the Great Migration in 1910-1970 and general urbanization patterns since through surveys conducted by the U.S. Census Bureau (USCB, 2024). As the population becomes more dependent on industry to supply what used to be cultivated, people could choose new careers not relating to agriculture and build other aspects of society. However, this has led to a startling realization that many have lost touch with how exactly food is produced, what goes into the process, and what truly comes out.

Today considering both pre and post pandemic conditions, consumers have started to change what they buy and the way they shop with 5.6% of them diverting to the online route (FMI, 2023). Most notably, the recent movements in farm to table, where the emphasis and conscious effort to source local, organic ingredients illustrate this change. This sentiment is also seen within specific industry sectors that can truly focus on community development, such as restaurants in collaboration with local farmers. It is important to contrast and understand food insecurity and resource management for rural vs urban communities to create unique solutions that consider local conditions and needs.

“Food security is defined as the all-time access to certain amount of food required to lead a healthy life” (Chakraborty, 2021, p. 42) and key components include availability, accessibility, acceptability, and adequacy. These components immediately stand out as opportunities for consideration when emphasizing disconnects in the system where food is discarded and loses potential for circularity. When comparing food security status in the U.S., shown in *Figure 2.2*, the 13.5% of food-insecure households (USDA ERS, 2023), it is disheartening to see that households contribute 36% of total food waste or around 42 billion lbs. (Feeding America, 2024). The idea of an urbanite originated during the Great Migration when people migrated to the city for work and slowly lost their sense of touch regarding agricultural practices that sustained them in the past. This created a distinction between the ‘wealthy working class spenders’ and the ‘poor providing farmers’, which perpetuated an elitist mindset that ultimately left most of the population to be ignorant on where our food comes from and where it goes. While more awareness has developed, there is a still lack of behavioral changes due to no incentives to reduce organic waste.

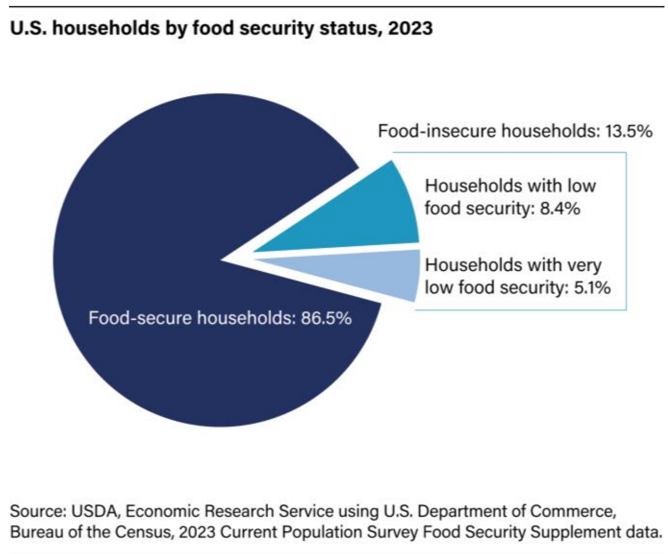


Figure 2.2 U.S. household food insecurity (USDA ERS, 2023)

The need to create more of a connection with how our food is produced and where food is consumed can support waste reduction through educational and interactive experiences for both customers and employees. This concept helps support the development of future observation tools by highlighting disconnects within the system to learn more about in the specific context to implement.

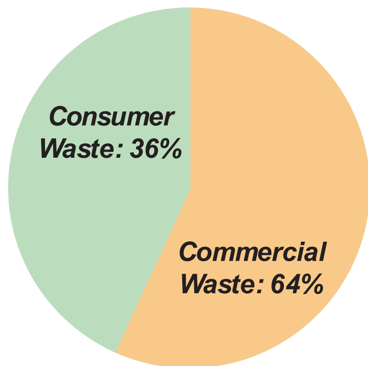


Figure 2.3 Food waste contributions of consumer vs commercial segments (Feeding America, 2024)

Transitioning into the industry impact, see *Figure 2.3*, which has a 64% contribution to food waste (Feeding America, 2024), the current research shifts to discover what aspects of their processing consumers might not understand in terms of sustainability and how to improve transparency and ease of effective disposal. The higher strain of industry on degradation alone should be the main reason for them to have a greater ethical responsibility; however, their focus is directed at profits and growth. While there are regulations in place, there seems to be a disconnect between monitoring and enforcing them which allows industry to often avoid repercussions of bad practices. When trying to create a business case for sustainable design, there are many opportunities to validate various design interventions based on how one approaches the challenge.

2.3 Interdisciplinary Efforts

This subject requires an adequate understanding of the behaviors for a specific community before applying the same thinking process to the local providing retailers. Overall, starting with psychology factors provides insight into being able to empathize with how humans handle environmental issues through four main viewpoints on the world (Chakraborty, 2021, p. 98):

Altruistic- seeing the benefits of resources at a cost to oneself.

Biosphere- seeing the collective whole or the earth, its atmosphere, and living organisms as one entity.

Egoistic- motivated by self-interest.

Hedonic- motivated by immediate pleasure and avoiding long-term gratification.

Considering the range in how individuals and entities are motivated, whether intrinsically or extrinsically, determines their engagement with pro-environmental actions. From here, one can then evaluate the best methods to encourage engagement through design interventions, which can help leverage psychological insights to raise awareness and improve communication. Additionally, this allows for barriers to change to be understood to design systems that are easier to adopt and maintain. Designers can provide value to businesses by transforming operations with solutions that align with human needs for deeper engagement and environmental responsibility for long term success.

"The Psychosocial model of pro-environmental behavior for sustainability has to be validated by the researchers before implementing… focuses on basic human values which place emphasis on understanding group dynamics, culture and hedonic values" (Chakraborty, 2021, p. 108). The importance of emotional and social factors is clear, where positive responses can increase commitment to long-term engagement with these designed systems. By considering the overall perceived value of a true green model, the population should feel supported in their habits and present just the right technology for the time needed. Designers can greatly benefit from thinking intuitively about organic waste management to leverage feedback to create the right experience. *Figure 2.4* begins to outline ways to maintain long-term engagement with a more integrated food system.

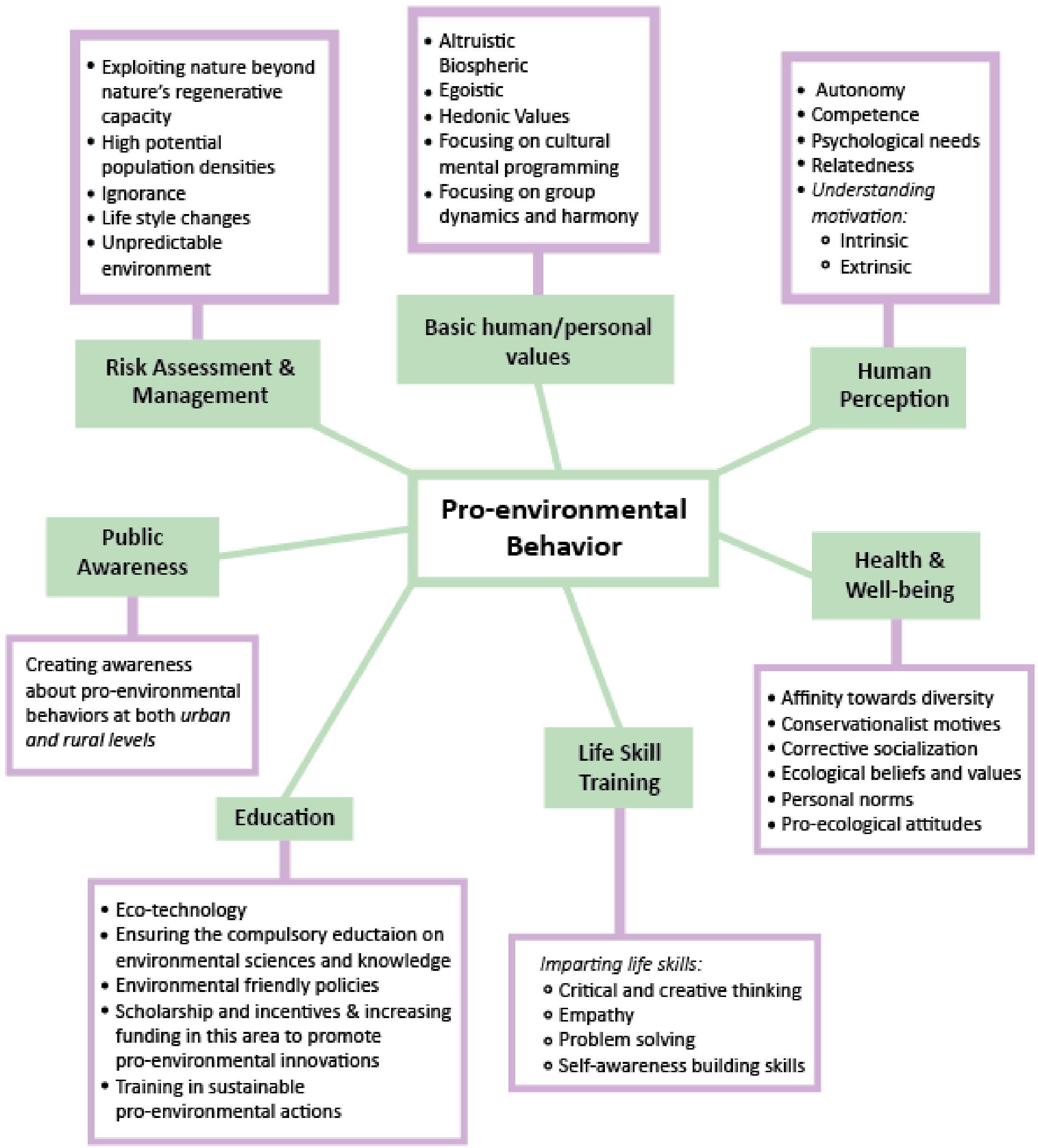


Figure 2.4 Adapted from Psychosocial Model focused on pro-environmental behavior for sustainability (Chakraborty, p. 108)

Behavioral influences towards the environment is described by Roberston as "biophilia, the genetically encoded emotional need of humans to affiliate with nature with other living organisms, evolved as an adaptive mechanism to protect people from hazards and to help them access resources such as food, water, and shelter" (Robertson, 2014, p. 302). The author points out that while this is an evolutionary advantage to be able to gain resources, it is ultimately a weakness as it relies on learning and experience to become integrated with nature. However, it is possible to consider the learning process as a positive influence on consumption and circular network development when it highlights collective adherence and engagement with sustainable behaviors.

The initial inspiration for rethinking where design interventions can be used comes from Victor Papanek's sentiments in *Design for the Real World.*

> *The designer's responsibility must go far beyond these considerations. His social and moral judgement must be brought into play long before he begins to design…will his design be on the side of the social good or not.*
>
> *(Papanek, 1972, p. 66).*

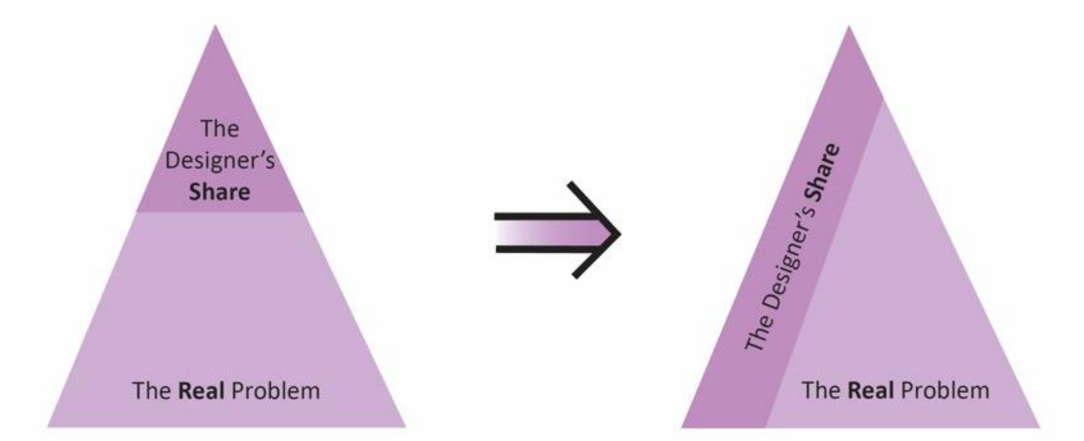


Figure 2.5 Adapted from diagram 1 (Papanek, p.68)

This sentiment frames how design can be political in the sense that it directly influences how the population and environment interact with each other. He argues that designers tend to work solely for manufacturing and maximizing margins, while simultaneously ignoring the real problem. He states that "there are professions more harmful than industrial design, but only few" (Papanek, p. 14) in the sense that we have the methodology to create holistic solutions but due to a variety of reasons instead deliver designs that do not consider the product's life cycle or the environment. Presented above in *Figure 2.5*, the first triangle illustrates the traditional position of an industrial designer, where the scope of their problem is limited solely to the design implications and current conditions. However, the nature of the profession allows us to serve as a bridge between the population and industry, which brings up the opportunity of responsibility. It is important for designers to also consider the social and environmental design factors rather than solely consumerist principles which may lead to planned obsolescence. By making the intentional shift represented by the arrow, designers can empathize with the needs of their target design groups while also considering the manufacturing concerns regarding environmental impact. This means finding balance between resource consumption and the real problem, represented by the second triangle. This core issue is the degradation of the commons stemming from industrial production and can be mitigated through improved resource management. By focusing and expanding on this real problem designers can be empowered to work across the social hierarchy and collaborate with U.S. industries, as illustrated later in *Figure 2.6*. These actions will allow designers to position themselves as agents for change and capable of solving socio-economic problems in a creative and circular way.

This argues the need for improved accountability in food retail operations and impactful efforts when handling issues surrounding the food system. The moral implications of so much usable food going to waste and increasing harmful emissions while so many households remain food insecure, are socially and environmentally illogical. However, this way of operation can be viewed with a new approach to improve circularity and resource management across the food system. When designers are empowered to push for sustainable interventions in their respective industries, the shift to true green potential is marketed as a differentiating factor within the food retail industry.

As mentioned, the perceived intentional avoidance of environmental responsibility is a common sentiment in the nation, yet oftentimes a designer can only do so much within their realm of constraints. *Figure 2.6* illustrates the dimensions of a design problem and the flow of information/power within the consumer economy. Here one can see the correlation between Papanek's first triangle where a portion of an issue is handled typically by higher power entities in the social hierarchy. The one-way flow in blue highlights this top-down regulatory framework that should be followed in accordance with the one-way flow in orange, where appropriate feedback and incentives are established as a balancing loop. Instead, what has been occurring is that the flow of top-down actions has led to harmful EES consequences for both the U.S. and global population. Additionally, the lack of integrating feedback of the population's true needs has allowed industry to get away with unethical operating practices.

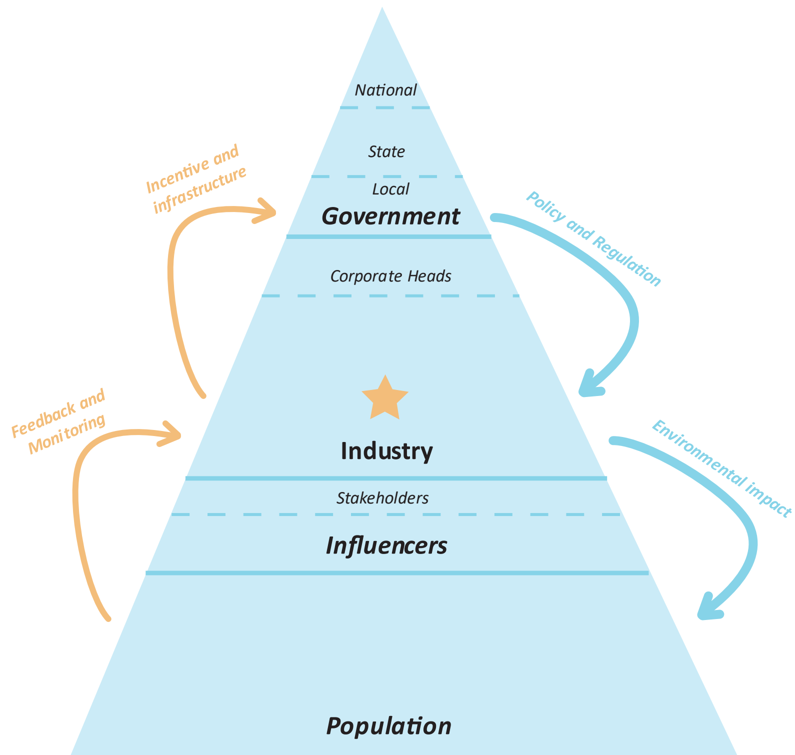


Figure 2.6 Social Hierarchy of the consumer economy in the United States

Existing linear business models pass the disposal burden onto their consumers while also expecting them to pay for the product/service. When one considers the scale at which this happens, industry should be expected to utilize more recyclable materials or have the means to collect specific waste types. However, often the products in the food retail industry are overpackaged with single use plastics and containers such as ready-made meals or to go orders. Furthermore, this exists in bulk shopping where packaging is often incompatible with local recycling streams and leave consumers morally responsible for landfill disposal such as chip cans and water bottles. It is not as simple as standardizing recycled material use as companies lack investments in reprocessing technology despite high profit margins, which has only further pushed their environmental responsibility on to their users. These invisible barriers under the false pretense of convenience harm the morale of consumers, leaving them feeling unsupported by powerful stakeholders in their efforts to be less wasteful. There is a clear disconnection that does not allow food retail services to meet the performance and standards needed by the population and the environment.

Papanek (1972) suggests that designing for specialized problems is what we as designers inherently do, so applying design principles to reduce the impacts of consumerism is beneficial to society and our finite planet. Applying this concept to food waste in the United States, there are many barriers to understanding general waste management and/or any sustainable endeavors in communities. This can be seen through a lack of clear knowledge in landfill locations or awareness of environmental impact due to cultural norms. However, this lack in human capital serves as an opportunity to create connections and interactive experiences that support wase reduction efforts. Designers can be empowered to support the population in engaging with sustainable systems through a bottom-up paradigm shift that transitions the interactions needed for improved organic waste management to be visibly impactful and physically rewarding. This would create balance in the power consumers and industry holds to coexist and regenerate rather than compete and deplete collective resources. This influence on government policies strengthens the designer's position as the bridge between complex socio-economic issues and creates more flexible systems.

Another essential framework that shaped the research were the problems defined by Horst Rittel and Melvin Webber in the 1970's. The synthesis of their work considers complex social or cultural problems with an unknown number of potential solutions.

They note 10 distinguishing properties of these 'wicked problems', which have been further illustrated in the *Appendix* (Buchanan, 1992, p.16):

1. Wicked problems have no definitive formulation, but every formulation of a wicked problem corresponds to the formulation of a solution.
2. Wicked problems have no stopping rules.
3. Solutions to wicked problems cannot be true or false, only good or bad.
4. In solving wicked problems there is no exhaustive list of admissible operations.
5. For every wicked problem there is always more than one possible explanation, with explanations depending on the Weltanschauung of the designer.
6. Every wicked problem is a symptom of another, “higher level," problem.
7. No formulation and solution of a wicked problem has a definitive test.
8. Solving a wicked problem is a "one shot" operation, with no room for trial and error.
9. Every wicked problem is unique.
10. *The wicked problem solver has no right to be wrong- they are fully responsible for their actions.*

These principles ultimately stress the importance in implementing interventions as resolutions, as they can only be evaluated and are unable to be tested before implementation. For designers, this concept requires a continuous refinement cycle due to the finality of actions and is even more difficult to test as simulations can only explain possible outcomes. The most important thing to note about these wicked problems is that the nature of how one frames the problem will directly influence how the solution develops, and because there is no one definitive correct solution it is essential to pull in all resources to make considerations. The topic of the food system was introduced as a wicked problem due to the variety of interconnected variables and the idea of one-shot operations. This is directly related to these principles as a designer working towards organic waste reduction as the food system has been presented as complex, interconnected, and resistant to simple solutions. It is clear there is no all-encompassing solution to the problem of organic waste management, however, by viewing the U.S. food system as a problem needing solutions in sustainable systems will allow designers to create adaptable components for targeted pain points.

2.4 Initiatives and Organizations

Despite the existence of a network of global and national groups with specialized goals towards environmental issues, there is still confusion, and disparities do not allow them to work seamlessly thus decreasing chances for large impact. For example, the origins of the 'polluter pays' principle started in 1972 with the Organization for Economic Co-operation and Development (OECD) trying to enforce environmental justice (Trancon, 2022). This would start to hold industries accountable for the byproduct impacts of their business and give underprivileged communities support. And according to the global coalition Environmental Justice Organizations, Liabilities and Trade (EJOLT) "environmental taxes can go a long way in helping to preserve environmental quality" (Crump Law, 2022) where the state may be responsible if a polluter is either not identifiable or insolvent. Ultimately, being responsible can be a motivation for policy makers to uphold environmental laws and increase monitoring. The idea of the main consumers not having much input, yet directly or indirectly contributing to the degradation of communities represents the lack of feedback and transparency.

The related initiative for environmental responsibility could include sustainability reports, which have been around since the 1970's, but not standardized or enforced throughout industry until the development of Environmental, Social, Governance or ESG reports (Anderson, 2023). This updated approach to holistic business practices is a good direction in accountability and showcases a desire to maintain high standards to report on. Included in ESG reports are statistics and information on environmental, social, and governing factors however the U.S. Securities and Exchange Commission (SEC) only requires companies to report on information that may be material to investors. By considering ESG-related risks, industry started to guide decisions to a more sustainable and socially responsible future. Additionally, in June 2021 the U.S. SEC proposed the ESG Disclosure Simplification Act to cover 5 main topics to go into effect in 2023: ESG metrics, political spending, pay raises, climate disclosures, tax havens and offshoring (Congress, 2023). This further improves industry accountability to ensure their operations are considering those environmental factors and provides transparency for consumers to make more informed decisions. Additionally, by having these reports mandatory with specific criteria to cover there is a level of societal and industry pressure to not be perceived as having poor practices in comparison to others. Ultimately, these types of effort help push industry and consumer behaviors towards pro-environmental frameworks.

As mentioned before, the Environmental Protection Agency was founded on December 4, 1970 (EPA, 2024). Delivering a 37-point message on the environment, President Nixon created a council to organize federal government programs to reduce pollution. By consolidating environmental responsibilities under one agency, the goal was for them to be able to handle matters better than previous initiatives. With this, the EPA has done a tremendous amount of work towards these efforts and holds most of the responsibility for enforcing regulations. Most relevant to the topic of food waste, they

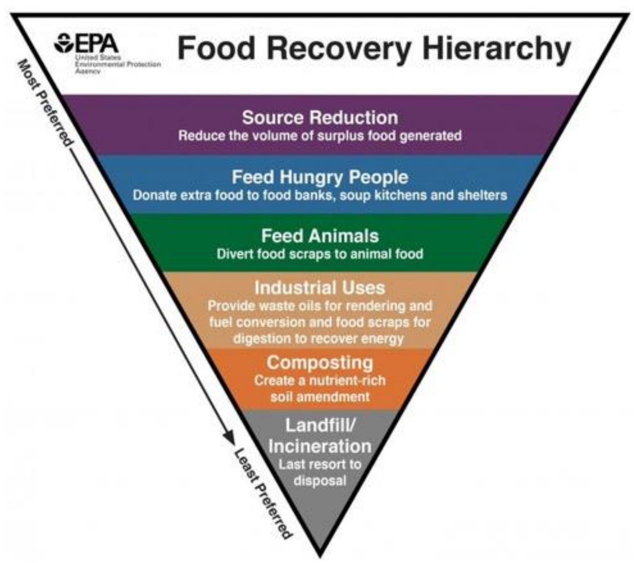


Figure 2.7 Food recovery hierarchy as proposed by the U.S. EPA (EPA, 2024)

put out the Food Recovery Hierarchy, see *Figure 2.7*, as a resource and food waste reduction goal as a monitoring tool. The visual utilizes psychology to better understand the different decisions at different steps of diverting waste. This concept is a suggestion to be applied for both consumers and producers to align with ecofriendly goals (EPA, 2024). Additionally, they are responsible for the U.S. 2030 Food Loss and Waste Reduction Goal guidelines that were proposed on September 16, 2015. This was the first domestic goal to address climate change, food insecurity, productivity and economic efficiency and conservation of energy and resources. Through the hierarchy and other tools, they aim to target output and management to achieve a 50% food waste reduction goal.

Another key partnership pushing organic waste reduction is the U.S. Food Waste Pact which follows successful initiatives to demonstrate the benefit of businesses working towards sustainability goals. The national voluntary agreement is led by ReFED and the World Wildlife Fund, aligned under the global framework of "Target, Measure, Act" to help food retailers reduce organic waste (US Food Waste Pact, 2024). Most notably, their efforts in pilot projects support the testing and implementation of scalable, cost effective, high impact solutions by working with stakeholders across the system. Additionally, the agreement is improving awareness and transparency for sustainable interventions by publishing all findings from said projects as well as a comprehensive analysis of the statistics from the year. Overall, the pact is creating scalable efforts across sectors to manage organic waste directly and cooperatively.

While there are many definitions that exist for the term circular economy, the EPA defines it as keeping materials and products in circulation for as long as possible (EPA, 2024). Additionally, they stress its importance in addressing the climate crisis and the potential to improve economics and elevate social justice. With this they have outlined principles for sustainable materials management (SMM), which is a systematic approach to using materials more productively over their live cycle. As a federal regulation entity, they have established goals and strategies to be less resource intensive and recapture waste as a resource. Overall, the EPA validates the importance of reducing organic waste volume to reduce landfill methane emissions while providing support to willing industry participants with educational strategies and materials as well as funding.

Another key player supporting efforts, the United Nations Development Programme (UNDP) has been working to uphold the Paris Agreement which is a voluntary global initiative to help "limit average global temperature rise to below 1.5°C, adapt to climate impacts and attract sufficient finance to support these efforts" (UNDP, 2023). Their efforts are mostly to support developing countries in reducing their environmental impact by focusing on the thematic pillars: adaptation, mitigation, carbon markets, forests and policy. Additionally, the UNDP has the largest climate portfolio in the UN system and has supported climate action in more than 140 countries with a portfolio of over U.S. $2 billion in grant financing. Importantly, the portfolio leverages strong links with UNDP's expertise on gender equality, energy, nature, poverty, health, finance and climate security to provide the correct resources. In terms of applicability to the research, they have defined another example of circular economy that can be promoted to countries of aid. They note that a circular economy aims to minimize waste and promote sustainable use of natural resources, through intentional product design, recycling of materials, and regenerative systems. With this economic model, complex challenges such as climate change can be addressed and through supporting economic, environmental, and social changes, the organization is able to build the countries' foundations in a sustainable manner.

Currently, there are 5 landfills active in the US and over 6, 100 closed since 1988 that now serve as repurposed land (EPA, 2009). The EPA initiated the Landfill Methane Outreach Program (LMOP) that provides key data on municipal solid waste (MSW) landfills and landfill gas energy projects, although the outreach is voluntary per industry stakeholders. The LMOP works cooperatively to reduce methane emissions by putting out reduction rate goals, monitoring data collection, and encouraging the recovery and use of biogas generation. While this is a great initiative to align the U.S. consumption rates with the global agreements, there are still many hidden factors to waste management that feed into the disconnect between how the operation works vs should work. For example, the voluntary nature of the program does not support the needs of sustainable systems with a lack of engagement and incentive to 'buy into' the system. Additionally, the data the LMOP provides currently is limited to research in energy projects and does not explain how waste is quantified and monitored or the waste streams for input into sustainable systems. This increases the barrier to industry taking actionable steps to operate in a true green manner with invisible actions that ultimately impact the commons. This idea will later support case study research points for comparison in transparency and method of data collection/feedback.

The government coming together to consolidate individual agencies with similar goals has been very impactful in how many measurable actions can be done. Applying this on a micro level, the concept of a high impact stakeholders in the food system being able to collectively support the environment they benefit from can have a domino effect and contribute to a circular, sustainable economy. One example, the emergence of more specialized recycling and composting efforts through organizational efforts and regulation enforcement. The Recycling and Composting Accountability Act (RCAA) serves as legislation to cover standardization and increase in identifying national composting infrastructure challenges, improving recycling data measurement and reporting, transparency on end markets and diversions, and evaluation of federal recycling practices (Congress, 2023). Following this development, the U.S Composting Infrastructure Coalition established composting infrastructure leading to the COMPOST Act in 2021 which awarded $2 billion in grants and loans for food scrap composting. (USCIC, 2024).

2.5 Design and Standardization

Beyond the design approach described later in this thesis, there are many influential design organizations and resources that have addressed circular approaches to sustainability that have aided in validating focused design interventions and developing methods to achieve them. Four are described here, starting with The Okala Practitioner (2013). This is a well-recognized tool for all design disciplines that aims to promote the integration of ecological design, due to its holistic views stemming from over a decade of research and development by professional IDSA (Industrial Designers Society of America) members. Additionally, the information in the guide has been adapted over time to better support industry through a variety of strategies. The most prominent for this research is the Ecodesign Strategy Wheel, see *Figure 2.8*, that outlines sustainable approaches according to the stages of the life cycle to reduce its overall ecological impact of the product, system, or service. The wheel helps facilitate brainstorming improvements and considerations for eight categories corresponding to the PLC (product life cycle) stages to be more ecologically responsible.

Figure 2.8 Ecodesign Strategy Wheel (White, 2013)

Overall, the Okala tools are powerful for designers to help consider the possibilities within the total life cycle and will aid research development in Chapter 4 by serving as a foundation to build targeted sustainable design strategies from. For further information regarding ecology for designers and more from this organization, one can look toward the Okala Educational Presentations found at Okala Practitioner. The most relevant chapters to understanding the conditions and dynamics of organic waste management include but are not limited to 3, 4, 9-14, and 16-18.

The Design Council, while focused on British industry, started by promoting practical improvements during post-war economic recovery in 1944 and has become the national strategic advisor for design. Their integration into social work services has been a monumental milestone for the discipline as it promotes an industrial designer's ability to communicate and bridge the gap between consumers and industry by providing human centered solutions. The organization has published a variety of technical magazines, hosted design summits and workshops, and started many initiatives. Since 2020 they have been working towards more environmentally focused goals and in March of 2023 announced their next big five-year mission for the British economy, Design for the Planet, which challenges designers to view earth as the key stakeholder and evaluate aspects of how we live for opportunities to address the climate crises and achieve net zero emissions. This initiative provides more support and visibility towards environmental issues and the call to action as well as acts as a positive example for other countries to implement (Design Council, 2024).

With a diverse and rich network, the organization has put forth many resources for designers and non-designers to design inclusively and for the planet. One of the most familiar and universally accepted models is the double-diamond that depicts the design process, see *Figure 2.9*.

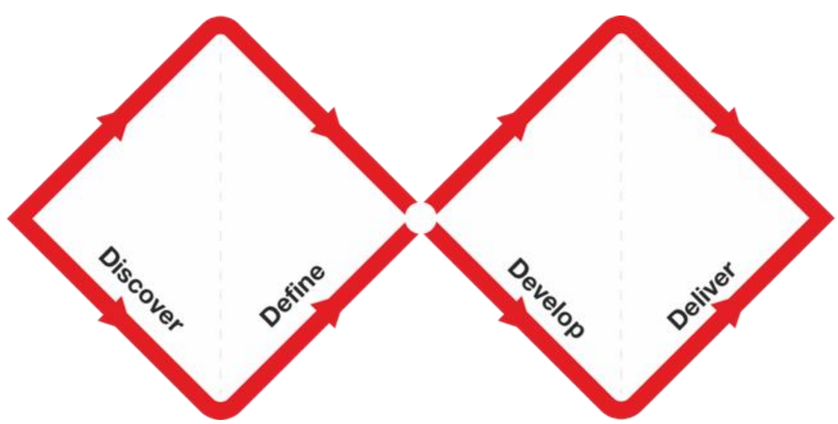


Figure 2.9 Double Diamond from Design Council (Design Council, 2004)

Additionally, the proposed seven tenets of human-centered design are powerful as a set of steps to reality check oneself during the research process and ensure empathy stays in the forefront. These principles include (Design Council, 2024):

1) *Get past your own great idea*
2) *Do not be restricted by your own knowledge*
3) *Spend time with real people in real environments*
4) *Identify other users*
5) *Follow your users leads and needs*
6) *Think about the whole journey of the product*
7) *Prototype and test your idea*

For further information regarding the role of design in policy and more resources from this organization, one can look towards Make life better by design - Design Council (2024).

IDEO is a multidisciplinary group of makers leading the way in design research for products, services, brands, and experiences with over 40 years of experience. The organization is well-known for their consulting capabilities and sustainable strategies that transform businesses, governments, and communities. The organization also put forth a guide to human centered design but in a more thorough framework broken into three digestible phases- inspiration, ideation, implementation. Later, one can see the relationship between the designed *Approach Card Set* and the IDEO nature cards presented in their guide that act as a segue for ideation and inspiration. The supporting material for ideation and development is especially impactful in providing users with a tool to interpret and communicate information effectively. Lastly, designing for public services is a good tool that guides the designer through unknown social/political realms using familiar design thinking. It would be beneficial for those looking towards co-design and strategies to ensure tasks lead to adaptable, mutually beneficial partnerships. For further information regarding the role of design in policy and more resources from this organization, one can look towards IDEO - A Global Design & Innovation Company (2024).

Lastly, the World Design Organization (WDO) is a key player when it comes to promoting industrial design as a profession. Advocating and integrating into new realms since 1957, the organization has become an international non-governmental entity and gained UN consultative status. Starting in 2020, the WDO has been working towards a new project that explores design for sustainability in dimensions that directly parallel the Sustainable Development Goals. This project aims to use multidisciplinary teams of design professionals and students to curate content and resources. Additionally, there is the opportunity for designers to submit feedback and develop resources for review that allow the final database to include a variety of strategies and information types. For updates towards the project, one can visit WDO | Resources | Sustainability x Design About (2024).

Within industry there are certain organizations that provide product certifications through scrutinized operations that are ethically recognized and accepted for high quality operations. Additionally, these standards allow for better comparative means by highlighting product shortcomings through supporting assessments. These factors are essential to impacting the top-down flow of responsibility of industry and empowering systems that facilitate improved waste stream diversions.

Most notably, the ASTM International was formed in 1898 and is one of the largest international standards representing over 90% of the world's population. The organization defines and develops their own content in technical quality and maintains a global network of technical experts for collaboration. ASTM standards are used and accepted worldwide and cover areas such as plastics, textiles, construction, energy, the environment, consumer products, medical services, advanced materials, etc. Interestingly, the organization was formerly known as the American Society for Testing and Materials which by nature would have a significant role in the development and standardization of life cycle assessment methods (ASTM, 2023).

The life cycle assessment has its origins in the 1960's to evaluate a product or systems' impact on the environment throughout its entire lifespan from "raw material inputs, passing through processing, finishing, and assembly to distribution, consumption, and disposal" (Inoguchi, 1999, p.186). This systemic way of thinking offers a basis for reimagining humanity's relationship with its surrounding environment through a more comprehensive understanding of the interconnected network to transition the negative impacts to regenerative systems. By breaking down the actions that occur at each component stage in the food processing and retail industry, businesses can strategize their own waste management methods to improve their relationship with the planet. From here, one can identify the interactions and dependencies between different stages to highlight opportunities to implement circular principles. These concepts are most relevant to the overall topic of organic waste as they validate these changes through case studies and support future field investigations.

Founded in 1999, BPI is an organization that supports the shift to circular economy while being "America's leading authority on compostable products and packaging" (BPI World, 2023). Services include extended producer responsibility (EPR), labeling and identification, compostable products in foodservice ordinances. Transparency within operations and strict qualifications allows the BPI Certification Mark to indicate opportunities for end-of-life within industry and for consumers. With the certification comes a variety of fees from sublicensing, membership, and recertification every 3 years to maintain the level of quality needed to make a positive environmental impact (BPI World, 2023). *Figure 2.10* showcases the visual identity of the BPI certification mark and highlights the product's nature of being solely commercially compostable.

Figure 2.10 Visual brand identity for BPI certified products (BPI, 2023)

Following the emergence of these initiatives and standardizations, the Millennium Ecosystem Assessment (MEA) was developed as a comprehensive assessment of the human impact on the environment. This was called forth by UN Secretary Kofi Annan in 2000 which "reflected the urgent need to focus on environmental sustainability" (Chakraborty, 2021, p. 106). Overall, a pattern in actions towards standardization can be seen that ultimately revolve around increasing transparency and accessibility through incremental goals.

Although more U.S. companies have been trying to align with more sustainable operations worldwide, the integrity of the product or service may not be entirely as represented. This is the basis of greenwashing, and the concept has existed since the 90's, proposed by Jay Westerveld (1986), that companies mislead the population regarding how environmentally conscious they actually are (Becker-Olsen, 1970). By calling out counterintuitive business practices that are not honest, there is the possibility for those companies to reevaluate their operations to retain their market. It is essential for consumers to be informed regarding the ethicality of a business to then make decisions on whether to support them. There is this idea that the consumer holds more power than forced business decisions, where collective disapproval or lack of support ensures environmental factors are a consideration in the forefront to continue business. By focusing on the four development phases to sustainable efforts in a variety of food retail settings, designers also have a major opportunity to implement efforts in a feasible way.

One way to achieve that implementation is by considering integrated product policy (IPP) as a method to sustainable industry practice where the whole implementation of a product is evaluated for improved consumer awareness and engagement (Charter, 2001, p. 103). This policy can be evaluated through five key building blocks:

1. Managing waste
2. Green product innovation (e.g. stimulating R&D and eco-design)
3. Creating markets (public procurement)
4. Decoding environmental information (eco-labelling, product declarations)
5. Allocating responsibility (towards producer)

This approach adopts a holistic perspective which allows for identifying areas for optimization in resource use and to minimize environmental impacts. While IPP aligns with circular economy principles by promoting closed-loop systems, Weimar's (1999) paper added 2 more building blocks to provide more factors to repair, refine, redesign, and/or rethink.

6. Sustainable consumption
7. Chemicals management

These ideas work together to create a system that's more sustainable in resource consumption and an optimized supply chain that facilitates circularity. The way these can apply to food waste diversions will vary greatly depending on the industry sector and characteristics of its operations. It is also important to note that IPP works to collaborate between stakeholders but does require alignment of regulations across sectors to promote standardized sustainability. The concept of standardized sustainability should be based on objective criteria to assess environmental and social impacts, emphasize accountability and transparency, and view a product or system holistically to ensure continuous improvement.

2.6 Implications of the U.S. Food System

This research has presented the clear disconnect between policy and environmental design which leaves behind economic, social, and environmental costs to be paid by the population and the commons. The current food system operates in a linear model that expands to be an interconnected web of interactions that generates a significant amount of waste throughout its supply chain. This causes a variety of negative effects in both domestic and international realms where industry shifts responsibility of disposal to consumers and lower level employees which typically ends in landfills; however, through literary research it is evident that organic waste has the highest potential to directly impact climate change with reduced methane emissions. The environmental benefits when shifting towards circularity would follow the trends of global initiatives, where the communities operate in a true green way and the population is subjectively happier. Additionally, by reducing resource inefficiencies the U.S. can utilize land, water, and energy to other efforts. The economic opportunities through organic waste management can create revenue streams that outweigh the initial investment costs and push for regenerative systems within the food chain supply.

Starting with what organic waste is and where it comes from, *Figure 2.11* illustrates a variety of industry sectors that input into this system. This way of framing the problem allowed the research to expand on and visualize these ideas in more detail in *Figure 4.1* (and also found in the Appendix *B*,), which further characterizes many industry sectors as a way to help designers outside of a preconceived scope to relate to the improved responsibility of the designer. For this research, food waste has been defined as edible food that is discarded at various points in the supply chain. However, in each context there are additional factors to consider. Due to the interconnected nature of food and packaging and recent research exposing environmentally unsound practices in the plastics industry (Allen, 2024), it is important to clarify how to divert waste streams accordingly and create a more transparent standard for reprocessing practices. Is this idea supported through infrastructure or an operational shift or a relationship with service vendors? For this reason, the research

Figure 2.11 Industry segmentation within the U.S. food system

scope will cover organic waste which consists of not only food waste but also fiber packaging. By thinking of these elements as a double headed opponent to face, there can be more applications for circular and sustainable interventions.

This begins to relate to the article *The Experience Economy*, where Pine and Gilmore put forth the argument that economic value progresses through distinct stages- commodities, goods, services, and experiences. In this model, illustrated in *Figure 2.12*, experiences are defined as the highest level of value creation. This means that businesses can effectively differentiate themselves and achieve a competitive advantage by staging designed meaningful experiences for their consumers rather than simply providing the product/service. This is possible due to the view on their consumers as active participants in an immersive experience over a passive, transactional recipient.

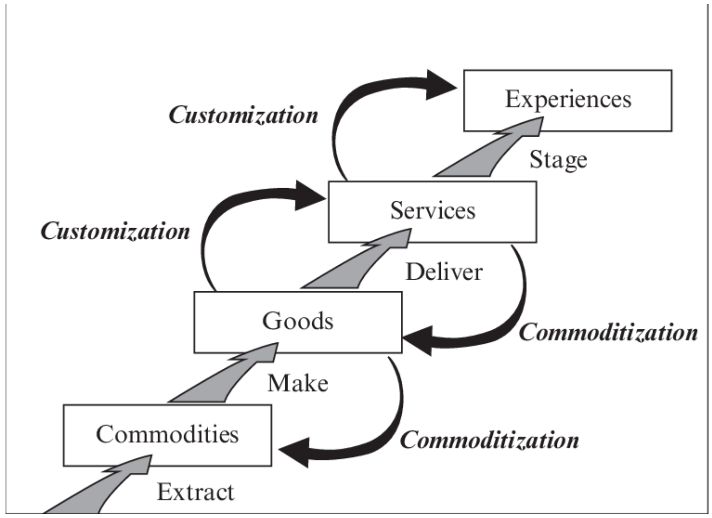


Figure 2.12 Pine and Gilmore's proposed Experience Economy Model (2014, p.111)

For example, think about Disney World and the accompanying value the patrons are willing to pay for designed interactions from buying tickets to visiting parks vs a county fair with lower prices overall but a subpar experience that relies on the patrons to create the memorable interactions. Thinking about the commoditization of goods and services helps business transform functional products into touchpoints that evoke emotional and experiential value. Additionally, by customizing these experiences to fit the needs and desires of consumers further increases brand loyalty and perceived value as a system. They end their argument by stressing the importance of organizations considering how their offerings engage with all five senses to provide these transformative outcomes.

Considering organic waste through this lens, reassigning the value of waste can be the valorization of organic potential as it is reincorporated into regenerative, circular systems. In this way, designers are improving their personal and overall industry responsibility to consider sustainability in their operations and create financial incentives to commoditize organic waste through service applications. Most notably, these solutions reflect trends of energy applications or continuous production models where waste feeds input needs which can be found discussed in depth in Chapter 3: Exploring Perspectives on Organic Waste Management.

With the scope of research defined and target product for innovation, the next layer to the problem is when the waste is generated. This can be thought of as *pre-consumer waste*- coming from harvesting, processing, and transportation- and *post-consumer waste*- coming from retail, consumption, and disposal. When looking closer at the total life cycle, one can see the additional impacts associated at each checkpoint and the typical end destination for organic waste, see *Figure 2.13*. This research aims to focus on the circular applications to the food system to create adaptable waste streams diversions and opportunities for individuals to engage with the system. Determining how and

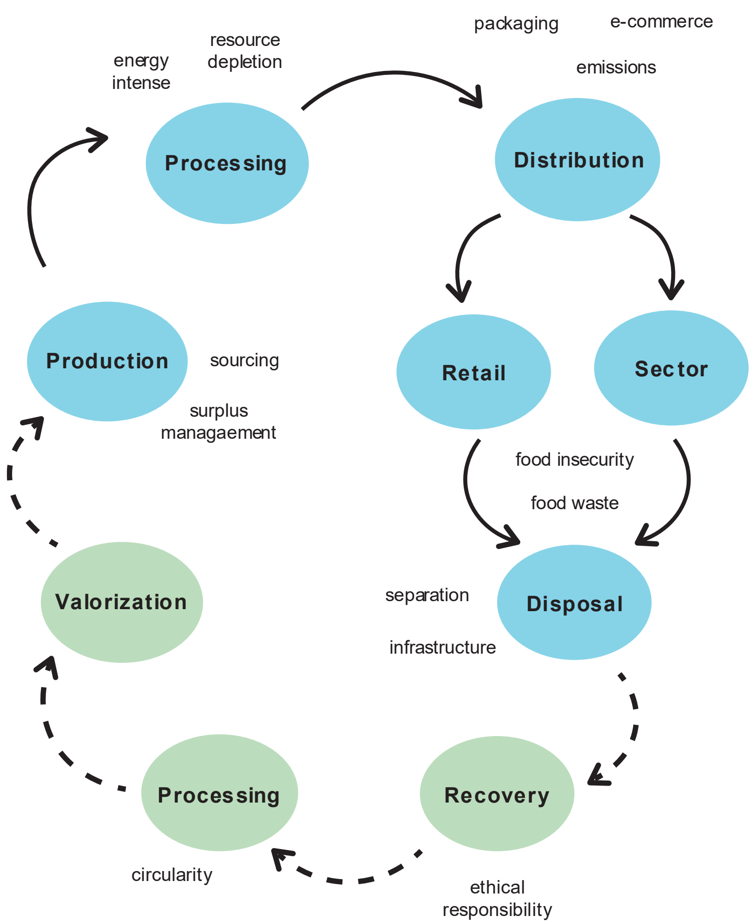


Figure 2.13 Proposed direction for circularity

where to make these sustainable interventions will be the focus for secondary research and development towards empowering designers to make these decisions. Overall this will be done through strategic design methods catered to the food industry to create efficient stream diversions and valorize organic waste.

Overall, the societal pressures and global initiatives towards improved social, economic, and environmental responsibility have made the United States a target for scrutiny. Though the United States has a higher rank on the human development index scale, 21 out of 193, the country lacks in infrastructure and policy to maintain environmental ethicality, making the gap between this country and other more successful countries wider (UNDP, 2023).

Ultimately, the goal is to develop a holistic approach designers can use to evaluate, strategize, and implement sustainable organic waste management within their contexts and limitations. It should consider the main issue systematically to work outwards and solve the accompanying implications. With this, the framework for collaborative networks that service the community's needs/wants and replenish the commons can be developed for scalable implementation. See *Figure 2.14* for the approach to secondary research which focuses more on applications of organic waste for food retail. By specifying the overall approach from this point to help designers look for those opportunities, the research from here supports efforts to refine the true green potential of industry. It will begin to look at these different aspects of organic waste management to strategize

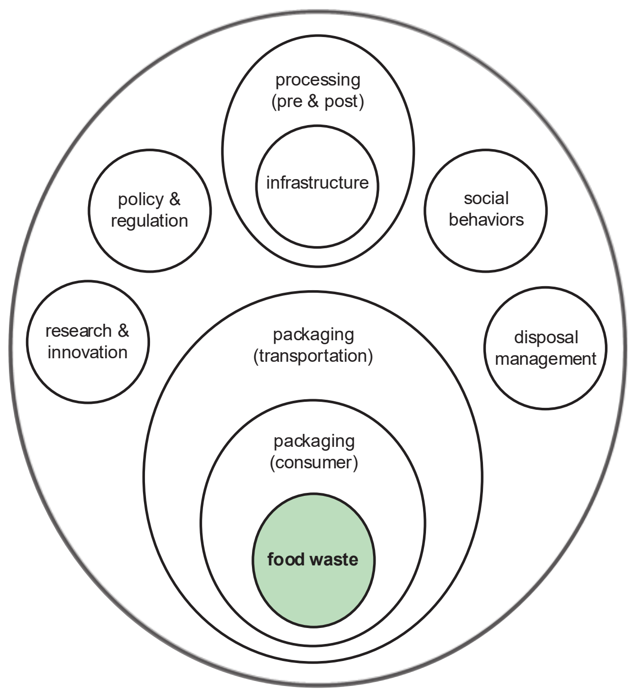


Figure 2.14 Holistic approach to secondary research for approach development

an approach for circularity and sustainability based on the insights gained from this literature review.

2.7 Environmental Concepts

This segment is important in understanding the long-term impacts of current operations and possibilities to reduce environmental impact. By considering the constraints and basic science of how we interact with the world, designers can better define specified opportunities as a business case for sustainability. This begs the question of what areas industry needs to target to replenish the commons.

As mentioned in Initiatives & Organizations, the Landfill Methane Outreach Program (LMOP) came to be from research finding that organic municipal waste has the most compounding impact when decomposing in landfills. Additionally, it was found that captured biogas generated by organic waste can be used as a renewable fuel for many end uses such as electricity generation, industrial heating, vehicle fuel (EPA, 2005). The circular benefits are a great motivation for a shift to reduce local air pollution. With an interconnected system that incentivizes industries to push further toward sustainable goals, the scale for renewable energy can be more impactful on populations in terms of consumption levels and overall create a positive feedback loop.

While called many things- reservoirs/ pools/ stocks- a carbon sink is simply where carbon is stored. These sinks are categorized by impact and measured by Gigaton (Reed, 2018). The main ones consist of oceans (40,000 Gt), fossil fuels (4,000-5,000 Gt), worldwide soil (2,000-3000 Gt), atmosphere (700-800 Gt), and all terrestrial organisms (600-650 Gt). Note that the soil sink is larger than the atmosphere and all vegetation combined. The “carbon footprint is the total amount of greenhouse gas emissions caused by individual, product, organization, or event” (Reed, 2018, p. 9). This concept is more relatable to designers as we consider the environmental impacts of the products we make and the footprint as an inevitable byproduct in the post-industrial era. Therefore, by closing the loop and having products provide an additional service after their intended one passes or expires is a method that would allow designers to balance out the initial environmental costs needed to produce it or leverage mimicking natural systems.

“Carbon sequestration is a natural or artificial process through which carbon dioxide is removed from the atmosphere and held in solid or liquid form. Sequestration simply means storage” (Reed, 2018, p. 9). Taking this into account, the applications of the output emissions from production being refocused into energy that later provides and supports the needs of the community and environment can be a form of sequestration. The main takeaway is that organic matter has energy that can be transferred to another matter, and taking mass scale input from sectors of industry could allow optimization to produce new business opportunities. For example, organic fertilizers have nutrients attached to complex structures, which add to the soil’s humus, do not rinse away easily, and overstimulate soil microbes to consume the available organic (carbon-holding) matter (Reed, 2018, p. 20). By creating methods to help designers and their clients in specialized composting infrastructure for a business to have a closed loop system for food processing, the opportunity for saleable organic compost becomes available to maximize agricultural benefits and energy efficiency.

Additionally, the fact that industrial composting services differ by creating the ideal conditions for breakdown of organic matter into a saleable product via an accelerated process leading to profits and acceptance of a wider range of feedstock. These specialized conditions at the scale of input processing have the biggest potential to make positive environmental impacts and replenish resources. Currently, there are 270 specialized facilities in the U.S. with plans to develop a more diverse network (US Composting Council, 2023). There are few collection methods industry employs, either dual-stream recycling where sorting is the consumers responsibility or single stream where commingled recyclables are collected as mixed recyclable materials and sorted at the facility. This leads to questions regarding the variety of waste for industry/ service and how design interventions can streamline certain tasks for workers to create an efficient closed loop system for a business.

Composting is the natural process of recycling organic matter into valuable fertilizer that can replenish nutrients in soil, prevent topsoil erosion by allowing more soil absorption, lower landfill contributions, help eliminate incinerators, and tackle global warming (Reed, 2018). Compost can replace synthetic fertilizers which deplete soil of nutrients in the long run and produce nitrous oxide, which is 310 times as potent than CO2 over 100yrs and contributes to smog and other pollutants that wash into waterways (US PIRG, 2022). There are multiple, useable byproducts of composting that can be used to replenish resources but also generate power. For example, digestate is a nutrient-rich solid or liquid material and can be applied to fertilizers to maximize the efficiency of growth, which serves as an opportunity to close the loop through collaboration with agricultural producers. Biogas containment can further improve initial investment costs by providing an electric resource to power a facility or be sold commercially. The gas takes little processing once captured and can be applied to heat and power operations as well as a fuel source (EESI, 2017). According to the EPA, these methods are considered source reduction and not recycling because composted materials never enter the municipal waste stream. These facts together are interesting when one considers that food waste sent to landfills is not only wasted energy potential but also emitting higher levels of methane. The disconnect between food production and waste are evident but can be improved through understanding end of life opportunities.

The current methods used around the U.S. are more generalized than facilities seen internationally, but still work towards increasing industrial composting efforts:

- Aerated Static Pile (ASP): organic matter is mixed with loose, dry material which allows air to travel through perforated pile eliminating need for turning and better control oxygen levels leading to faster biodegradation times (produces volatile gases vs anaerobic digestion through aerated turning pile produces digestate and biogas) (US Composting Infrastructure Coalition, 2024).

- Anaerobic digestion: organic matter is broken down with specialized bacteria in the absence of oxygen and takes place in a sealed vessel (reactor). Produces solid and liquid digestate as well as biogas that can be captured and used for energy purposes (EPA, 2024).
- In-Vessel: considered most effective, matter shredded and placed in commercial machine that controls the temperature, oxygen, and water exposure. Automatically rotates to ensure even rates of decomposition. High temperature process kills off harmful bacteria. Limited to the amount processed at a time, but in just 1 month, fastest operation (US Composting Infrastructure Coalition, 2024).
- Vermiculture: using specialized worms to break down organic matter into nutrient rich, quality soil in as little as 2 months (lesser used due to difficulty managing) (US Composting Infrastructure Coalition, 2024).
- Windrows: not as applicable, downside of manual labor to turn long rows of material for improved porosity and oxygen (US Composting Infrastructure Coalition, 2024).

While these examples of circular practices are informative, it is important to consider how they would operate in relation to the conditions. To see this on a scale, one can start by looking towards the Earth Flow system which uses automation for in-vessel composting allowing for urban living applications and improved operations (Green Mountain Technologies, 2024). The three-week process involves minimal effort beyond loading and unloading makes this product ideal for farms, universities, municipalities, resorts, etc. By designing their system with integration to existing facilities in mind, designers can innovate a client's operations and serve as an example of a high investment with lower stake interactions.

Another domestic example is the Gore system that utilizes similar in-vessel and positive aeration principles but includes a specialized membrane laminate technology to produce high volumes of compost using the community's feedstock (Cedar Grove, 2008). Additionally, the city of Seattle expanded the scope of sustainability beyond infrastructure by developing the means for their community to engage in pro-environmental behavior. This includes considerations from packaging appropriate for circular waste streams to resources that help the population calculate services and projects, thereby providing the support the community needs to function with lower environmental impact. By looking at organic waste from a holistic view, the city can create mass long term change that represents high investments with high stake interactions. Overall, considering how to integrate these environmental concepts into the desired sustainable system is a matter of managing risk factors and strategizing for future feedback.

3 Exploring Perspectives on Organic Waste Management

By analyzing diverse systems in diverse areas, we can begin to see patterns in technology utilization and active user input through designed interactions while acknowledging the unique needs of each community. This chapter will be broken into two segments: study and observation. As each study is presented, the research is aiming to understand and reimagine the factors that allow current organic waste management to be successful for other developed countries and determine how these concepts apply to the diverse applications of United States. These insights will be applied and referenced accordingly in Chapter 4: Approach to Sustainability once methods for each context are explored.

3.1 Global Efforts in General Waste Reduction

It is important to acknowledge the implementation of waste management practices in other countries tend to have higher levels of engagement and success due to societal implications. While immigration exists, these countries have more homogeny within their culture and involve a level of assimilation that encourages fuller participation. Additionally, there will always be a select few who refuse to participate. This concept is not entirely negative in nature as it allows for more unitary efforts to be pursued, but it is essential to consider these behavioral factors when considering success rates and the general outlook on waste interventions in countries with more developed systems.

Chapter 2: Implications of the Food System in the Post-Industrial Era within the U.S., discuss a variety of international organizations that can promote and enforce certain policies. This can be seen through compliance of many countries to align with global goals and interventions to further improve sustainable waste practices. An enthusiastic approach is supported by a strong relationship between the community and industry enforcers that take steps in transitioning to more environmentally friendly practices that support everyone's' longevity.

The following figures begin to analyze and summarize the different approaches our global counterparts take when establishing initiatives and what their dimensions of focus are. The first important thing to note is the range of countries selected for closer evaluation and reasoning. These specified countries give a good sample of solutions for European vs Asian applications and help this research understand the experiences that ultimately to contribute to pro-environmental behaviors. Then regarding the table itself, the categories for comparison were chosen to give a common benchmark for how successful systems for organic waste management work on a holistic level. Lastly, to serve as the most useful resource to designers, the table will include the terms they could look up for future reference with further citations found below.

With this, one can begin to look at *Figure 3.1*, which outlines the factors that contribute to best practices informed by the global citations. First, one can note the standardized collection methods and types of materials managed all follow similar targets within the food system. It is essential here to consider the processing needs of the packaging these organic goods come in which is seen through various specialized facilities throughout these countries (European Compost Network, 2023). Particularly, the interactions designed around composting and recycling centers allow for positive engagement for both the population and industry workers to occur all while increasing education and awareness for sustainable practices (Schüch, 2016).

Additionally, the thoroughness of collection and processing demonstrate the effective waste segregation systems that support efforts for valorization (Okada, 2023). An interesting cultural note that was discovered about Asian countries processing methods is that they tend to favor chemical reactions, such as fermentation and digestors, which align with a long history in each of the country's cuisine (Nuwer, 2024). While in the European regions the focus is on creating effective waste stream diversions and incentives to be circular (BMUV, 2022). Overall, these four categories highlight how systemic policies, advanced technologies, and community involvement create effective waste management systems, offering valuable insights for implementation.

Country	Materials Managed	Technology Used	Innovation?	Infrastructure
Germany	Organic, Metals	Biogas Plants, Recycling	Deposit refund system: incentiveses consumers to return glass/plastic bottles	Moderate: recycling centers
Switzerland	Organic, Glass, Metals	Recycling, Incineration	Pay-as-you-throw in bags with mandatory purchase sperrgut stickers	Advanced: many public facilities,
United Kingdom	Organic, Plastics	Anaeribic Digestion, Composting	Food waste apps to inform public	Advanced: many facilities
Japan	Organic	Composting, Recycling, Incineration	Smart bin technology: monitor levels for efficient pick up	High: innovative technology
South Korea	Organic	Anaerobic Digestion	Electonic bin technology: weighs residential food waste to log with digital cards, monthly pay-as-you-throw fee	Advanced: composting centers
Taiwan	Organic, Plastics, Metals	Composting, Recycling	Circular agriculture: food waste becomes fertilizer quickly through specialized enzymes	High: efficiency treatment centers

Figure 3.1 Successful global practice categories: materials, technology, innovation, infrastructure

Next, the research can begin to look at *Figure 3.2*, which outlines the factors that contribute to designing interactions for the best sustainable experience. Here one can begin to see the connection between severity of policy enforcement to perception and engagement to sustainable systems (Elhardt, 2022). It seems to be the case that strictness does not always correspond to positive engagement with the designed interactions which lead to resistance from the population. By understanding the methods used to leverage psychology to transition wasteful models into circular systems, designers can benefit in strategizing adaptable solutions for the communities they serve (Ng, 2019).

Overall, it benefits each country to have a specialized education program that trains their population from a young age how to interact with the world with minimal impact. In this way, these societies are creating generations of environmentally conscious individuals that know techniques to reduce consumption and lobby for sustainable measures in their communities (Rapid Transition Alliance, 2019).

Country	Policy Enforcment	Community Engagement	Educational Programs	Challenges
Germany	Moderate	Moderate: community centers	Limited	Public awareness
Switzerland	Strict	High: public campaigns (eco-friendly food fridge)	Limited	Food culture
United Kingdom	Strict	High: public campaigns	Comprehensive: school ciriculum	High cost
Japan	Strict	Low: minimal campaigns	Moderate: some programs and infographic references	Infrastructure strain
South Korea	Strict	High: local initiatives	High: school ciriculum	Food culture
Taiwan	Moderate	Moderate: public campaigns	Comprehensive: school ciriculum	Infrastructure strain

Figure 3.2 Successful global interaction categories: policy, community, education, challenges

Additionally, this supports the systems that are put in place by improving awareness and transparency of operations and how to appropriately divert waste streams (Circular Taiwan Network, 2024). This helps create a system where the population can buy into the infrastructure needed to be more sustainable and validate long/short-term costs (Chen, 2016). Lastly, this approach illustrates how to design for misuse and contamination in a systematic approach that utilizes indirect and direct concepts to solve the problem of organic waste.

3.2 Global References

This section includes the specific references used to inform the global case study content. These have been compiled below for improved accessibility and relatability for the designer when researching successful management methods for organic waste. They are organized by the country for convenience and provide valuable insights on more established initiatives. Detailed citations can be found further in the References at the end of this research.

Germany

BMUV. (2022, May 16). *Ordinance on the recovery of bio-waste on land used for agricultural, Silvicultural and horticultural purposes- BMUV - laws*. bmuv.de.

CRI. (2024, May 24). *Germany.* Container Recycling Institute.

Schüch , A., Morscheck, G., Lemke, A., & Nelles, M. (2016, August 4). *Bio-waste Recycling in Germany – Further Challenges*. ScienceDirect.

Switzerland

Country Report Switzerland 2023. (2023, December 5). European Compost Network.

Elhardt, C. (2022, February 22). *Swiss Population in Favour of Strict Food Waste Rules*. ETH Zurich.

Federal Office for the Environment. (2024, November 28). *Food Waste and Loss*. FOEN.

United Kingdom

Burnett, N., Malik, X., Smith, L., & Stewart, I. (2024, April 12). *Food Waste in the UK* . UK Parliament.

Environment Agency. (2022, May 17). *SR2021 No 5: Composting in Open and Closed Systems – Waste Recovery Operation*. GOV.UK.

Ng, K. S., Yakovleva, N., & Yang, A. (2019, April 17). *Sustainable Waste Management Through Synergistic Utilisation of Commercial and Domestic Organic Waste for Efficient Resource Recovery and Valorisation in the UK*. ScienceDirect.

Japan

Nuwer, R. (2024, August 26). *Japan is Recycling Food Waste Back into Food With Fermentation*. BBC News.

Okada, Y., & Shimbun, Y. (2023, November 4). *"Smart" Trash Cans Cut Littering in Japan's Former Capital Kyoto*. The Japan News.

Okayama, T., & Watanabe, K. (2024, February 8). *Performance of the Food Waste Recycling Law in Japan with Reference to SDG 12.3*. MDPI.

Seven & i . (2024, February 21). *Measures Against Food Loss / Waste and Measures for Organic Waste Recycling*. セブン＆アイ・ホールディングス.

South Korea

ENVAC. (2024, June 14). *Tackling Food Waste: South Korea's Success Story*. Envac group.

Jeong, A., & Yoon, J. (2024, August 9). *How South Korea Recycles 98% of its Food Waste*. The Washington Post.

Lee, E., Shurson, G., Oh, S.-H., & Jang, J.-C. (2024, January 19). *The Management of Food Waste Recycling for a Sustainable Future: A Case Study on South Korea*. MDPI.

Taiwan

Chen, Y.-T. (2016, November 22). *A Cost Analysis of Food Waste Composting in Taiwan*. MDPI.

Circular Taiwan Network. (2024). *Composting System for Biodegradable Fresh Produce Bags*.

Rapid Transition Alliance. (2019, June 18). *Taiwan's Transition – From Garbage Island to Recycling Leader*.

3.3 National Efforts Towards Food Waste Reduction

In the United States, there are a variety of initiatives and organizations working towards food waste reduction. However, there is also a discrepancy in reporting that conceals the true nature of conditions. While consumers are shifting to supporting more environmentally friendly businesses and engage in recycling projects, they cannot know what they do not know and contribute to waste while thinking they have done their part. This can be seen in the battle of recycling where consumers are split on contributing due to lack of transparency in processing operations and concept that all waste goes to the same place anyway. However, in a similar manner, other businesses are leveraging these ideas and promoting their true green practices thus differentiating themselves and aligning with sustainable community goals.

In terms of the delivery system of these solutions, they may come in the form of digital shopping platforms, re-purposing companies, or educational marketing through signage and packaging. For example, Misfits Market was founded in 2018 and works directly with farmers and makers to rescue organic produce and other grocery items that might otherwise go to waste, the ‘misfit’ produce, for sale for direct consumer shipping (Misfits Market, 2018). This operation works due to the relationship between producers and streamlining the retail process to reduce emissions and what would have been useable wasted food. Another example is seen from ReFed (2015), who has been working since 2015 to leverage the holistic view of the food system to provide data and promote capital innovation. They, alongside key partners, can lead the US Food Waste Pact to increase reach and increase the scope of implementation measures. On the producer side, they tend to focus on employee education and engagement to reduce operational waste from the start of operations with accompanying surveys and observations. When working towards changing business operations, relying on prevention and education are more successful and probable to be incorporated than specialized infrastructure with high upfront costs. Referring to case studies within the pact reveals more data reports on food waste and greenhouse gas emissions and serves as another great resource in validating strategies.

Geographically, the United States is challenged with space and capacity, making the issue of food waste management difficult. Currently, new initiatives for food waste reduction come from larger cities due to opportunity and variability for applications. State level strategies have been making efforts in developing circular systems for the lifestyles of their population. Research in this topic was split into west coast and east coast interventions for comparison. As of 2023, the most populated state was California with over 38,900,000 individuals in the 3rd largest state by area (U.S. Census Bureau, 2023). The biggest challenges for sustainability in any city would be high infrastructure costs and space to operate. However, San Francisco has become the first U.S. city to establish a large-scale food composting program with accompanying landfill diversion goals that are exceeded yearly (Recology, 2024). The city further built on this system to reduce organic waste impacts by mandating the Recycling and Composting Ordinance since 2009 with increasing success rates over the years.

With this addition comes new guidelines and technology around auditing waste content and transaction methods to help the population be more conscious about consumption. Managed by the San Francisco Department of the Environment (DOE), the city has been committed to phasing in legislature, ensuring access to modern facilities, and using education and incentives to engage with stakeholders. Information on the types of technologies utilized in these modern facilities is limited, but documentaries and articles generally inform this research with the idea of reverse air composting in windrow fashion (Collins, 2017). In this way, facilities can produce nutrient-rich compost that directly supports the various vineyards and farms in the state.

Moving north up the coast to Washington, where Seattle is taking a similar route, but focusing efforts on the economic factors of circularity. Their approach to waste management has led to decreased disposal per household and increased cost savings through extensive curbside services (Morris, 2020). The model that allows this focuses on creating a separation between customer rates and contractor compensation, which creates a reinforcing loop where customers are incentivized to reduce waste and collection compensation is not affected by customer choices. Additionally, the city has distinguished disposal contracts from specialty collection and processing contracts so that service providers can focus on their areas of expertise and encourage top zero waste contractors (EPA, 2024). While this model seems to ignore the human factors, the operations focus allows for a system that objectively works alongside capitalism and ultimately serve the environment to be developed.

Over in New York, the Department of Sanitation has been updating their curbside organics collection program with wavering success since 2015 (MacBride, 2024). There have been many strategies to transition the city into a more circular model; however, past initiatives were costly with low engagement. Surveys over the decade uncovered the social and economic factors to this, such as operational issues with missed collection or stolen bins. While there is a need for more educational programs and awareness for these communities, the lack of participation may be due to a disdain for the program (DSNY, 2024). Because there are so many hands on the operations, the moving pieces leave behind shortcomings and reflect disorder in management which is hard for the population to get behind. Although more recent efforts have been to simplify the diversion and collection systems, color coded bins and timely pickup, it can be observed that organic waste is overflowing in both residential and commercial areas. Overall, the state can serve as a powerful case study in managing organic waste by analyzing developments that lead to a successful system for a dependent population.

Lastly, the research looks to Colorado as major contributors in reducing landfill methane emissions (Eco-Cycle, 2024). The Colorado Department of Public Health and the Environment (CDPHE) has partnered with Eco-Cycle to set a precedent for the nation through legislation and action. For example, in 1994 the city of Boulder initiated a voter approved ‘trash tax’ that generates approximately $1.8 million a year that goes towards the city’s zero waste initiatives. This includes a simplified single-stream composting program that outlines the two categories for collection for improved processing efficiency. Additionally, the state appears to focus sustainable efforts on incentivizing local composting by providing workshops, outreach programs, and educational materials for residential processing (EPA, 2024). In this way, the city uses its population to build on circular systems and connect with other businesses to strengthen collaborative processes.

3.4 National References

This section includes the specific references used to inform the national case study content. These have been compiled below for improved accessibility and relatability for the designer when researching successful management methods for organic waste. They are organized by state for convenience and provide valuable insights on the implementation strategies for newer initiatives. Detailed citations can be found further in the References at the end of this research.

California

Collins, A. (2017, October 24). *Food to the Rescue: San Francisco Composting*. Be a Force for the Future.

Recology. (2024, July 5). *Recycling Legislation*. Recology Waste Zero.

Colorado

Eco-Cycle. (2024, November 14). *The State of Recycling & Composting in Colorado*.

EPA (2024, October 22). *Zero Waste Case Study: Boulder*. Environmental Protection Agency.

New York

MacBride, S. (2024, March 17). *Is New York City Getting Curbside Organics Done?*. BioCycle.

Collection Laws for Residents. Collection Laws for Residents - DSNY. (2024).

Washington

EPA. (2024, October 22). *Zero Waste Case Study: Seattle*. Environmental Protection Agency.

Morris, J. (2020, August 12). *Seattle's Winning Strategy for Managing Organics*. BioCycle.

3.5 Insights and Key Takeaways

From these findings, one can see the correlation between policy and community engagement in determining the success of said initiatives. This is due to the structure these initiatives provide for existing systems and implementing changes that consider the human factors and equip the best tool for the specific problem. A clear framework supported by visible actions allows communities to flourish through organized efforts and improve interactions with infrastructure. Especially for homogeneous societies, it is important to take successful strategies and apply them in a culturally appropriate manner. By leveraging this relationship, policy makers, community leaders, and designers can actualize sustainable changes that not only foster a circular economy but active engagement in pro-environmental behaviors.

Additionally, the opportunity for policies to include incentives for both industry and consumers has been beneficial in positively influencing behaviors. The most important thing to note overall is the sharing of best practices and learnable moments that provide resources to other nations trying to improve their impact. By incentivizing research and developing a global database with these innovations, industries and external entities will be more motivated to elevate their operations to a true green level. This would also aid in the continuation and improvement of monitoring systems that leverage technology to support the ever-changing needs of the population. When considering the 'wicked problem' the American food waste system presents, there are many directions a resolution could take.

4 A Circular Approach to Sustainability in Food Retail Sectors

The following approach was developed to be a holistic tool to aid designers looking to reduce organic waste in food retail sectors. Previous chapters presented a range of information to fully explore the evolution and implications of the U.S. food system. It has been establsihed that large scale distribution networks that were designed to increase efficiency and accessibilty have had major negative impacts on economic, environmental, and social realms. This has resulted in physical and mental barriers between production and consumption that lead to excessive waste of usable food and wasted energy potential.

A variety of industry sectors were first observed as areas for sustainable intervention in Chapter 2.6 *Implications of the U.S. food System*. The initial scope for this thesis included both food production and retail due to the nature of the supply chain, but this would have led to a perpetual research project. Additionally, the opportunities to work closely with food production sectors were limited to front of house or public area observation; however, casual interviews with food sector employees acknowledged the various pain points and needs to be considered to create unique solutions that could support the entirety of the supply chain. Because it is not possible to cover every avenue for organic waste interventions within this thesis, the industry sectors for circular applications were re-evaluated and visually organized building on the evaluation of organic waste and its various sources in *Figure 2.11*.

This visual analysis of industry context includes how types of operations run, what challenges/ policies exist, and what technologies and innovations are special to them.

These insights are presented in the Industry Characteristics Comparison Table, see *Figure 4.1* or a full-size printable version in *Appendix C*, which provides designers looking to reduce organic waste for a business to see where their respective client sector aligns with industry practices and determine what strategies can be employed.

Industry Sector	Type of Waste Generated	Waste Management Practices	Technology Used	Regulatory compliance	Sustainability goals	Challenges	Opportunities
Agriculture	Crop residue, animal manure	Biogas plants, recycling	Vermicomposting	FDA, EPA, local laws	Soil health improvement	Volume capacity managmenet, nutrient management	Close-loop nutrient cycling, bioenergy production
Healthcare	Biodegradable packaging, food waste	Composting, sorting	In-vessel composters	FDA, EPA, local laws	Reduce non-hazardous waste	Sorting, contamination, strict regulations	Biodegradable packaging, on-site composting
Hospitality	Food scraps, kitchen waste	Donation, on-site composting	Anaerobic digestors	Health and safety standards	Zero waste initiatives	Variability in waste types	Food banks network, improvements on sorting technology
Facilities & Venues	Food scraps, expired goods	Composting, recycling, incineration	Compactors, composters	Health and safety standards	Reduce landfill waste	High volume, contamination risks	Collaboration with local composting facilities, waste to energy, reduction strategies
Commercial/ Government Transportantion	Food scraps, recyclable packaging	Anaerobic digestion, incineration	Compactors, incineration	FDA, EPA, local laws	Reduce landfill waste	Variability in waste types, contamination	Improvements on sorting technology, tracking and monitoring, collaboration with composting networks
Schools & Institutions	Food scraps, expired good	Sorting, donation	Compactors	FDA, EPA, local laws	Zero waste initiatives	Volume capacity management	On-site composting, waste to energy, biodegradable alternatives

Figure 4.1 Industry Characteristics Comparison Table

Utilizing data in this table, designers outside of the scope food retail can find this research valuable in making circular and sustainable design interventions as a starting point and reference. The Industry Characteristics Comparison Table highlights the overlaps in operational qualities that exist across a variety of sectors to help validate the problems and solutions needed for a specific design scenario targeting organic waste. It provides value for designers to quickly analyze the conditions of the food system and facilitates discovery and ideation in a range of dimensions.

The designer's specific industry will determine the nature of the potential solutions and strategies that will be successful in managing wicked problems. While the design approach in **Chapter 5 *Demonstration with Waffle House*** will be catered towards food retail sectors, the framework developed within this chapter is intentionally broad and adaptable, allowing it to be applied across other sectors facing similar challenges. This generalization ensures that the approach is versatile and promotes a wider adoption of true green practices.

When considering *the Implications of the U.S. food System* and the nature of its wicked problems, it became apparent that the production sectors are directly influencing the operational capacity of food retailers. Because the retailer's actions are limited when the product is packaged and delivered in an unsustainable manner, a holistic evaluation needs to be made, and circular innovations should be applied.

It is also important to clarify the types of clients a designer might engage with and how the client's goals might differ. This person may be an internal part of a company that receives consumer supply and manages its end-of-life cycle or may be a manager component of a manufacturing/processing plant wanting to implement solutions that improve efficiency and sustainability within their operations. Furthermore, they may be a store chain owner of a larger entity wanting to incorporate circular principles to promote their environmentally ethical practices while supporting the needs and wants of their community, or a new business owner opening an establishment where they want to showcase these similar sentiments. Regardless of what industry or position level, along with the designer, these people can utilize the approach card set to make a business case for environmental responsibility, validate their stance through research and opportunities, and learn how to create the systems to actualize their plans.

Refining and formalizing this approach involved developing, informing and specializing strategies for organic waste reduction while also working in parallel on the demonstration project discussed in the next chapter. These real time efforts helped to create the necessary connections to align to a true green model that targets design thinking towards circular interventions.

Introduction to the Circular Approach

The 'Approach to Sustainability' cards (see *Figure 4.2*) were created as a visual reference to walk designers through the exploration and development process for sustainable systems. They are directly inspired by the visual delivery style of IDEO's method cards for their practicality as a resource. However, to make them more sustainable they are available for digital use in the appendix to promote less paper usage and improve convenience/ usability for the designer during the project. The four phases outlined here guide the designer and their client throughout the design process for targeted actions to develop specialized interventions. These *Approach to Sustainability* cards can also be utilized by non-designers and sectors out of the scope of organic waste management that might benefit from reducing waste.

Figure 4.2 Circular Approach to Sustainability Cards - Overview of Phases

This approach aims to equip and empower designers with a practical framework to provide clear, actionable steps to help businesses: reduce waste; streamline recycling and composting processes; and improve their overall environmental performance. The flexible and scalable format is designed to be implemented in phases for maximum potential exploration of solution opportunities. It serves as the foundation to create a design brief to guide designers towards adaptable, true green solutions. The emphasis is on crafting solutions for an overall sustainable system that addresses the root causes and possibilities of organic waste, rather than offering temporary fixes that further stress environmental conditions. Industry, as the higher contributors to environmental degradation, can become more responsible for the actions of their operations with this approach, see *Figure 4.3*.

Figure 4.3 Circular Approach Card Set

The 'Approach to Sustainability' cards define four simple design phases to be expanded upon in this chapter: *Establishing the Stage, Performance Criteria, Application, Implementation*.

4.1 Establishing the Stage

Figure 4.4 Establishing the Stage Cover

Define the scope of the project

The project can begin with a conversation with the client to establish clear sustainable and circular economy goals and a project brief. For the lead designer, this initial conversation with the client is essential as the basis for opportunities and a mutual agreement of the nature of what will be designed, whether a product, system, or graphic. By defining both the goals and the initial targeted areas for improvement at the start of the process, the designer can use this knowledge as a baseline to research and ideate from within the discussed timeframe. This can come from a predetermined brief by the company that outlines their needs and expectations with a general budget and constraints to follow. However, the first meeting could be a more casual brainstorming session to pitch the need for a proposed sustainable system. With this, the designer would want to ensure they ask the client preliminary questions before proceeding to the next steps. These questions will help establish clear goals and define the scope of the project:

Where is our target location for design? – While this seems like a simple question to answer, it is the designer's role to forecast the project to ensure longevity and adaptability is integrated into the design solution. This may change significantly depending on the budget, scale, and size of the project so framing the problems and opportunities from a broad lens is essential.

What do you (think you) want designed? – In the design process it is a common experience that what was originally intended may not be the final design direction. While it is important to keep a flexible mind to find the best opportunities, it is also true that the direction of the original goal is a good starting point in breaking down what is truly needed to succeed in a space.

What should it do? Why? – This gives a more specific look into what the client is wanting by seeing how it should act in a space giving the designer an idea of the type of interactions that could be incorporated into the final solution. The why aspect helps the designer know the client's level of understanding of the problem, whether superficial or deep. This can impact how involved the client is in the design process and require more long-term validation for design solutions to avoid resistance.

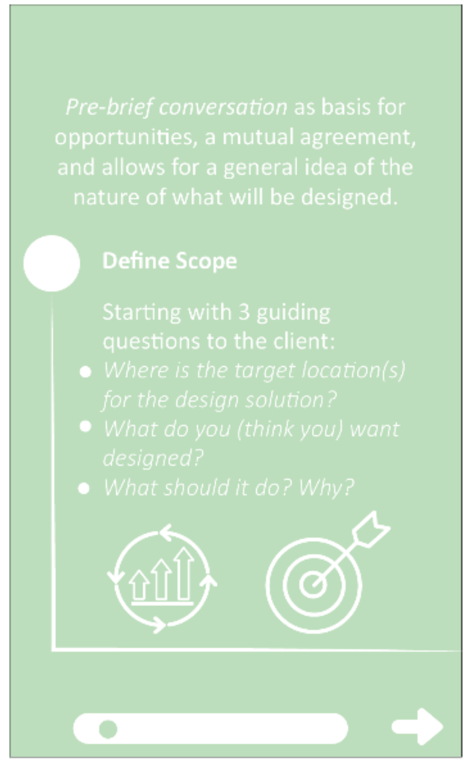


Figure 4.5 Define Scope

Contextualize and Validate

For this portion, the main aspect to understand is the environment in which food waste exists and how to regenerate the environment. The designer should finalize their initial meeting by gaining some background in the conditions of the client's operations. With this, the designer is going to want a foundation in the types of interactions that lead to organic waste which will help guide later field observations and overall solutions. They can consider this in terms of understanding the cultural, circular, operational, logistical, and sustainable frameworks to better understand the current conditions. The designer might want to start to look at additional opportunities for validation by looking at commercial businesses in the area.

By understanding the larger environment the business lies in, for example a rural side road vs an entertainment facility, can help designers find opportunities for collaborative valorization. Lastly, the designer might want to define the client's sustainability score as a benchmark to compare to one the proposed system is in place to see how it improves over time. This can be done with the help of the client, but should be a delicate conversation to ensure a negative rating from the beginning does not adversely impact client participation. It should simply state how green a client's practices are objectively on a graded system for equal awareness for all stakeholders.

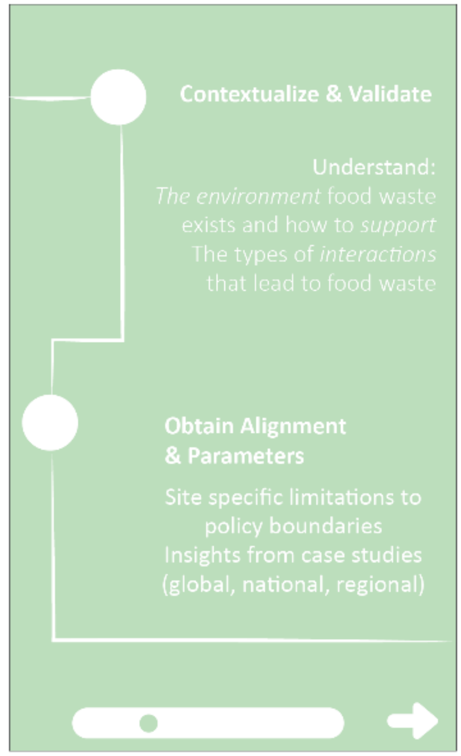


Figure 4.6 Contextualize and Validate & Obtain Alignment and Parameters

In the Demonstration with Waffle House, the research utilized the traditional academic letter grade but later developed a rubric to aid the designer in this grade evaluation. Similar to academic applications, the rubric is an essential tool in helping the individual align their project deliverables to the required performance criteria. This grading system is already present in the food retail industry in the form of health inspections that typically occur biannually.

By taking the form of a rubric, see *Figure 4.7* or [Apendix AA]() for full versions, the necessary criteria for effective and efficient organic waste management can be defined and used to grade the client's current operation in terms of sustainability. Therefore, the approach suggests the designer to apply this grading system to a businesses' operations to evaluate their sustainability grade to serve as a benchmark for recognition and improvement.

Reviewer Name/ Contact:

Date:

Sustainability Grade Rubric

This rubric emphasizes critical factors across EES dimensions to ensure design solutions effectively reduce organic waste, enhance resource efficiency, and create lasting value for a business entity.

Rubric Categories	Score
Proficient	5
Emerging	4
Average	3
Fair	2
Inadequate	1

Scoring Scale	Total
Exemplary	100 - 85
Commendable	85 - 60
Satisfactory	60 - 30
Unsatisfactory	30 - 0

Criteria & Objectives	5	4	3	2	1
Carbon Footprint					
Metrics: Energy sources *(renewable vs nonrenewable)* Operation Emissions/ sq. ft. Transportation Emissions	No tracking or reduction initiatives	Basic tracking or some renewable energy use < 10%	Moderate tracking and renewable energy use < 30%	Significant tracking with moderate renewable energy use > 30%	Comprehensive tracking with significant renewable energy use > 50%
Community Impact					
Metrics: Participation in local initiatives Sign and communication	No participation	Occassional participation	Moderate efforts	Significant efforts	Maximum commitment
Economics					
Metrics: Investments in sustainability Profit/ EES impact balance	No balance	Minimal balance	Moderate balance	Significant balance	Maximum balance
Packaging					
Metrics: Use of compostable, biodegradable, or reusable packaging	No separation or diversion efforts	Minimal waste separation and recycling < 10%	Partial waste separation and recycling < 30%	Significant waste separation and recycling > 50%	Comprehensive waste management > 70%
Waste Management					
Metrics: Diversion methods and rates Secondary use: composting, recycling, programs	No management methods	Minimal management methods	Moderate management methods	Significant management methods	Comprehensive management methods

Figure 4.7 Sustainability Grade Rubric

Obtain Alignment and Parameters

An important aspect of developing the design brief is understanding the main *parameters* and why they exist to ensure design for the conditions of operation with the future in mind while being a catalyst for true green change. Examples of main parameters include but are not limited to:

- Diversion rates (how much a business successfully sorts and processes organic materials i.e., recycling, composting)

- Economic viability
- Energy efficiency rates
- Environmental impact
- Operational insights
- Sales or customer retention
- Site specific limitations to policy boundaries
- Stakeholder engagement and impact

Success metrics will be defined based on the client's existing parameters during the initial meeting. The designer will use these to plan for innovative deviation strategies from harmful industry practices and later develop methodology.

The initial client meeting should be finalized with any burning questions that arose throughout the initial interview and review of their defined brief (if provided) to ensure the key points for circularity are addressed. The designer should compile the introduction material into their own project alignment and definition debrief. This final step ensures that they can continue with a clear objective to solve for and align future tasks towards achieving it.

Creating a visual representation of this design brief/debrief will help both the designer and client understand what the proposed sustainable system should entail and be referenced back to throughout the design process. This summary and outline of tasks to detail later in a timeline can be developed using traditional design thinking methods or recognized design entities discussed in **Design and Standardization** (Chapter 2 Section 5). The value in this provides the designer with a clear road map to follow throughout the design process and the client with manageable expectations to reference during final project evaluation. Additionally, this can be beneficial in supporting future presentation needs if done in a way that aligns with the brand visual identity.

Conduct Preliminary Research

The next step in this phase gives the designer the most flexibility in how they want to develop their research. They should use broad tools starting from on-site observations, field studies, and user journey maps before transitioning into precise tools like user interviews, affinity diagrams, SWOT analysis (strength, weakness, opportunity, threat), and/or NOISE analysis (needs, opportunities, improvements, strengths, environment). The critical things the designer needs to identify here are the key players, what they do, how they contribute to organic waste/management, goals and expectations.

Figure 4.8 Conduct Preliminary Research

All these factors will support the range of solutions that can be proposed and opportunities for ideation. They can also utilize the *Industry Characteristics Comparison Table, see* *Appendix C,* as a starting point to find overlapping themes amongst the sectors nearby based on their operations and codesign potential. Additionally, they can reference any relevant information provided in Chapter 2: *Design Standardization* *and* *Environmental Concepts* (Chapter 2 Section 5, 7) as a foundation. The following non-exhaustive list can help guide the designer towards preliminary research:

Understanding current waste streams: type generated, volume, waste segregation practices

Existing waste management practices: disposal methods, infrastructure, equipment, handling, transportation

Stakeholder roles and behaviors: employee involvement, management policies, customer interaction

Legal and regulatory framework: compliance requirement, incentives, penalties, networking opportunities

Existing technologies and innovations: current technologies used, emerging innovations, integration opportunities

Industry trends and best practices: case studies, circular economy initiatives

Economic Considerations: cost analysis, potential savings

Community and environmental impacts: environmental footprint, community engagement, codesign opportunities

The overall investigation should revolve around topics that promote a holistic view to bridge gaps between production and retail in managing organic waste. The goal is to gain a comprehensive understanding of the challenges and practical considerations needed to make sustainable design interventions. Templates that can be used here include:

- interview questionnaire deck, see *Figure 4.9* or *Appendix F* for full sized version
- observation template, see *Figure 4.10* or *Appendix Y*
- taskscape template, see *Figure, 4.11* or *Appendices CC* and DD

Figure 4.9 Sample set of questions from the Interview Card Set

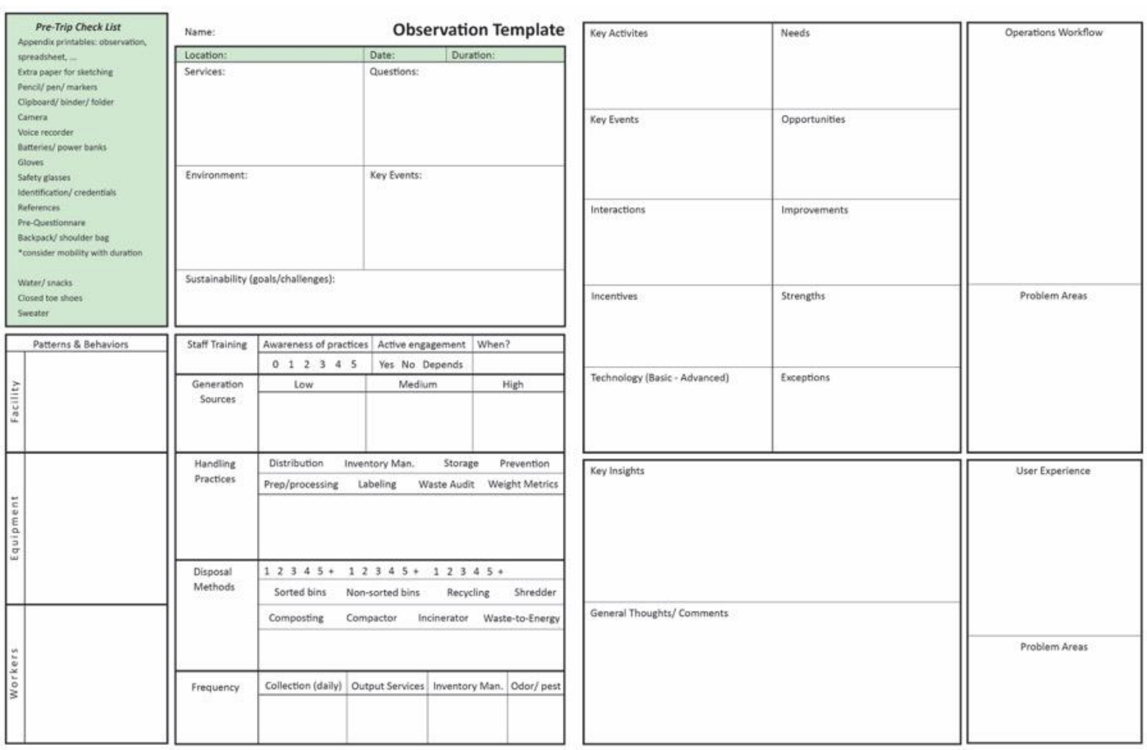


Figure 4.10 Observation Template

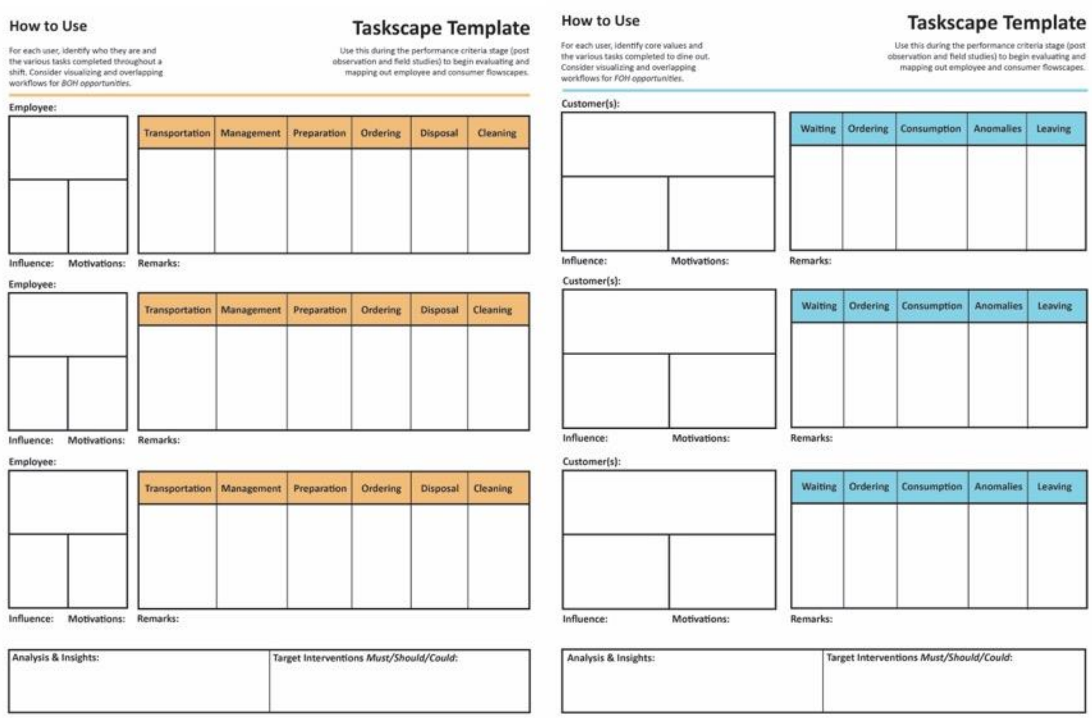


Figure 4.11 Taskscape Templates

If the designer follows the tool order above (broad to precise) they can use each template as shown to inform the next. For example, this research suggests conducting multiple interviews throughout but starting with interviews to inform the designer what to look for during the observations. Additionally, this would further uncover opportunities based on different key player expectations in the environment. By thoroughly detailing the observation template the designer can use that information to evaluate task streams to understand the flow of energy and waste. User insights can be gained from the developed categories in each taskscape template based on the user's motivations and goals regarding organic waste or any additional ones that the designer chooses to add. The compounding effect this has on the designer's research will directly support the development of performance criteria as major factors to consider for ideation, see *4.2.4. for Solution Table*.

Conduct Systems Analysis and Circular Mapping

This section outlines the implications of the food system for the designer's respective industry to identify and rank the leverage points. For systems thinking, this refers to the minor changes that can yield significant results and can be applied strategically to transform waste management systems. For example, if the designer's direction leans towards a product, they may leverage high impact and minimal risk prototypes for maximized exploration. If the solution needed to be more complex in production and costs the higher stakes could create more scrutiny to implementation means. The idea of leverage points begins to build on initiatives towards design for social and environmental change, where the interventions in product, packaging, and process become the main factors for closing feedback loops. By analyzing the system components in this way, big ideas or themes can be highlighted as directions for concept exploration and will become more apparent in the Application Phase *Section 4.3.2.1.*

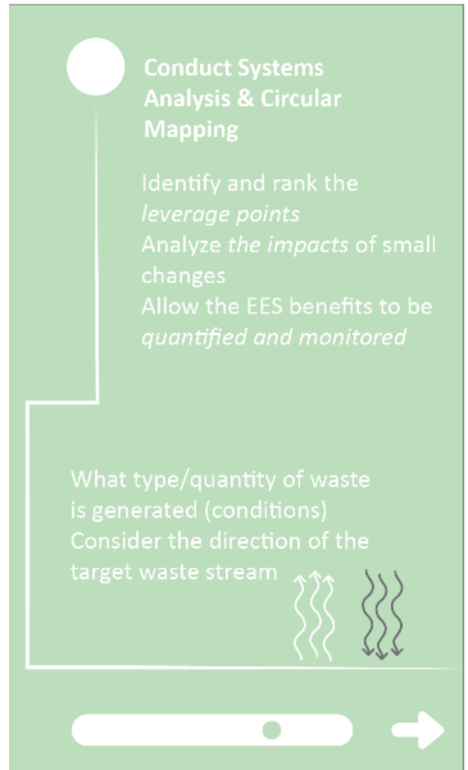


Figure 4.12 Conduct Systems Analysis and Circular Mapping

The utilized templates from the prior step should aid the designer in gaining an appropriate understanding of the client's organic waste conditions to begin examining why exactly levels of waste exist in the food retail operation. This is also where connections from uncovered insights can begin developing possible performance criteria. It is essential to consider the direction of the target stream, whether *upstream* (production, packaging) or *downstream* (distribution, sales), as it significantly changes the approach to a resolution. The audience and end goals for *upstream* vs *downstream* interventions are drastically different and impact the considerations needed for solution delivery method. Within this evaluation, like the traditional life cycle analysis, noting the environmental impacts of each step and validating with detailed field research starts to highlight the system interactions to focus on.

Visually communicating the flow of energy, both in terms of *organic waste* and how it moves in the environment, along with the interactions of *users* highlights the bottlenecks and points for intervention and provides direction for performance criteria. Following the designer's field observations, they can conduct traditional systems mapping with arrows showing the flow of interactions, or floorscapes which detail the flows of materials and users within the environment. A floorscape is a graphic representation of the actual floorplan showing where and how interactions occur (demonstrated in *Chapter 5 Phase 1*) and is created by the designer to understand the client's environment.

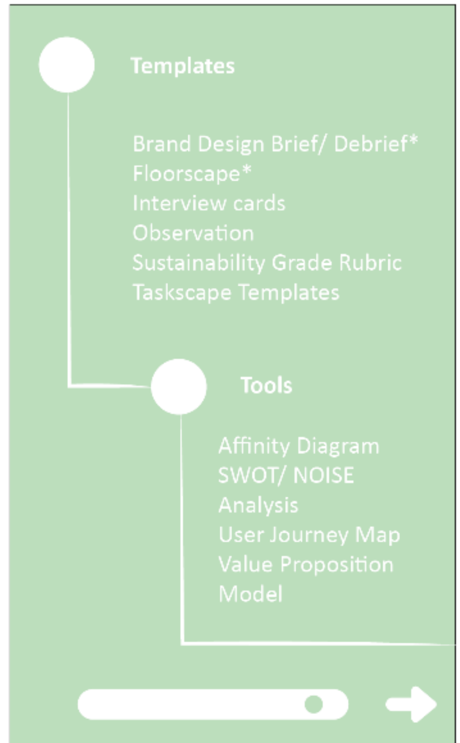


Figure 4.13 Phase One Templates and Tools

The designer should consider factors such as environmental impact, waste stream data and feedback mechanisms, and long-term sustainability when developing a system map and work strategically to build the most appropriate map for their needs. The recognized order for systems mapping is based on conditions complexity and depth of analysis and is as follows (Barbrook-Johnson, 2022).

- Brainstorming: connection circle, rich pictures, theory of change
- Identifying structure and dynamics: causal loop diagram, cognitive map, participatory systems
- Quantifying: fuzzy cognitive map, stock and flow model
- Running simulations: Bayesian belief network, fuzzy cognitive map, system dynamics

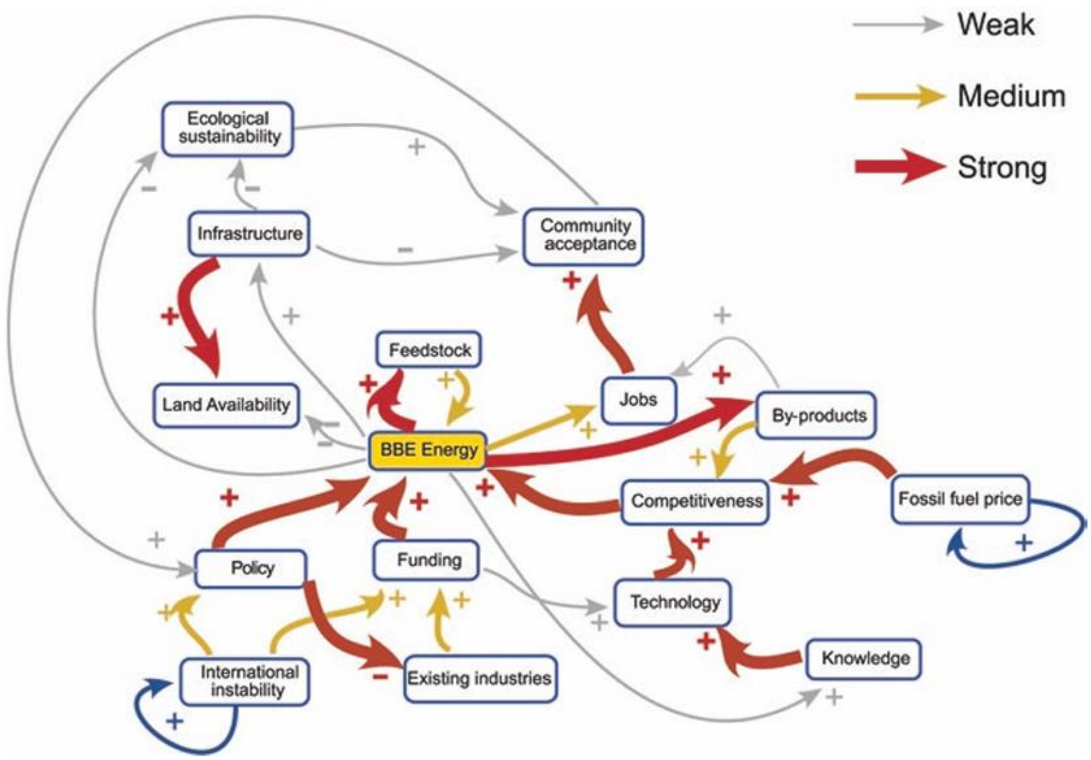


Figure 4.14 Example systems map (Barbrook-Johnson, p. 84, 2022)

The advantage of a system map developed in this section of the approach is that it shows exactly the needs and wants of the present day and the opportunities within the solution. This is mostly seen through industry conditions having reinforcing interactions of wastefulness and linear flows with landfills as the sole destination. By creating a map system, the designer can analyze their findings by aligning the operations with a proposed circular framework to determine what current flows need to be transitioned and possible solutions for improved interactions around organic waste management. This can be done visually to represent how far away the sustainable goals are to being achieved. The circular framework should include the principles of sustainability as discussed in Chapter 2 Section 5: Design and Standardization and look at the types of organic and non-organic waste managed in the environment in a holistic manner. With this, the designer can start to analyze how to shift current operations to developed sustainable strategies that are appropriate for the client. It is another validating point to show how linearity affects community resources and health. This can also serve as a beneficial monitoring tool later to see how new implementations feed into the loops and ensure that flow of material efficiency is managed more sustainably. These two tools work together to allow the designer to identify bottlenecks where waste can be reduced or redirected and provide a good basis to present co-design opportunities.

Figure 4.15 Performance Criteria Cover

4.2 Performance Criteria

Develop Performance Evaluation

In this phase, the designer should be able to utilize their system mapping and/or circular framework to ensure a means to evaluate material efficiency at different stages.

The observations, interviews, taskscapes, and additional research will support the means to develop the appropriate criteria. The end goal is to not just minimize waste, but to incorporate a quantifying aspect for monitoring. From here designers can identify and establish targets with the client for the rate of waste recovery and valorization. This is a possible resolution with real-time monitoring and communication helping to reduce harmful outputs. With this step, designers would be analyzing the products and packaging that exist and outlining worker flow to see when waste is being generated.

This is beneficial in framing the deliverables into achievable components that will ultimately create circularity which leads to regenerative systems in place that replenish the commons. By incorporating these systems into organic waste management, it ensures design solutions not only meet current needs but align with the broader ecological imperative to replenish and sustain the planet's resources. Ultimately, the designer should have a clear outline of system expectations and the tools to move forward with ideation in the Application Phase. They want to make sure that the organized content not only refers to the original established sustainable goals but also push the client's share of the problem in a feasible way.

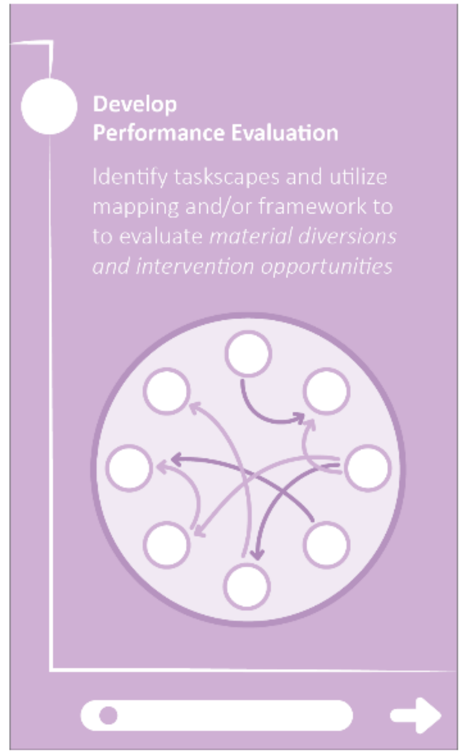


Figure 4.16 Develop Performance Evaluation

Outline Expectations with Design Thinking

Using this context, the designer should outline expectations for ideation through human, technical, and production factors to ensure the proposed system is functional, user-centered, and sustainable. Most importantly are the human factors due to the success of the system being based on engagement and usability. As a bridge between industry and the population, industrial designers must understand the psychological motives behind the operations that lead to food

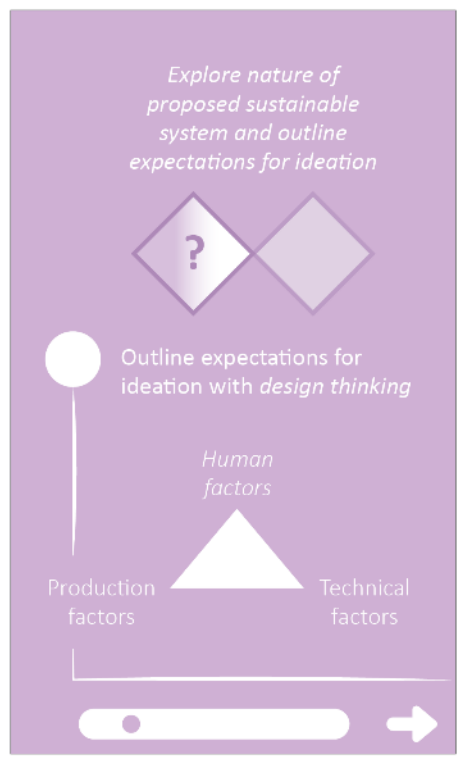


Figure 4.17 Outline Design Thinking

waste. Thus, it is important to assess how the different users contribute to sustainability goals.

With projects of this nature, it is typical to have a user breakdown that consists of the following: managers and team leads, staff, vendors, and consumers. This list is presented in terms of hierarchy and influence on organic waste management. By better understanding the different motives, the designer can strategize for a range of interaction types that encourage *pro-environmental behavior*. For those reasons, the designer should outline how to apply human-centered design principles and psychology to improve compliance, reduce errors, and foster a sense of responsibility. Additionally, they may utilize the most recent data from organizations such as WDO and IDEO or behavior reports from voluntary reporting parties such as the Global Reporting Institution with voluntary reporting as more validating points that show a population willing to pay a premium for sustainable options.

Regarding organic waste, the technical factors are second most important due to feasibility, durability, and compatibility with existing systems or infrastructure. These should begin to align with the constraints of the scope and parameters of the environment for the proposed sustainable system. With that, the designer can ensure the solutions are implementable and thoroughly consider energy flow and waste diversion capabilities. Production factors are still essential despite ranking last simply based on the designer's involvement regarding the nature of the problem. Depending on the agreement, the designer may deliver a proposed system of solutions but not be involved for actual implementation. For this type of project agreement, it is crucial to set up an implementation outline that organizes the tasks needed to launch different products or processes to ensure the client is not left without guidance. This outline should serve as a future forecast that considers any possible fail safes, threats, and methods to remedy any challenges that may occur. Or the agreement calls for the designer to be involved throughout the product manufacturing process, where they can address real time factors to better align the proposed sustainable system to operational realities for improved durability and impact. Regardless, the designer should still address these future factors to ensure the proposed system aligns with operational realities and maintains cost-effectiveness.

Determine Criteria Considerations

A range of considerations that reflect insights gained from practical applications in organic waste management have been discussed in *Chapters 2.4 Initiatives & Organizations* and *Chapter 3 Exploring Perspectives in Organic Waste Management*. The designer may choose to incorporate some of these criteria into their development or they can compile their own criteria based on field research. While this is not an exhaustive list, these categories are comprehensive for analysis to set the designer up for ideation. These may also serve as descriptions to the developed design objectives to serve the designer better in creating a Solution Table as a future step in this phase, see *Figure, 4.21*.

Figure 4.18 Determine Performance Criteria Considerations

Clarify Contamination & Misuse

The last critical aspect of these criteria is design for misuse and failsafe strategies. Both global and national case studies have shown that a significant challenge to effective organic waste management is contamination when trying to implement sorting practices. In this paper, this will refer to the addition of non-compatible material into compostable/ recyclable feedstock thus making the processing batch unusable. This idea extends into employee and customer education of material composition and appropriate waste streams with the prevalence of greenwashing. It has been observed that users of products believe they are doing their best to be environmentally responsible when consuming goods, yet their attempts to recycle are difficult because disposal methods can be misleading due to labeling and local waste streams often are eventually consolidated into landfills. For example, claims that a product is made from recyclable materials may omit key details on whether they are accepted into local recycling programs. If there was more applicable consumer education on material composition that would allow people to understand why and how different materials are disposed and processed, there could be more efforts in ensuring that waste types are more effectively sorted and valorized.

Figure 4.19 Clarify Contamination & Misuse

With the primary goal of this thesis being to reduce wasted energy potential, the challenge of contamination and misuse threatens the success of organic waste being valorized. By knowing how the different users will work with the product/system, the designer can specialize interactions accordingly. Considering how solutions to communicate and inform their patrons on sustainable efforts could lead to further innovation and revenue opportunities. Therefore, the designer should ensure they review their content for policy compliance alignment and additional means to design for transparency. This can be focused on signage, education, monitoring and feedback, behavioral nudges, process integration, and incentives for effective engagement.

Create Solution Table

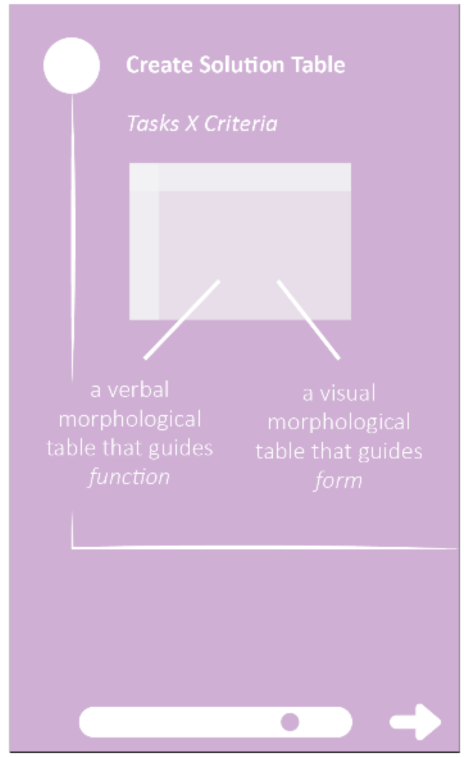


Figure 4.20 Create Solution Table

The designer can finalize this stage with a tool for ideation. The concept of the table is to develop a *verbal table* that guides function and/or a *visual table* that guides form and is based on brand parameters. To do this, the designer should set the table up with user tasks for targeted interventions (based on analysis in 4.2.1.) on the vertical axis and the categories for performance (based on objectives and design criteria) on the horizontal axis. In this way, each concept can consist of a combination of solutions per category and be more comprehensive in what it solves for. With the solutions, the designer could choose to organize ideas based on feasibility and impact to further rank the possible outcomes of indirect and direct methods. This indirect/direct concept will come into play in the following phase with the 3Ps model (product, packaging, process), see *4.3.2.1*. Overall, this table will be a tool to set the designer up for success in ideation through a comprehensive design template. *Figure 4.21.* begins to illustrate what the sample setup of the solution table looks like based on insights from Establishing the Stage. Here, one can see the correlation between the stakeholder tasks associated with organic waste management and the defined design objectives or performance criteria for circularity and sustainability. By mapping these relationships, the table helps designers identify how specific tasks align with overarching goals and criteria. This setup facilitates the creation of an adaptable system by encouraging the combination of solutions that address multiple aspects of organic waste management.

It is important to note that each performance category does not always require a solution from a specific user/task due to the range of interactions discussed. Therefore, whether the designer sets up the verbal or visual table they should be aware that it may contain gaps to communicate non applicable solution types for the purposes of the project. Additionally, this would significantly aid future ideation by providing more options to be presented and possibly encourage the client to engage in the brainstorming process. Lastly, it can serve as a presentation aid for the client to see the dimensions of opportunities in reducing organic waste and improving waste stream management in a visual way as options to expand upon. By providing the client with a range of options alongside the final proposed sustainable system they can be influenced by positive feedback to incorporate more options into their operations. In this way the designer is supporting the need for stakeholder engagement thus improving industry responsibility and opening up longterm design opportunities.

	Design Objective/ Performance Criteria 1	Design Objective/ Performance Criteria 2	Design Objective/ Performance Criteria 3
User Task 1			
User Task 2			
User Task 3			
User Task 4			
User Task 5			

Figure 4.21 Sample Solution Table setup

4.3 Application

Figure 4.22 Application Cover

It is a simple solution to say 'build new infrastructure' to reduce organic waste, yet this has not happened for a multitude of reasons: budget, land, space, feasibility, personal gain. Therefore, it is the designer's responsibility to approach the topic with practical resolutions that positively differentiate the client from poor industry practices. Incorporating sustainability into business operations is a trend, but achieving true green status that speaks can be a catalyst for positive environmental impact.

Ideation Considerations

At this point, the designer should have preliminary research and a general understanding in place and can start comparing this with the basic food waste hierarchy or their developed life cycle analysis to find overlaps in interactions. Determining how organic waste is managed will better inform how to ideate the best delivery method for applicable sustainable strategies. By finding the best stage for each intervention, solutions are more feasible and impactful for operations. Therefore, the designer can use this phase to apply a combination of performance

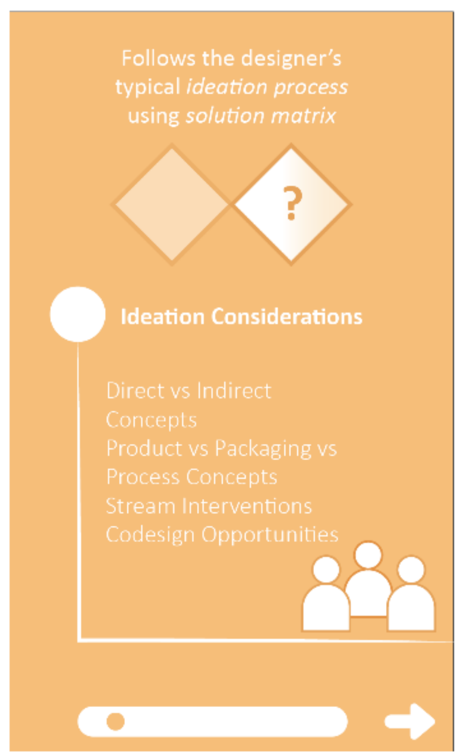


Figure 4.23 Ideate and Refine

criteria to develop concepts, discover what the nature of solutions can be in relation to the system, and prototype for feedback. This is the main diverging and converging section of the typical design process and should include the designer's typical methods for concept exploration with the goal of getting closer to the client's wishes. Additionally, the designer should conduct any necessary secondary research as ideation begins to become clearer. This can look at local circular applications to gather specific resources for financial support for infrastructure development or technology and innovation applications. In this way, industry can push government to incentivize and support sustainable initiatives and transition national operations to be more circular.

Ideation Evaluation

In terms of categorizing concepts to be more systematic, the designer must first decide whether something is *directly* or *indirectly* related to managing organic waste. To be *directly* related, it should focus on factors such as operational efficiency, while the *indirect* relations could include customer awareness. As the concepts become more organized, the designer can start to consider the simple formula: 1 + 1 + 1 + 1 …= 1. Essentially, a combination of indirect and direct solutions- or components of the proposed sustainable system- to implement accordingly can culminate in a holistic and unique solution. This systematic approach simply means that each intervention at different stages in the cycle will support the overall businesses' success in reducing organic waste. While certain steps may appear more important to the effort, it is essential to consider the system for a long-term solution that can be adapted in different ways if possible. For example, a

Figure 4.24 Perform Ideation Evaluation/ Tools and Techniques

back-of-house solution may be more permanent based on technical constraints/improvements, but the nature of customer engagement can be adapted as population consumption patterns change.

The designer could also benefit by considering how their solutions use organic waste diversion and reduction, innovation, and/or human centeredness to push the client operations to a true green model. Again, this is the undeniable effort that showcases a business's responsibility to sustainability, so if the overall concept does not fit this scope, then it may need adjustments or to be retired. By referring to the goals and objectives as well as the criteria to be true green and performance of the proposed system, the designer can ensure that solutions are catered to the cause. Overall, the designer should fully explore the possibilities of solutions based on the solutions table and ideations that extend from it to begin considering how multiple solutions would work together. In this way the best combination for the sustainable system can be developed and refined through sketching and rendering. As the designer considers the system, they should evaluate how each concept will interact with each other and the environment.

4.3.1.1 Process, product, and packaging – the 3Ps

By re-examining the features and functions of a concept, it can be classified into one of three categories (*process, product, or packaging*), helping the designer assess its potential to function effectively as a component of a sustainable system.

Process concepts should focus on how food is handled throughout the retail system to optimize operations to reduce waste, improve efficiency, and minimize resource use/impact. This can include employee training as a first step to improving the client's operations, using the employee workflow as a foundation to include where interventions lie. Developing clear procedures for waste stream diversions allow organic material to enter composting and recycling streams, thus closing the loop and reducing environmental impact. Additionally, reimagining the handling and rotation of inventory can be beneficial in standardizing practices to reduce product spoilage and packaging waste. Lastly, for inventory management a client may find predictive analytics and/or AI appealing so the designer should be able to present customizable programs to better track demand and reduce over-ordering.

Product concepts should focus on the goods themselves that the retailer offers and how they are managed in the business. In terms of sourcing, offering stages to become more farm to table could be a desirable solution if the cost-benefit analysis could be made. By sourcing from manufacturers with true green practices, utilizing seasonal/local foods, and upcycling ingredients as alternatives the client can lower their environmental impact. The designer can look more towards customization and modularity in the products offered to facilitate portion control and reduce organic waste. This can be presented in the form of inventory management systems that suggest secondary uses for prepped material or transitioning existing modular solutions to better suit optimized ingredient use. They can also focus on the actual designed product to help the employees do their jobs more efficiently and sustainably and promote the clients' efforts through customer engagement measures. Indirect product concepts may involve menu design to leverage psychology and increased customer education to decrease organic waste at the source.

Packaging concepts are generally most successful when done in the food production realms due to the scale of the trickle-down effect. However, it is possible to consider a food retailer's operations to see if it is feasible to streamline, but they mostly package as a transportation measure. This observation can be easily made by driving past the back outside areas for stores, where there are often piles of flattened boxes as part of the worker flow. These boxes are not always put into a recycling bin often due to the lack of bin availability. This is an obvious intervention point that can majorly impact big box stores and food retailers when a designer can work with these companies to develop multiconfiguration packaging. With this, the designer would then look at the best means for modular packaging to be transported, stocked, and broken down for effective collection. This could support the first in first out (FIFO) principle and improve employee workflow. Lastly, the designer can evaluate the current material use and composition for opportunities to reduce impact and use more sustainable material compositions. In this way, research would allow a top-down flow of influence that supports food retailers in effectively managing their waste streams through lower contamination.

With a collection of concepts, the designer should review and organize them based on the previously mentioned categories. The designer can reference *Figure 4.26* to summarize their concepts for future presentation purposes as well.

	Product	**Packaging**	**Process**
Consideration 1	Redefining product life cycle: extend shelf life and contributions to organic waste diversions	Shift to ecofriendly materials: biodegradable/ compostable and/or recyclable to reduce environmental impact	Efficiency and organic waste reduction: focuses on improving transportation, handling, storing, and preparation
Consideration 2	Inventory and waste management: standardized portioning and opportunity for upcycling (composting, fertilizer)	Education and engagement: clear labeling on materials and disposal for maximized impact (validation and awareness)	Employee training and workflow: adopting new changes to operations require time and commitment
Consideration 3	Sustainable systems: feasibility of multiple small interventions that create overall large impact to make appropriate waste diversions	Brand image and loyalty: signifies committment to environmental responsibility, while avoiding greenwashing (transparency)	Regulatory compliance and reporting: future forward solutions align to upcoming industry standards (cost savings over time)
Summary	*Easiest to implement on small scale for feedback* *Difficult to raise capital for infrastructure (look for codesign opportunities)*	*Requires collaboration with food production sectors for downstream interventions on scale*	*Longest implementation period due to psychological factors of environment stakeholders*

Figure 4.25 The 3 Ps Model: Product, Packaging, Process

The 3 Ps model summarizes the main considerations for each of the categories discussed in this section. By providing designers with a lens to view sustainable solutions, they are better equipped to identify the methods needed to transition a client's operations to be circular. This research encourages designers to balance immediate changes for systemic operational strategies as the most direct touchpoint for users and utilize solutions across the innovation model for adaptability and scalability.

By simplifying the concept type, it will allow the designer to better present the proposed system as a holistic solution, where each component covers a different objective and works together to accomplish a common goal- circularity and sustainability. This model can also help them evaluate the most successful concept type for a specific task and determine the appropriate implementation strategies based on the combination of proposed solutions.

Prototyping Considerations

The next crucial step is the refinement phase which starts with the best combination of proposed sustainable solutions. The designer should have a good development of sketches to begin prototyping and gaining feedback from. Buchanan (1992) notes that that wicked problems have an infinite number of solutions that cannot be tested *(see Appendix A).* However, it is still beneficial for the designer to create low fidelity mockups to gain meaningful insight from users and the client on direction. The solutions can be either digital or physical but need to be tested for overall functionality and circularity to ensure the

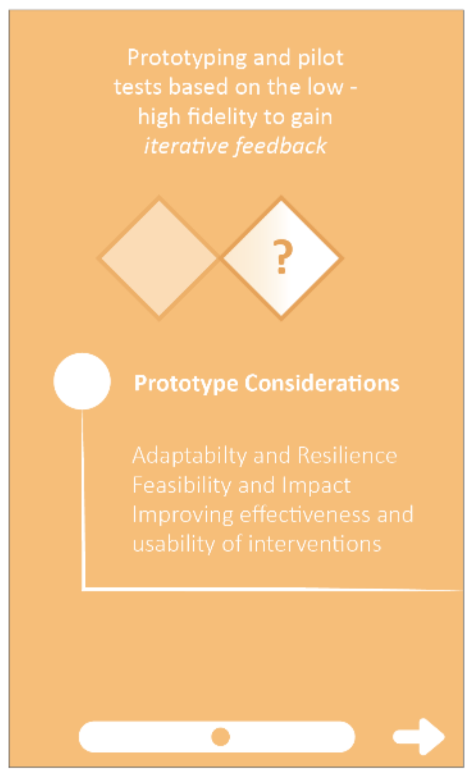


Figure 4.26 Prototype and Refine

performance criteria are being met and see where improvements to the design can be made.

This should first be done using design methods tools such as stakeholder mapping to analyze the impact of proposed solutions. The designer can organize insights from different users in an affinity diagram to help make connections between positive and negative points for improvement. Next, they should move into actual mock-ups ranging from low to high fidelity as the idea develops. The designer can use paper/ cardboard prototypes to test for ergonomics and performance before moving into CAD, 3D printing, and live simulations that test proposed modified operations and refined concepts to further test system viability.

Implementation Validation

At this point, the designer will have ideated, refined, and prototyped solutions for the proposed sustainable system. The last step of this phase is for the final system to be evaluated critically in terms of the performance criteria, client expectations, and sustainable goals which could result in two outcomes. The system can fail based on overall performance and could need a different solution type inputted to resolve the issues. The new system would need to be retested before being validated, but this would allow the best solutions to be presented. Or the system could meet the criteria due to throrough refinement and testing and can proceed with implementation.

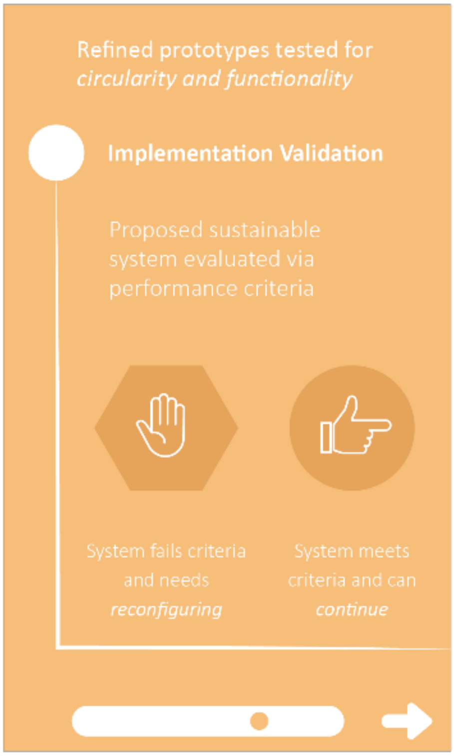


Figure 4.27 Perform Evaluation

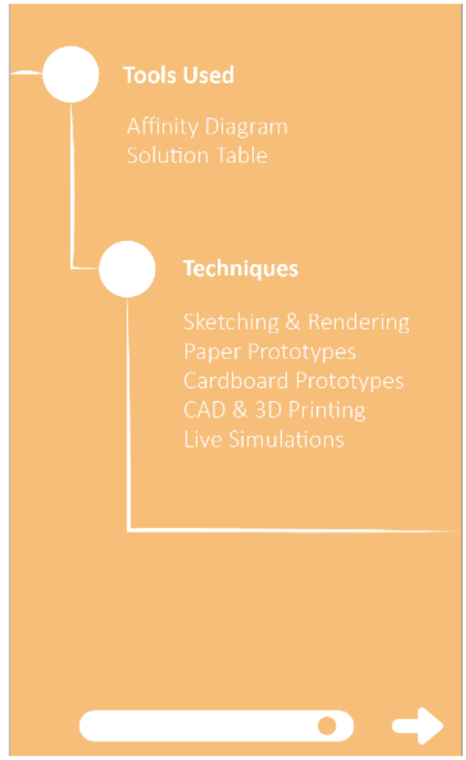


Figure 4.28 Phase Three Tools and Techniques

4.4 Implementation

The previous phase included prototyping, but here is when the designer can consider the implementation and feedback portions before presenting them to the client. The final developments help communicate how human-centered circularity is achieved through valorization. These further outline how the infrastructure created is based on the staging of the services and highlight opportunities for collaborative networks.

Figure 4.29 Implementation Cover

Specify Feedback & Monitoring Measures

A critique from field observations and casual interviews was that sustainable efforts were unclear at best and nonexistent at the worst. While the barriers have been discussed to implementing circularity for food retailers, there is also an important opportunity for this sector to improve customer experience. Brand loyalty is a major reason consumers frequent specific food retailers and by showcasing how the business not only cares for their users but also the planet is a method to promote their environmental, economic, and social efforts. This can encourage leadership within the food retailer's staff to ensure sustainable measures are being met according to the set goals and improve business accountability. Lastly, a way to obtain insights from a variety of

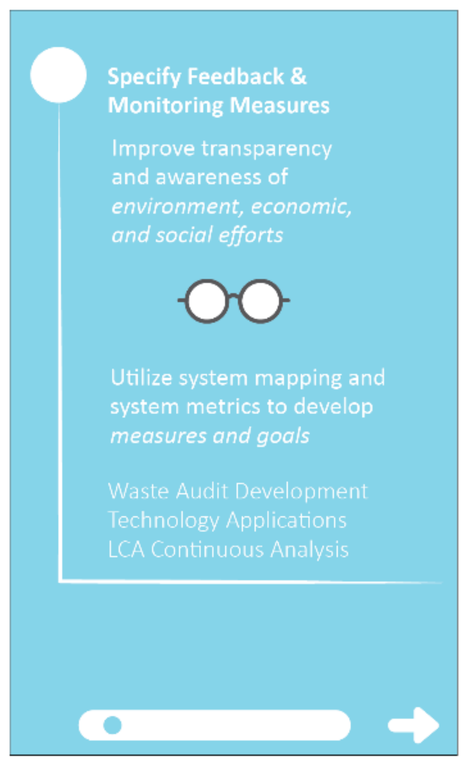


Figure 4.30 Specify Feedback & Monitoring Measures

users of the proposed system would allow both employees and consumers to voice praise or concerns to support personal responsibility towards wasteful systems. These considerations could aid in developing employee training and updates for future thinking. They also highlight the psychological aspects to design to positively pressure industry into true green practices.

Due to the nature of the wicked problem of food waste in America, there is a need to develop effective feedback and monitoring measures as a part of the solution. This would provide the client with tools to measure compliance, engagement, and areas for improvement. The designer can utilize the prior systems mapping they've done in addition to the defined performance criteria as a foundation. If there are waste audits, the form needs to be evaluated in terms of sustainability and circularity, where if these principles are not a consideration, then they need to be added (see Chapter 2 Section 5).

The designer should also review the application concepts to see if technology in data collections is feasible for the client's environment before determining the best direction for the concepts. The use of AI can be highly beneficial in tracking and streamlining data for the client to reference when determining project success if the client's technology operations allow.

To facilitate feedback from the proposed sustainable system, the designer can also establish key performance indicators (KPI), such as reduction percentages and contamination levels, to track if the system is achieving the performance criteria in place. This in combination with life cycle analysis (LCA) monitoring will ensure energy from organic waste is recirculated into the environment through composting and recycling efforts.

Develop Valorization Strategies

Throughout this paper, composting and recycling efforts have been highlighted, and the implementation phase is how/where the sector can divert waste from landfills, capture energy value, and promote circularity.

The designer should refer to their evaluation of the client environment to determine whether it is feasible to have an on-site composting set up or if an external partnership between other businesses in a retail complex or service vendor is required. With this, they can look back to Chapter 2 Section 7 for the most appropriate method and application before doing any secondary research to help connect the client with the best local resource. As seen in Chapter 3 case studies, a business may be able to integrate anaerobic digestion systems for biogas that can be used to power the facility or in-vessel systems that maintain satisfactory operations (lower chance for pests and odors). With additional research towards biodegradable and compostable packaging the chance to streamline waste streams by making them more compatible with circular processes is highly probable.

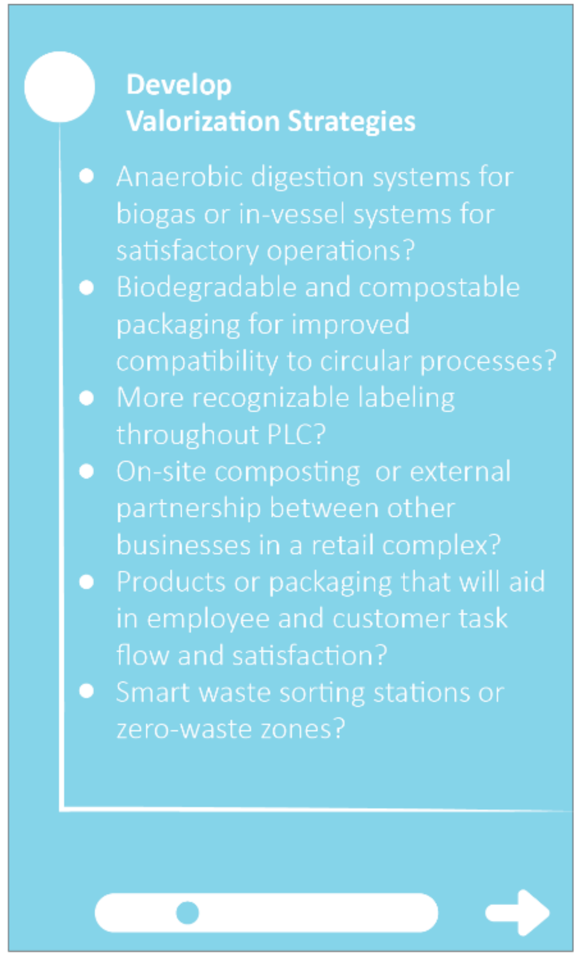


Figure 4.31 Develop Valorization Strategies

It is essential for the designer to consider any improvements to the current handling and storage of food and packaging. Redefining this system could allow for specific areas designated for food donation, where safe surplus items can be put aside for quality control. Adding smart waste sorting stations or zero-waste zones could result in a unique sustainable system solution. When food inevitably starts to lose peak freshness, these items are sometimes discounted for quick sales and to reduce organic waste. The designer can lean into this idea and develop more recognizable labeling to ensure this is being communicated effectively. Another opportunity is for the idea of on-site upcycling where organic by-products can be turned into new ones and sold thus creating additional revenue streams and reducing organic waste. This can be done for a category of foods apart from a business's inventory or strictly one food item. With this, partnerships between agricultural sectors and other food companies can be made to develop an interconnected sustainable food system. Additionally, these collaborative infrastructures can further promote and connect with eco-conscious consumers and strengthen brand loyalty.

Develop Implementation Strategies

To validate the project, it is essential to package the final deliverable in a way that is digestible to the client. If the proposed solutions are all high stake, high investment concepts then it is less likely to be done. Therefore, the designer should consider their ideation and refinement journey to see what themes exist to start ranking the solutions to be presented. Referring to the product, packaging, process model from section 4.4.1., the designer can deliver the appropriate strategies for each component going from least to most investment. By doing this in an economic manner, the designer can implement process concepts first to gain valuable feedback about the proposed new conditions and possible improvements. Additionally, thinking about it early on helps prioritize ease of use and improve the probability these interventions will be implemented.

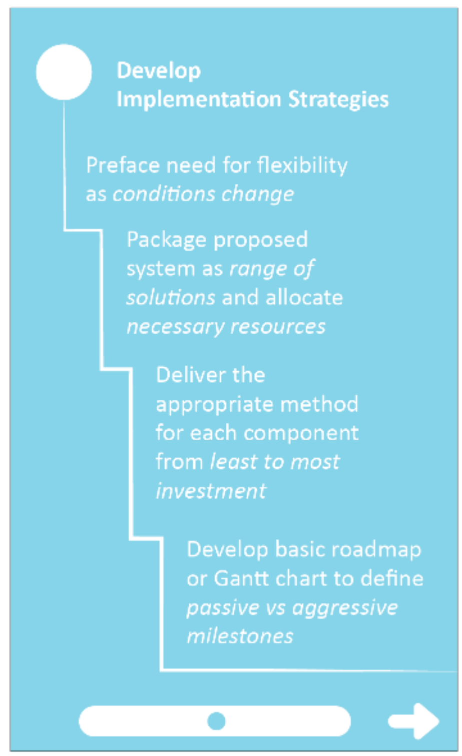


Figure 4.32 Develop Implementation Strategies

The designer should have already considered the environmental factors and manufacturing methods needed to actualize their concepts during the Application Phase. Following this, they can work with the client and any manufacturers needed to begin developing the products or packaging that will aid in employee and customer task flow and satisfaction. The designer would want to build on the previous stage by utilizing the prototypes to streamline product development and utilize prior design thinking to establish the least environmentally impactful goods. By gradually implementing solutions with maximum scrutiny, users of the system can be attracted to and buy into the sustainable measure being implemented which not only helps fund additional research and development efforts, but also validate the need for other industry sectors to buy into the system too. The scrutiny behind a proposed sustainable system ensures that it solves the wicked problem in the best way possible for the least negative unintended outcomes.

From here, the designer can start to develop and outline a basic roadmap or Gantt chart with details on implementation stages. This should clearly define what product/service will be put in place, when each stage will be implemented, the exact locations for interventions, how they should work, and a plan to receive feedback. By managing the complexity of a range of solutions and allocating resources and time to each system component, the designer is not only ensuring scalability of future opportunities for the client but also promoting true green practices for industry to follow. Serving as inspiration for the community and using real time insights to adjust components accordingly as they are rolled out will further clarify the protocols needed for effective organic waste management.

Alongside the actual implementation stages, the designer should also create some customer/employee/store document that compiles data collected throughout and after the end of the project which can be updated by the client as conditions change. This should include interviews/ surveys to measure changes in awareness, satisfaction, and engagement, KPI’s with appropriate monitoring methods, and benchmarking to compare system performance. It is important for the designer to preface their deliverables with the idea that a sustainable system is as flexible as the environment needs and therefore may require new features or regular adjustments. However, these changes within a set outline do not necessarily mean they are not beneficial, as they do provide a general outlook on the client's circular innovation journey.

4.4.1.1 Consider Economic Factors

While the need for sustainable interventions in the food system is prevalent, the next barrier the designer must cross is how to facilitate those cross-sector collaborations. At the end of the day, a business can do its very best to operate with a lower environmental impact, but if the efforts do not connect with larger opportunities, then the efforts may not be successful. In the case of food waste in America, it will be an even more difficult bridge to gap but design education and practice makes industrial designers well placed to take on the responsibility of solving this wicked problem.

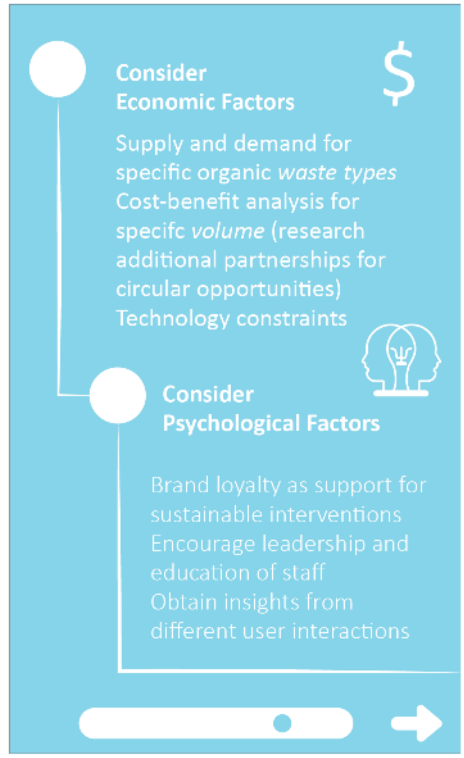


Figure 4.33 Consider Economic and Psychological Factors

To aid the designer in including more of the economic factors, updated research on the general supply and demand for specific organic waste will help to align their flow analysis with areas for waste diversion to happen.

The designer can then frame the economic value and return on investment (ROI) through initial investment, yearly savings, environmental impact, social benefit, alignment or performance expectations (exceeding or accelerating) to help the business review the outcomes of the project. This supports future circular and sustainable investments with visible positive feedback and points to increasing industry responsibility by providing the necessary data to validate the need for sustainable measures. In this way, the relationship between high volume organic waste matches the demand for applications in circularity, which can be applied to agricultural or landscaping sectors. A cost-benefit analysis will help determine if waste-to-energy applications are feasible with volume and infrastructure investment. The creation of these supporting documents helps ensure that the needs of each solution and accompanying resources are all delivered in an appropriate way to the client.

The final design deliverables might also include applicable software the client could utilize moving forward to automate monitoring measures. There is software that exists and under development to deliver systems mapping to support real-time monitoring and tracking technologies. Food retail sectors can utilize these to visualize organic waste streams, identify bottlenecks in operations, and map the relationship between waste source and disposal methods. Leveraging AI could also support effective design interventions and interpret data. Some examples of these used for systems mapping include but are not limited to Kumu, Lucidchart, Miro, STELLA Architect, Tableau, and Vensim. The designer would need to seek outside expertise to help the client make an appropriate software selection. Prior to that, it will be important for the designer to validate the need for such software due to high cost, therefore they can first investigate setting up a low-fidelity simulation for the client to plug data into or what the most appropriate data would be to create one or multiple equations to help them interpret flows. If this is not applicable, then the designer must design around the existing software used or acknowledge this as a possible later incorporation.

4.4.1.2 Consider Psychological Factors

To explore how people will react to their proposed sustainable system, the designer should consider conducting some smaller scale pilot tests with concepts that involve direct engagement from customers and/or employees. Depending on the location of the retailer, this solution may need to be catered to be more user friendly or feel less inconvenient to interact with. Gathering these behavioral insights from users can help the designer tweak the customer facing solutions more towards pro-environmental behavior and away from resentment for sustainability measures. The designer may also want to test a variety of infographics where the educational benefit enhances the overall dining/shopping experience and informs patrons on the client's upcoming initiatives.

Finalize Proposal & Handoff

The designer might develop a final evaluation for their proposed sustainable system to explain how the system components achieve the original design objectives and why the implementation methods were chosen. This will further validate applications of gained feedback throughout research and any need for financial capital. It should include means for the client to review the results of the project in terms of environmental and economic impact.

Figure 4.34 Finalize Proposal & Handoff

In evaluating environmental factors, system effectiveness in reducing organic waste in operations and in disposal should be considered. For this, the designer can include applicable federal and local monitoring programs that can help their client stay updated with global key performance indicators.

In economic evaluation, the designer should frame quantifiable factors in a way to help the client determine their return on investment. This can include revenue generation, cost savings, and investment recovery to better inform the client of the financial benefits to the proposed system. With this, the client can also consider their original sustainably grade as a measure to see how their operations have improved environmental responsibility over time and further validate higher stake solutions. Overall, the evaluation is a means of encouraging continuous improvement of the sustainable system and improving stakeholder engagement for maintained support.

The handoff of the project can either be the comprehensive communication of solutions to be manufactured and/or implemented, or the outline of continued involvement with the project/ client to actualize the proposed system. Elements of this communication should include:

- a system overview with a summary of the solutions and benefits of both the parts and the whole.
- the key metrics the system should meet, such as contamination prevention, sustainability measures, and waste diversion rates.
- an implementation outline that provides clear instructions on integrating the solution into daily operations with the accompanying timeline for launch.
- a roadmap providing current solutions and potential future iterations or upgrades
- a detail of tools, technologies, materials, and/or manufacturing methods to deliver each solution in the right timeframe
- necessary training materials for employees and communication aids for vendors
- a feedback and monitoring framework, which supports the client's need for adaptability and scalability
- supporting information based on research applications and a point of contact for any troubleshooting. This portion is beneficial when the designer is not continuing with the project and ensures the client is set up for success to transition to a true green model, where their operations clearly reflect circularity and sustainability.

Overall, by utilizing the ***Circular Approach to Organic Waste Management:*** *Sustainable System for Food Retail Sectors*, designers can develop unique strategies for industry to address the wicked problem of food waste in the U.S.

To illustrate the potential impact of this approach, this thesis will conclude with a demonstration of this approach using the food retail store Waffle House. By applying these tools and techniques to a focused scenario, the real-life applications for circularity can be further validated and support efforts to improve industry responsibility regarding sustainability.

5 Demonstration with Waffle House

As a beloved staple of the American dining experience, Waffle House is known for its 24/7 service and consistent menu and has been satisfying customers since 1955 (Waffle House, 2020). The nature of the chain's ecosystem revolves around the slogan 'good food fast and friendly' which is represented though a high customer turnover in a limited prep space. However, this model generates substantial food waste in their daily operations and contributes to high industry emissions that negatively impact the environment. Addressing food waste in this context will require sustainable strategies that align with their unique service style.

With a strong presence in the community and a high-volume, fast-paced environment, *how can design help reduce Waffle House food waste?* This design brief outlines resolutions that aim to create a scalable system for use across locations utilizing the Circular Approach to Organic Waste Management, see *Figure 5-1*.

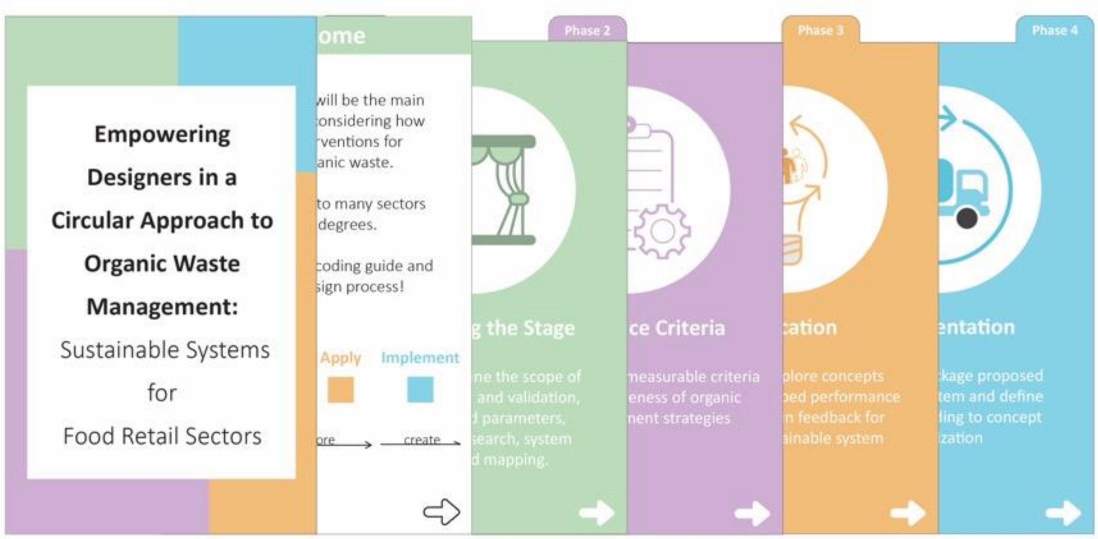


Figure 5.1 Overview of the Approach Card Set to be applied to the demonstration project

5.1 Phase One

Starting with *establishing the stage,* a general context and validation of study is determined before moving into clarifying the scope of research and development, see *Figure 5.2*. However, due to my prior experience working at a Waffle House restaurant (6 years seasonal) I will be skipping the preliminary questions and moving straight into context and alignment. In terms of Waffle House's alignment to the current market trends in sustainability, no specific goals or initiatives have been defined or outlined by the corporate entity. However, there are opportunities among franchises to implement them independently to better serve their community values. These actions would serve as a 'pilot study' for the company to see how incorporating circular principles into their operations can be beneficial to the business. This can already be seen in two successful cases out of the 2,004 stores that exist (Waffle House, 2023).

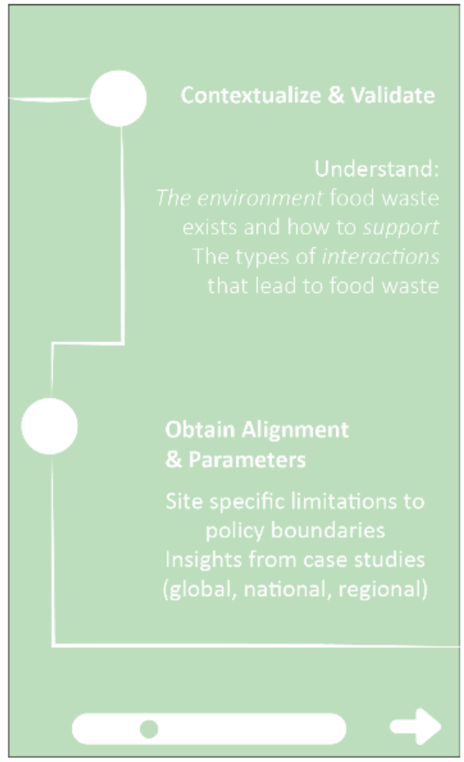


Figure 5.2 Phase One – Contextualize and Validate & Obtain Alignment and Parameters

The first initiative happened recently in February of 2024 between Waffle House and the Tennessee EV charging station program. As the name suggests, the program had a clear goal of utilizing federal funding to implement 30 EV charging stations across the state. The criteria to be chosen as a site was strict and the competition fierce with 167 contract applicants, but a Waffle House at 9780 U.S. Highway 64 in Lakeland, TN has received a contract based on its unique characteristics. For the charging site, a major condition is to have a gas station and retail food outlets in the same vicinity, but the restaurant was chosen as the only standalone site due to its 24/7 operations and commitment to their community. This exemplifies the opportunity for the brand to further serve their communities through true green practices (Casey, 2024).

The second initiative in August of 2024 between Waffle House and Georgia Power was demonstrated in Macon, Ga. Solutions focused on energy savings through Blue Frontier's Dedicated Outdoor Air System (LD-DOAS) technology that eliminates the use of high global warming potential (GWP) refrigerants and reduces energy consumption (Southern Company, 2024). This led to improved ventilation and humidity control for the facility and the operation running quieter with no condenser. Both are essential to the nature of the casual dining establishment where the facility is constantly kept cool to balance out the centralized open grills. The overall energy savings outcomes are based on internal collaborations that lead to a supportive network that show the value of branching into more sustainable operations.

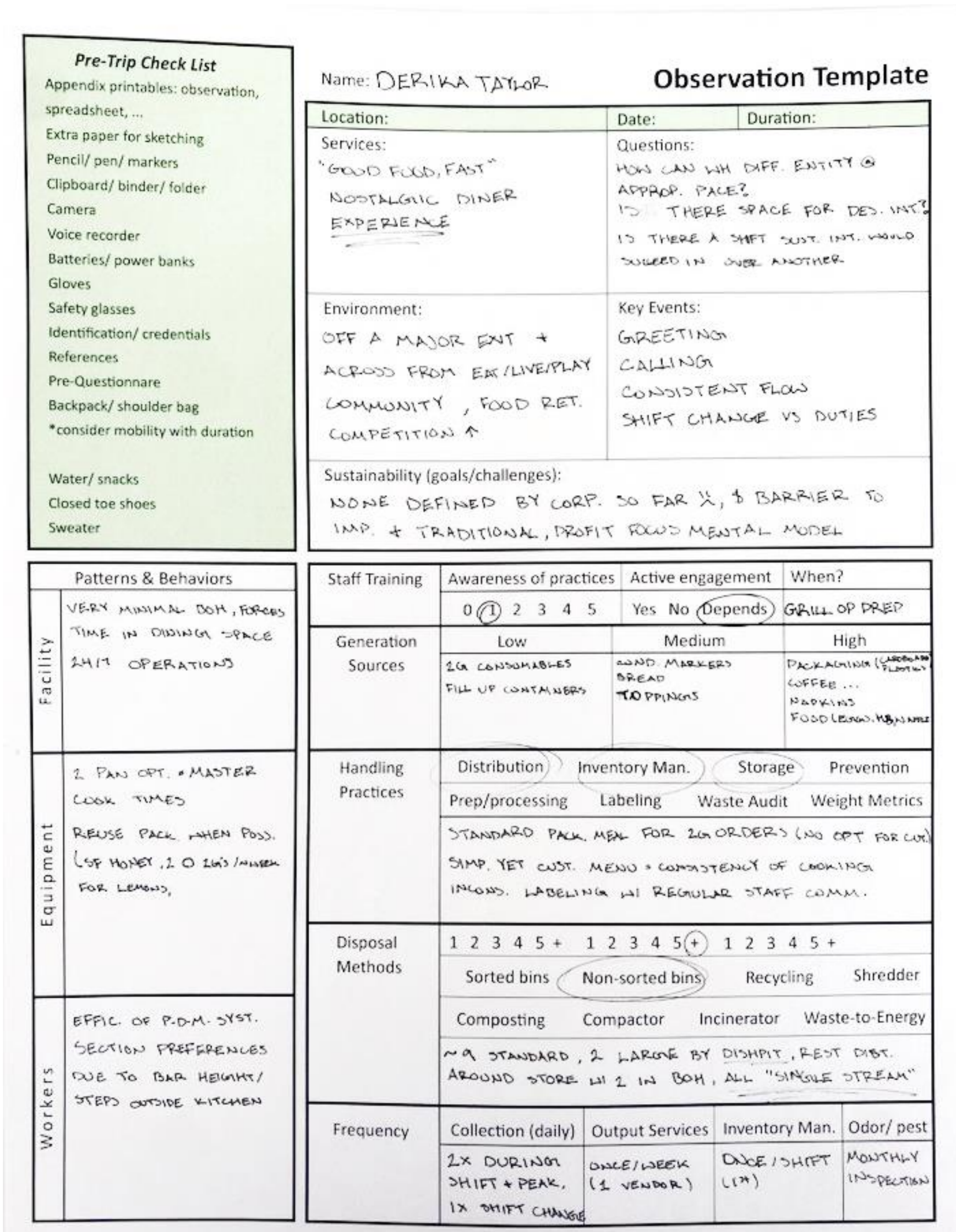
As outlined by Waffle House corporate, the brand has a high-performance rate with the average table turn being around 10-20 minutes during peak times and 30 during slow times (Waffle House, 2024). Additionally, because they manage the overhead data for the inventory that is distributed amongst all the stores, they can put out performance data to engage with stakeholders, see *Figure 5-3* below.

Figure 5.3 Scale and volume of Waffle House operations. Adapted from "Beyond the Menu", Waffle House.

With a general understanding of the operations and market alignment, the environment and conditional factors were evaluated through preliminary research to further define the design objectives. This began with the *observation template* that allows more to be learned about the loosely defined key players, see *Figures 5.5 and 5.6* below. Additionally, the observation was conducted before interviews due to my prior knowledge, as it was necessary to gain a refresher on the operations and understand any changes.

Figure 5.4 Phase One – Conduct Preliminary Research

The first thing to note is the compact footprint of the restaurant and the considerations for operations with high volume. A common sentiment is surprise and awe at how well-oiled the kitchen staff works to deliver throughout the store with efficiency. This is an essential part of the Waffle House culture that differentiates them from modern counterparts and maintains the feel of a different era. Additionally, the store's high volume means the workflows of each worker are simplified to allow effective service. The brand can maintain an 'old school,' nostalgic feeling through the closeness of the dining and cooking areas and the nature of interactions that occur. Specifically, certain Waffle House locations are favored by regulars for the quality of experience they have over others, which is an important cultural factor here.



Pre-Trip Check List

Appendix printables: observation, spreadsheet, ...
Extra paper for sketching
Pencil/ pen/ markers
Clipboard/ binder/ folder
Camera
Voice recorder
Batteries/ power banks
Gloves
Safety glasses
Identification/ credentials
References
Pre-Questionnare
Backpack/ shoulder bag
*consider mobility with duration

Water/ snacks
Closed toe shoes
Sweater

Name: DERIKA TAYLOR

Observation Template

Location:	Date:	Duration:

Services: "GOOD FOOD, FAST" NOSTALGIC DINER EXPERIENCE	Questions: HOW CAN WH DIFF. ENTITY @ APPROP. PACE? IS THERE SPACE FOR DES. INT.? IS THERE A SHIFT SUST. INT. WOULD SUCEED IN OVER ANOTHER
Environment: OFF A MAJOR EXIT + ACROSS FROM EAT/LIVE/PLAY COMMUNITY, FOOD RET. COMPETITION ↑	Key Events: GREETING CALLING CONSISTENT FLOW SHIFT CHANGE VS DUTIES

Sustainability (goals/challenges): NONE DEFINED BY CORP. SO FAR, $ BARRIER TO IMP. + TRADITIONAL, PROFIT FOCUS MENTAL MODEL

	Patterns & Behaviors
Facility	VERY MINIMAL BOH, FORCES TIME IN DINING SPACE 24/7 OPERATIONS
Equipment	2 PAN OPT. + MASTER COOK TIMES REUSE PACK. WHEN POSS. (SP HONEY, 2 O 2G'S / WATER FOR LEMONS,
Workers	EFFIC. OF P-D-M. SYST. SECTION PREFERENCES DUE TO BAR HEIGHT/ STEPS OUTSIDE KITCHEN

Staff Training	Awareness of practices	Active engagement	When?
	0 (1) 2 3 4 5	Yes No (Depends)	GRILL OP PREP

Generation Sources	Low	Medium	High
	2G CONSUMABLES FILL UP CONTAINERS	SAND. MARKERS BREAD TOPPINGS	PACKAGING (STYROFOAM, PLASTIC) COFFEE ... NAPKINS FOOD LEFTOVERS

Handling Practices	
	(Distribution) Inventory Man. (Storage) Prevention
	Prep/processing Labeling Waste Audit Weight Metrics
	STANDARD PACK. MEAL FOR 2G ORDERS (NO OPT FOR CUT) SIMP. YET CUST. MENU = CONSISTENCY OF COOKING INCONS. LABELING W/ REGULAR STAFF COMM.

Disposal Methods	
	1 2 3 4 5 + 1 2 3 4 5 (+) 1 2 3 4 5 +
	Sorted bins (Non-sorted bins) Recycling Shredder
	Composting Compactor Incinerator Waste-to-Energy
	~9 STANDARD, 2 LARGE BY DISHPIT, REST DIST. AROUND STORE W/ 2 IN BOH, ALL "SINGLE STREAM"

Frequency	Collection (daily)	Output Services	Inventory Man.	Odor/ pest
	2X DURING SHIFT + PEAK, 1X SHIFT CHANGE	ONCE/WEEK (1 VENDOR)	ONCE/SHIFT (1X)	MONTHLY INSPECTION

Figure 5.5 Filled out first page of observation template for Waffle House

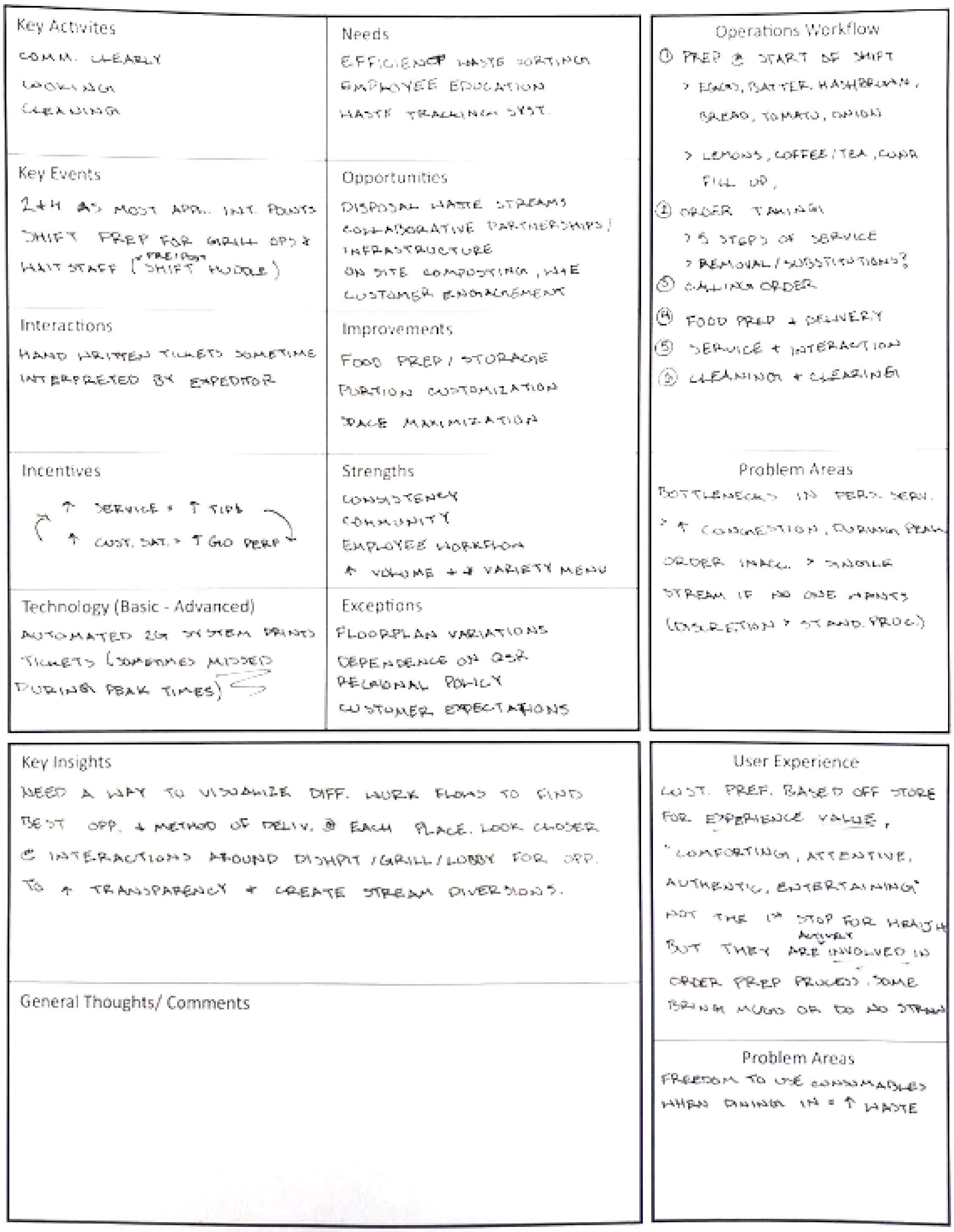


Figure 5.6 Filled out second page of observation template for Waffle House

This template helped realign my standards and expectations of current operations to ensure outlets for solutions are not already solved for. However, this alone was not enough to inform the design objectives so the next step in the phase was conducting user interviews to empathize with their opinions and understand any goals and needs. Due to my more detailed frame of reference into operations, the questionnaire deck was used strategically to reaffirm and inform the project objectives by utilizing the following questions, see *Figure 5.7:*

- What areas of your waste management system do you believe have the most room for improvement?
- What percentage of your organic waste do you estimate is properly sorted and disposed of?
- Do you use any technology or tools to manage/track waste?
- How familiar are you with the concept of a circular economy?
- How important do you believe it is for your organization to adopt circular practices for organic waste management?
- If no or considering, what challenges, if any, do you face in implementing these practices?
- Are there any specific barriers that prevent you from implementing more sustainable organic waste management practices?
- How does employee behavior impact the efficiency of organic waste management in your establishment?
- How does packaging influence the amount of organic waste generated in your operations?
- How do you think your business could better integrate circularity into waste management practices?

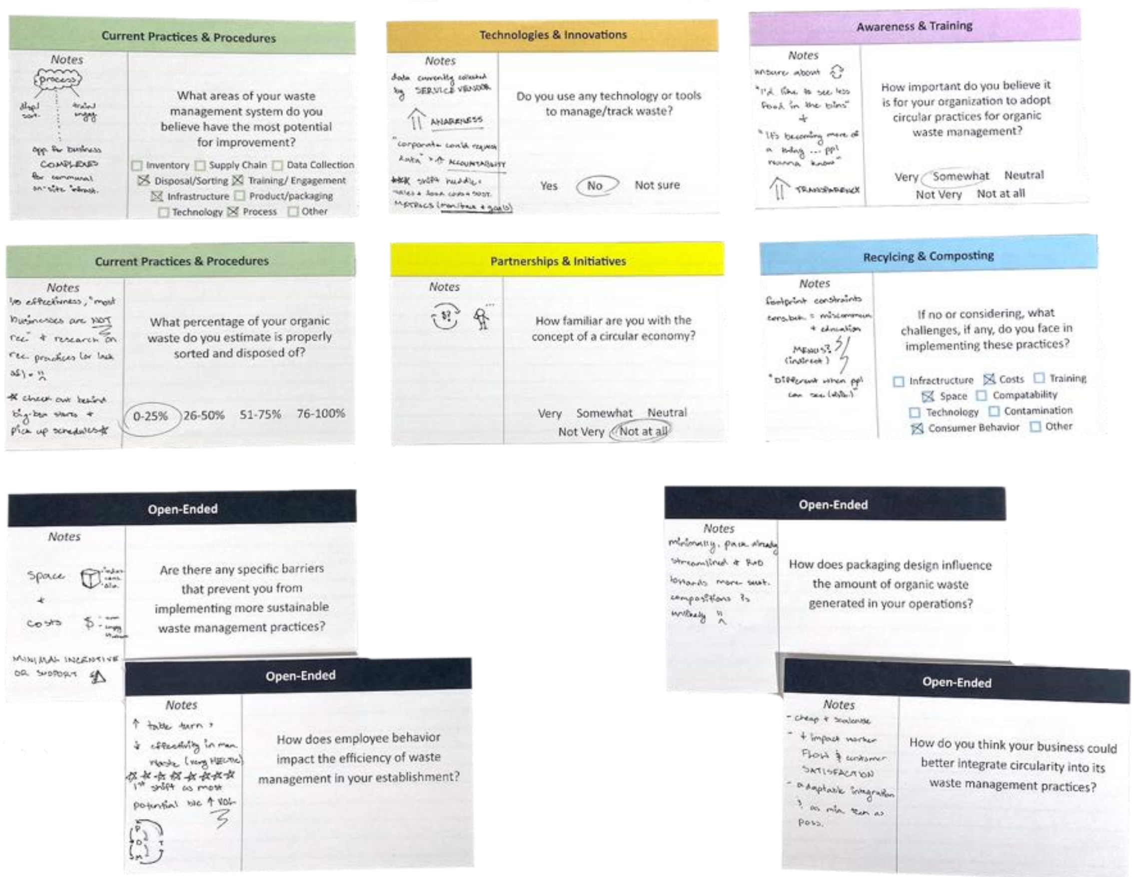


Figure 5.7 Specific questions asked during the interview process

This interview was conducted with an experienced manager of 5 years with a prior background in food retail. The accompanying answers were documented on cue cards during the interview then later compiled into a sketch noting summary page. This was done in the visual style of Waffle House but added memorable yet simple characters to start planting the idea for future content into the minds of stakeholders. Overall, the positive reaction behind using physical cards during the interview and coming back with a summary page helped engage this manager with the design process as an active participant.

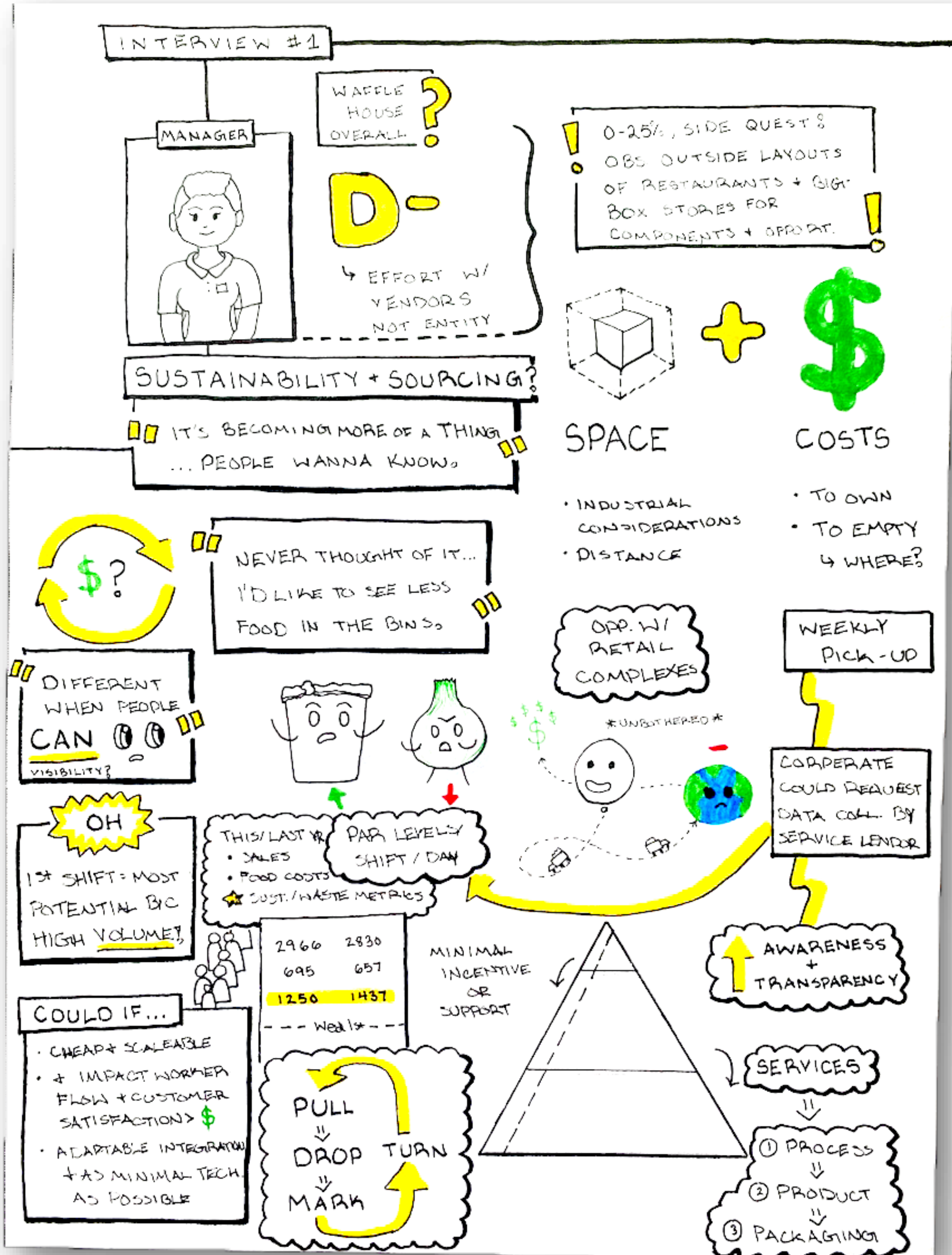


Figure 5.8 Sketch noting summary page for the interview

From this interview, the main points of insight were that the design resolutions should be focused on improving awareness and transparency of operations for consumers and stakeholders while creating incentives for employees and leadership. We determined that objectively and holistically, the Waffle House model gets a **D-** in terms of sustainability, with positive results only due to the efforts of their vendors. This data can be examined further on the 'beyond the menu' stats, where inventory vendors independently focus on animal health or agricultural quality (Waffle House, 2024). While the biggest barriers to implementing circular principles have been space and time, an interesting point was made that there is an opportunity for retail complexes to build a network that is more feasible and supportive (as Waffle Houses are frequently located within small retail complexes). This further supports the need and potential for codesign, not just food production and retail, but for the industry segmentation mentioned before. When asked about a trash circular economy, the interviewee was unsure at first but quickly understood the value of the concept and supported the sentiment with wanting to see less food in the bins.

These insights led to early co-brainstorming between the manager and designer on what possible resolutions would help the waste reduction effort and evaluating the strongest directions within 3Ps model for innovation, see *Figure 5.9*. The manager made a point that because their inventory is pretty streamlined that packaging would not be the best target, though it is still

	Product	Packaging	Process
Consideration 1	Redefining product life cycle: extend shelf life and contributions to organic waste diversions	Shift to ecofriendly materials: biodegradable/ compostable and/or recyclable to reduce environmental impact	Efficiency and organic waste reduction: focuses on improving transportation, handling, storing, and preparation
Consideration 2	Inventory and waste management: standardized portioning and opportunity for upcycling (composting, fertilizer)	Education and engagement: clear labeling on materials and disposal for maximized impact (validation and awareness)	Employee training and workflow: adopting new changes to operations require time and commitment
Consideration 3	Sustainable systems: feasibility of multiple small interventions that create overall large impact to make appropriate waste diversions	Brand image and loyalty: signifies committment to environmental responsibility, while avoiding greenwashing (transparency)	Regulatory compliance and reporting: future forward solutions align to upcoming industry standards (cost savings over time)
Summary	*Easiest to implement on small scale for feedback Difficult to raise capital for infrastructure (look for codesign opportunities)*	*Requires collaboration with food production sectors for downstream interventions on scale*	*Longest implementation period due to psychological factors of environment stakeholders*

Figure 5.9 Applying 3Ps model for innovation

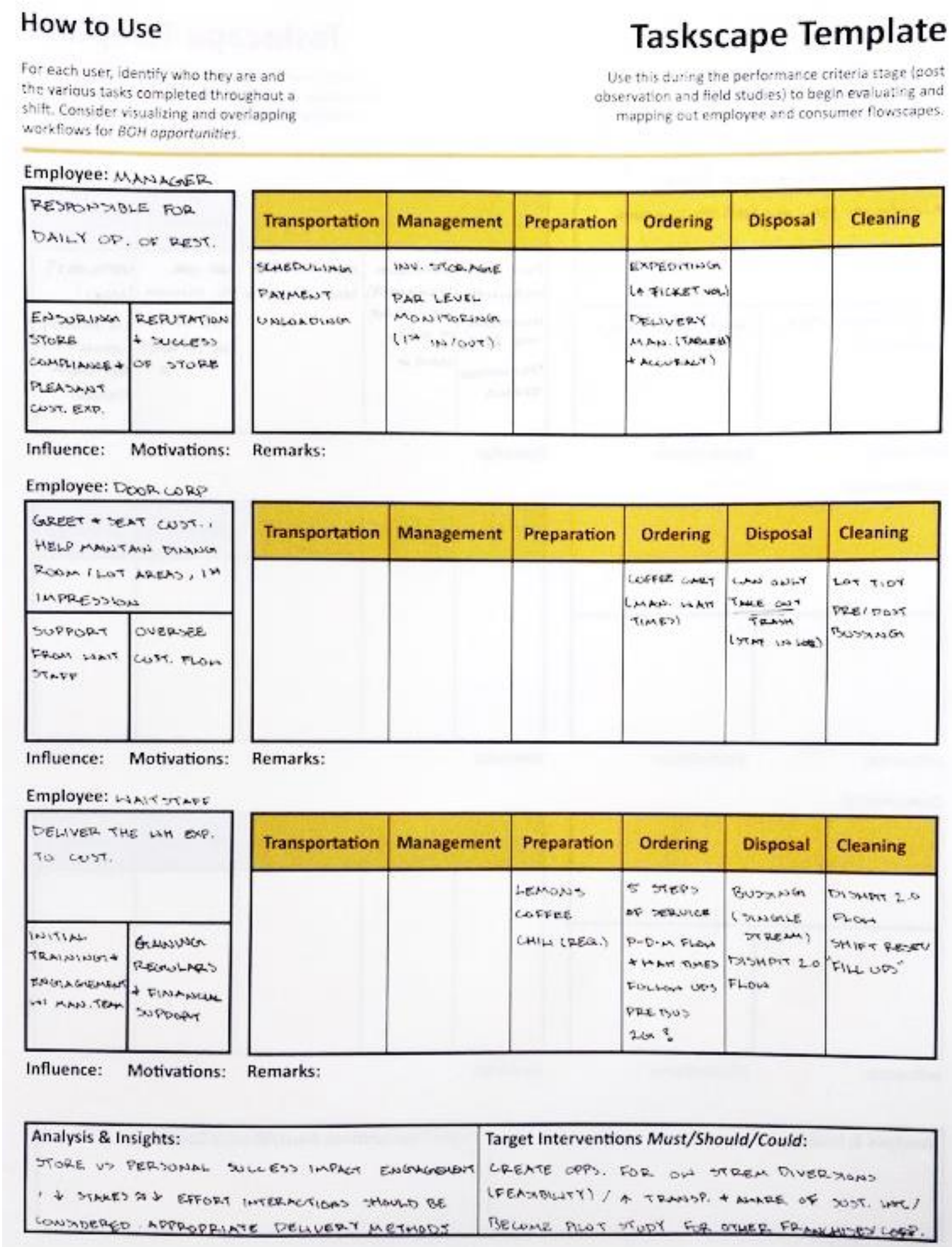
important to evaluate later. An early sentiment was the idea of implementing sustainability/ waste goals that highlight the business's shift to a commitment to sustainability. This system would target more of the process-related solutions and allow for the necessary product solutions to be implemented accordingly. In terms of product, a lot of innovations have been implemented to allow the business to operate under more variable conditions. For example, streamlined to-go ordering technology led to the development of walk-up order/pick up windows for both consumers and delivery drivers, all this an effect of a post-pandemic market.

After completing the summary page, a follow-up with the Waffle House manager was needed to finalize the design objectives. With the help of the client, five goals were created:

> ***Cost effectiveness:*** *solutions do not complicate technological conditions*
>
> ***Efficiency:*** *facilitate waste diversion and valorization processes*
>
> ***Feasibility:*** *implement a real-time waste monitoring system*
>
> ***Optimization:*** *enhance food preparation, storage, and waste management*
>
> ***User friendly:*** *for beginner server to diamond level and consumer engagement*

With those goals defined, the next step of the approach calls for a crucial analysis of workflows to better understand the interactions that lead to organic waste and identify target areas for design intervention. This process required a second round of field observations to help pinpoint leverage points or specific areas in the Waffle House system where small changes could lead to significant improvements in organic waste reduction and circularity.

To achieve this, the research utilized Taskscape *templates* to verbally map employee and customer interactions in detail. This visualization helped to highlight potential bottlenecks and inefficiencies in daily work operations as seen in *Figures 5.10 and 5.11*. These insights guided the focus for interventions and ensured the proposed system aligned with the practical reality of the Waffle House culture and objectives for sustainability.



How to Use

For each user, identify who they are and the various tasks completed throughout a shift. Consider visualizing and overlapping workflows for *BOH opportunities*.

Taskscape Template

Use this during the performance criteria stage (post observation and field studies) to begin evaluating and mapping out employee and consumer flowscapes.

Employee: MANAGER

RESPONSIBLE FOR DAILY OP. OF REST.

Influence	Motivations
ENSURING STORE COMPLIANCE + PLEASANT CUST. EXP.	REPUTATION + SUCCESS OF STORE

Transportation	Management	Preparation	Ordering	Disposal	Cleaning
SCHEDULING PAYMENT UNLOADING	INV. STORAGE PAR LEVEL MONITORING (1st IN/OUT)		EXPEDITING (& TICKET VOL.) DELIVERY MAN. (TABLES + ACCURACY)		

Influence: Motivations: Remarks:

Employee: DOOR CORP

GREET + SEAT CUST., HELP MAINTAIN DINING ROOM / LOT AREAS, 1st IMPRESSION

Influence	Motivations
SUPPORT FROM WAIT STAFF	OVERSEE CUST. FLOW

Transportation	Management	Preparation	Ordering	Disposal	Cleaning
			COFFEE CART (MAN. WAIT TIMES)	CAN ONLY TAKE OUT TRASH (STAY IN LOB)	LOT TIDY PRE/POST BUSSING

Influence: Motivations: Remarks:

Employee: WAIT STAFF

DELIVER THE WH EXP. TO CUST.

Influence	Motivations
INITIAL TRAINING + ENGAGEMENT W/ MAN. TEAM	GAINING REGULARS + FINANCIAL SUPPORT

Transportation	Management	Preparation	Ordering	Disposal	Cleaning
		LEMONS COFFEE CHILI (REG.)	5 STEPS OF SERVICE P-D-M FLOW + WAIT TIMES FOLLOW UPS PRE BUS 2nd ?	BUSSING (SINGLE STREAM) DISHPIT 2.0 FLOW	DISHPIT 2.0 FLOW SHIFT RESET/ "FILL UPS"

Influence: Motivations: Remarks:

Analysis & Insights:	Target Interventions *Must/Should/Could*:
STORE VS PERSONAL SUCCESS IMPACT ENGAGEMENT ↑ ↓ STAKES & ↓ EFFORT INTERACTIONS SHOULD BE CONSIDERED. APPROPRIATE DELIVERY METHODS	CREATE OPPS. FOR ON STREAM DIVERSIONS (FEASIBILITY) / ^ TRANSP. + AWARE OF SUST. WTC/ BECOME PILOT STUDY FOR OTHER FRANCHISEE CORP.

Figure 5.10 Filled-out Worker Taskscape template

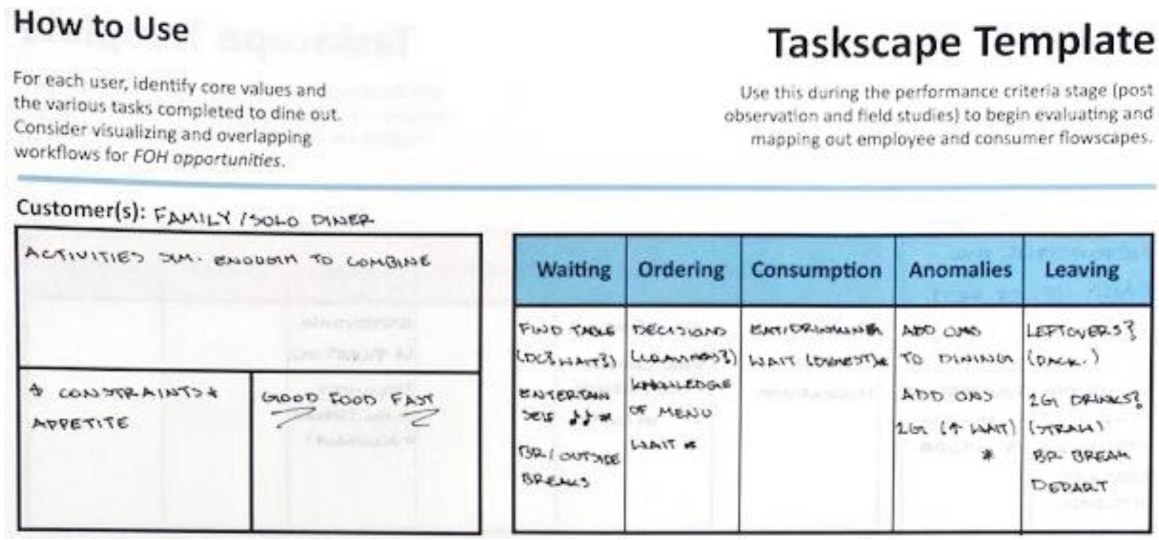


Figure 5.11 Filled-out Customer Taskscape template

From these templates, I was able to see that most interactions around organic waste management revolve around the ordering and table turning process. This means that education on the customer and employee side can be targeted to reduce organic waste at the source. Furthermore, it highlighted the inefficiencies that exist in the current food preparation and disposal process that can be optimized for reduced environmental impact. To solidify and conclude the preliminary research step, the supporting exploration was evaluated through a NOISE analysis to be an additional reference when considering performance and system expectations for other Waffle House designers, which can be seen below in *Figure 5.12*

N Needs	O Opportunities	I Improvements	S Strengths	E Exceptions
Efficient waste sorting Employee training Waste tracking system	Disposal Partnerships On site composting Material considerations Customer engagement	Food prep/storage Portion customization	Consistency Community Employee workflow High volume low variety menu	Floorplan variation Dependence on QSR Regional policy Customer ecpectations

Figure 5.12 NOISE analysis for Waffle House

The next essential step to conduct was circular mapping and systems analysis to start understanding the flow of organic materials throughout operations. This began by reviewing collected content from the previously used templates to better inform the flow of energy. Understanding what goes where, when, and how users interact throughout a shift, helped point to better ways to manage organic and nonorganic waste within the restaurant. The completed taskscapes helped inform the systems mapping and started off as a causal loop illustration before developing into a more detailed stocks and flows diagram, see *Figure 5.14*, that began to showcase the movement of organic waste in the restaurant.

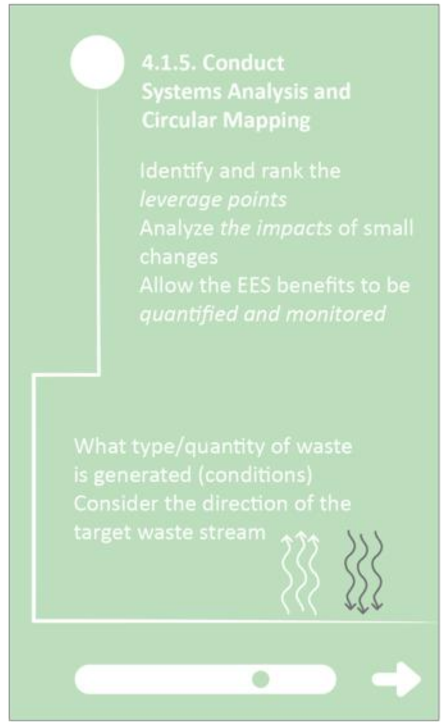


Figure 5.13 Phase One – Conduct Systems Analysis and Circular Mapping

This started to uncover the inefficiencies of operations in managing organic and nonorganic waste in the form of a single stream diversion with multiple points for input. Specifically, noting the locations of the primary and secondary waste bins points to the division between dining waste and grill op waste where waiters and patrons

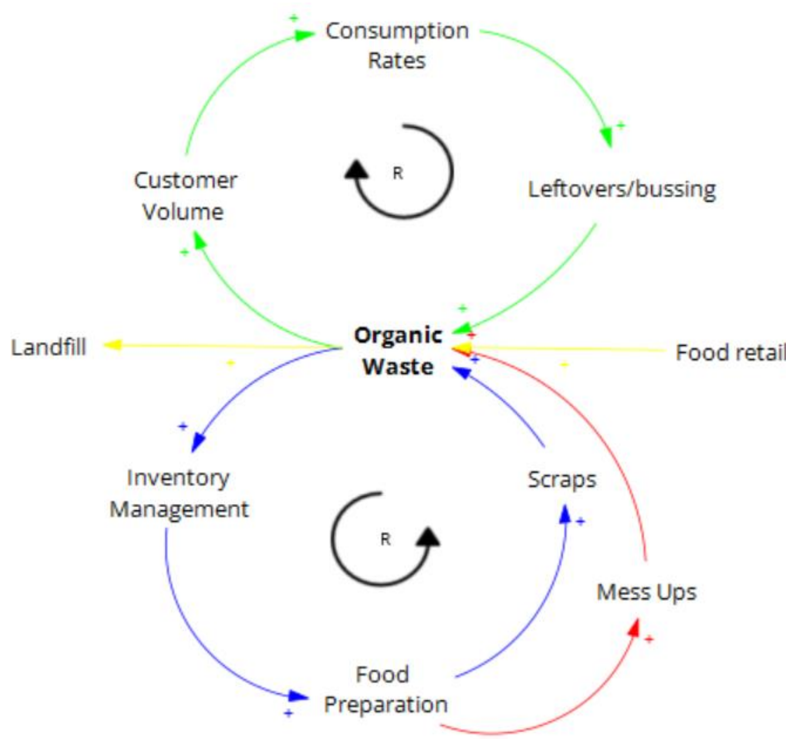


Figure 5.14 Stocks and flows of the Waffle House environment

use the primary bins. Secondary bins are only used by trained grill ops. Their location is confined to the grill space for the operator's convenience of waste disposal in high volume there.

This evaluation helped the restaurant management see that organic materials processed in a segregated manner only to be consolidated into the primary bins mixed with non-organic materials contaminates the organic materials and removes their potential for recycling. By leveraging this existing interaction, design interventions can begin to shift Waffle House operations to reduce environmental impact and improved circularity. This understanding ultimately supports the development of the performance criteria and provides a broader strategy.

The systems analysis makes it clear that a prioritized approach is needed to target items with high waste rates, significant environmental impact, or frequent handling errors. Due to the consistent yet limited menu at Waffle House, it was beneficial at this stage to create an inventory list to better visualize opportunities for circularity. *Figure 5.15* begins to showcase this list to ensure the right direction for material diversion and collection is validated. The highlighted items on the inventory list, show the organic materials that can be composted with some further consideration needed.

	Item	Packaging	Processed By
Organic, pre-made food	Bread/biscuits	Plastic film	Grill Op
	Coffee	Boxed, individul bag	Waiter
	Chili Mix	Pouches, film wrapped	Grill Op
	Hashbrowns	Carton	Grill Op
	Gravy Mix	Individual bag	Grill Op
	Salt & Pepper	Individual bag	Waiter
	Tea	Plastic film, indiv. paper wrapped	Waiter
	Toppings: ham, mushrooms, pickles, peppers	Individual bag	Grill Op
	Waffle Mix	Individual bag	Grill Op
	Toppings: chocolate chips, peanut butter chips, seasonal		Grill Op
Organic, food items	Eggs	Cardboard inserts	Grill Op
	Meat	Plastic wrapped, box	Grill Op
Organic, pre-made liquids	Big/little syrup	Jug	Waiter
	Cheese	Plastic film wrapped	Grill Op
	Creamer	Individually wrapped	Waiter
	Honey	Jug	Waiter
	Milk (2%/ chocolate)	Jug	Waiter
	OJ/ Lemonade	Indiv. Bottled	Waiter
Organic, fresh produce	Lemons	Plastic mesh bag	Waiter
	Onion	Plastic mesh bag	Grill Op
	Tomato	Box	Grill Op
Organic, consumables	Napkins	Paper wrapped, box	Waiter
	Paper towels	Box	Waiter

Figure 5.15 Waffle House inventory list

Referencing back to the NOISE analysis, a major challenge to composting and valorization efforts is going to be heavy grease and oils. When strategizing for collection systems, these environmental and scientific factors must be considered. This began to further validate the nature of the proposed system needing to favor process and product solutions.

Due to the limitations of this research, it is not possible to develop a system that encompasses all the possible organic waste that exists at Waffle House. However, based on prior observation and referencing the statistics from the context and validation step, it is evident that from the inventory list eggshells are the strongest contender for impact. The systems analysis revealed the difference in interaction types of both primary and secondary waste bins. Therefore, the performance of the sustainable system should leverage this existing pattern for design interventions.

5.2 Phase Two

Shifting into visually analyzing the different task flows helped inform how to deliver the best strategies. This pointed towards the need for a floorscape to better communicate where and how the proposed sustainable system could work. For example, it was observed that limited space and technology critically impact worker success during food preparation and high-volume times. The limited infrastructure for organic waste diversion and inventory tracking to quantify waste impacted the ability for workers to engage in pro-environmental behavior. The staff tries to reuse packaging when possible and reduce food waste by diverting incorrect customer meals to the back to eat when applicable, however, these efforts still fall short of being impactful for the business' sustainability grade.

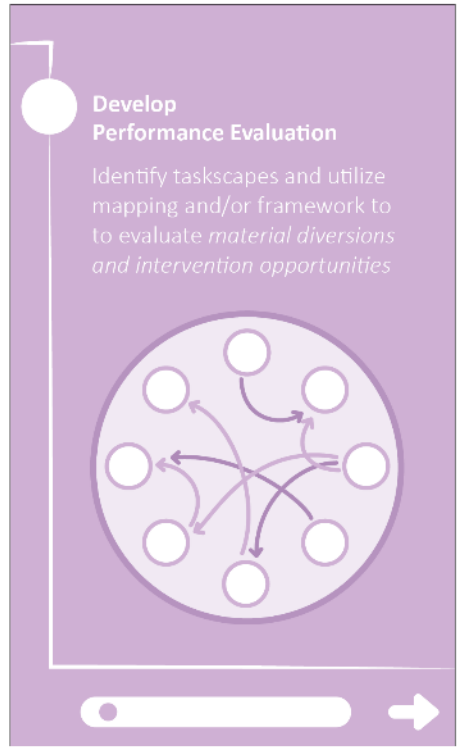


Figure 5.16 Phase Two – Develop Performance Evaluation

Through casual interviews, waiters and grill operators reported wanting to see less food in the bins or at least a specialized food waste bin but also admitted there is no space for these interventions, see *Figure 5.17* below.

The floorscape provided a visual overview of the Waffle House environment and truly showcases the organized chaos of daily operations, see *Figure 5.17* and also in Appendix N. Starting with the overall management of inventory at the store, the numbers in the graphic represent different processing steps. Goods first come into the store through transportation (1) and handling (2), before moving into processing based on inventory type. Typically, items come in on modular carts that stay in the back and items are transferred to a more functional cart before moving into the cook space. Fresh produce and any bulk processing of hashbrowns, waffle mix, onions, or tomatoes happens back here (3). This is also where the drink station hook-ups are and the drop-off location for boxes and trash from the shift that do not make it outside. Any dry goods are stored in the back and the necessary goods for the shift are carted to the front to be put away.

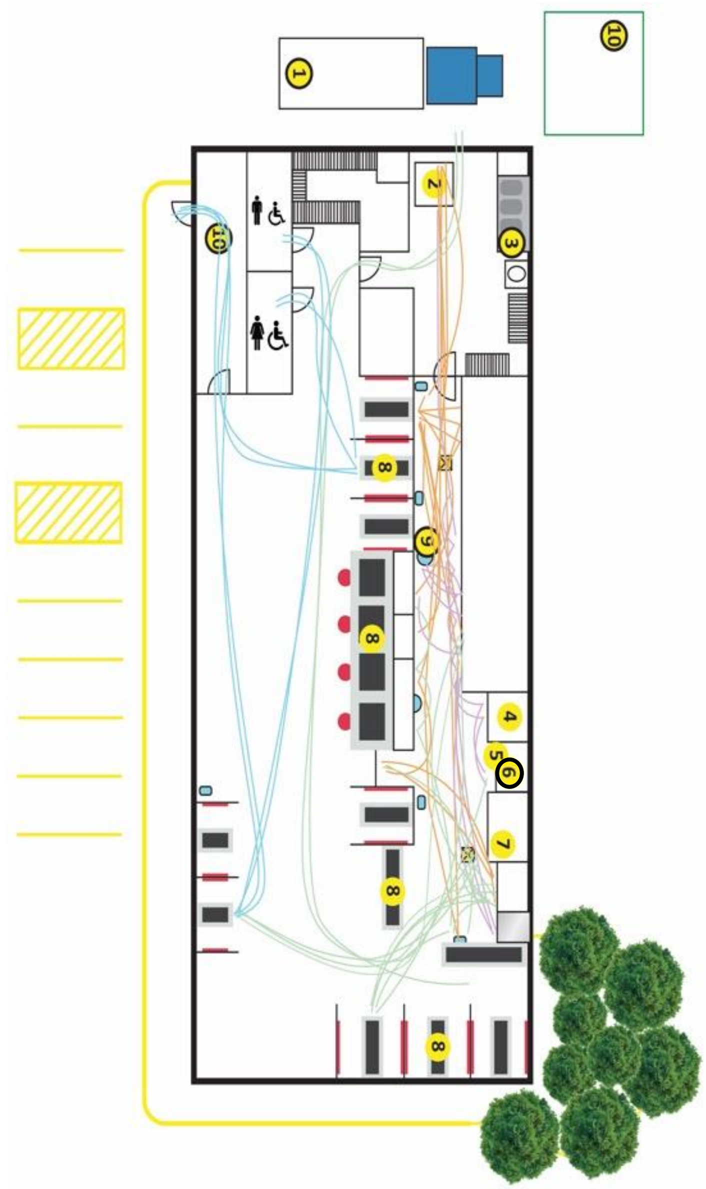


Figure 5.17 Floorscape showing customer, employee and materials flow

Areas (4-7) are for ordering (pull-drop-mark system) and preparation (order pick-up) during the shift while (8) represents where customers eat. In store disposal bins (9), for bussing and cleaning, and exterior disposal bins (10).

This floorscape addressed all the ways organic and nonorganic materials leave the store - from employees taking out the trash to the standardized back of house (BOH) set up or the customers taking home leftovers in branded packaging. The latter is an important consideration as it is the last interaction where a business can leave an impact on the customer, such as providing information on appropriate home disposal methods or sustainable efforts at the store.

Moving into the customer flow shown in green, how busy the store is determines how fast they get a seat and is based on the customer's location preference. For this graphic the customer seating areas (8) are separated into sections according to the number of people that can be seated and divided accordingly amongst waitstaff. Section One - the booths located near the bathrooms, Section Two – the high bar located above the dish pit and in front of the grill, Section Three – the low bar, and Section Four - the booths by the side end of the restaurant. The customer experience here can be broken into waiting to be seated, ordering, eating, and waiting to pay. However, there are opportunities within this cycle for the customer to be informed about sustainable practices and how their order can positively influence organic waste.

Next the graphic illustrates the employee flows shown where purple represents the grill op, and orange and green are waiters in sections one and four respectively. This visual analysis begins to uncover the operational inefficiencies and identify waste generation points to streamline employee tasks and enhance resource utilization.

The utilized templates and systems analysis have brought research closer to a specified organic type to strategize for based on the scopes and limitations of this research. To make all the necessary connections to move forward with the next phase, a circular mapping system was built on the foundation discussed above and is illustrated in *Figure 5.18* below.

Based on a deeper understanding from taskscapes and validated by statistics from the context and validation step, it is evident that eggshells are the strongest contender to be addressed in this thesis. Their high frequency of interactions within operations makes them a significant contributor to organic waste and the existing framework for segregation of the shells serve as the most feasible for sustainable solutions. With this position, research focused on critically evaluating the life cycle of an egg and framing solutions around these insights.

Similar to the floorscape grill op flow, looking closer at the egg journey illuminated the current operation around the grill. As the highest commodity in the store, they are consumed at a fast rate and are conveniently placed to grab, crack, and go. A specialized secondary waste bin nestled into the grill components allows shells to be disposed of here and consolidated when this bin is full. This process can be seen in *Figure 5.19* below that illustrates the real-life environment for this grill op flow.

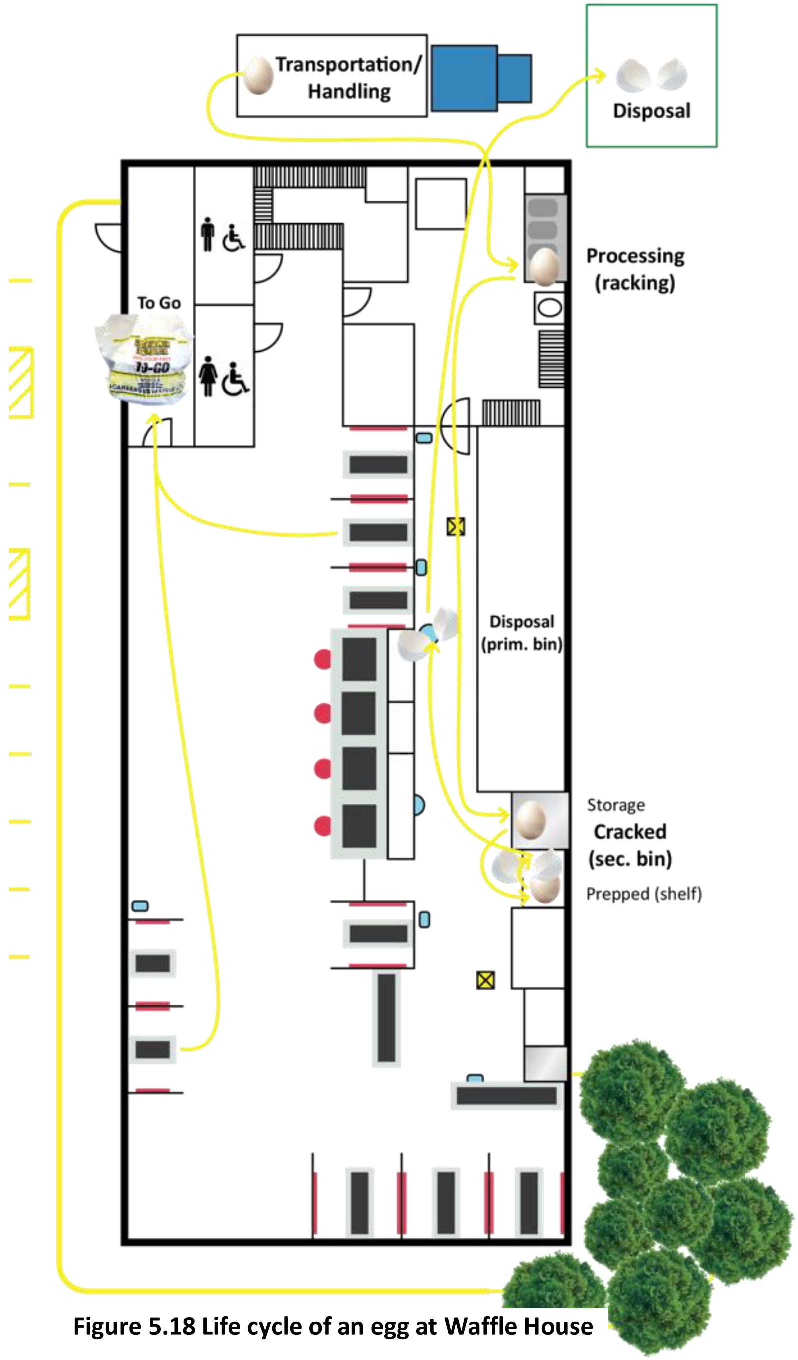


Figure 5.18 Life cycle of an egg at Waffle House

The floorscape and egg life journey highlight areas for potential design interventions, these being when the egg first enters the store and when eggs are cracked/disposed of. This begins to further align with the original direction as defined through the interview on what types of sustainable interventions would be feasible for the store, and by contextualizing and validating the target organic material in 4.1.2. Applying these insights to create process and product focused solutions has a high potential for success in achieving the design objectives. Looking towards transportation and handling opportunities began to take a holistic upstream approach to reduce the possibility of eggs cracking during transit or to design a way for the packaging to be broken down for system input as brown feedstock. At the local Waffle House store, the eggs go through processing which involves removing them from shipping packaging one by one and 'racking' onto metal storage racks for better accessibility during the shift. Sometimes eggs come in cracked and need to be disposed of, which creates a mess for the rest of the produce that is cleaned in the BOH.

The grill operator station is a major point for intervention, but the solution comes more in the form of worker training. First, being made aware that this specific Waffle House is taking sustainable initiatives and how that impacts their workflow will impact the grill operator engagement. Because they already have a specialized bin for eggshells the flow wouldn't change much here, see *Figure 5.19.* However, how they dispose of the collected eggshells is where a major change is needed. This is represented as the wider arrow in Figure 5.19. This points to an intervention within the system that implements stricter primary and secondary bin operations, where the

Figure 5.19 Real-life grill op flow for improved context

secondary bins with only organic waste end up in a separate area for processing and collection. As previously discussed, oils are a contaminant, and the grill op tends to get oil everywhere during busy times. Therefore, future ideation must focus on ways to reduce the chance of oil or food contaminants from the grill entering the eggshell collection bin.

For eggshells to be sustainably recycled, a drying system to reduce moisture and a crushing system to expedite decomposition and improve applications are required. Besides the investment for small-scale infrastructure, the store would need to set up additional pick-up service with whatever local service vendor is appropriate. For this project these should be based on their current ability to sustainably process (valorize) eggshells and future initiatives for scalability. This should also consider the logistics of the tradeoff including how Waffle House will know who will be driving, what needs to be done for effective pick-up, and any necessary checklists/prompts to finalize the interaction. Currently, the standard for services is once a week and so the system should align with this timeline. Additionally, there should be an incentive program to reward employee engagement with the system and educational material developed for the brand to promote active employee involvement in creating a sustainable experience.

Lastly, as mentioned in the overview of the floorscape, there is the opportunity to engage with customers and increase transparency of the store's sustainable practices. This can involve interaction prompts (perhaps on the menu or other locations in the store) that allow the customer to be informed of all the Waffle House food options but make conscious consumption choices to ensure minimal food waste occurs from the start. This does not have to be anti-consumption and remove upselling entirely, but it should allow the customers to consider portion and leftover life cycle. Additionally, it can include more home friendly packaging for take outs and leftovers that uses biodegradable materials for low impact disposal and ultimately shift environmental responsibility back to the brand. These stakeholder focused efforts should increase their curiosity and support in validating future sustainability initiatives for the Waffle House.

Overall, this analysis served as the starting point to understand the wicked problem in a manageable way and provide actionable strategies to reduce environmental impact. With prime opportunities for sustainable interventions explored, the research began to expand on the analysis and evaluation of Waffle House operations and frame the foundations to develop criteria.

Next, the project began to address design methodology starting with the human factors that were divided into employee, manager, and customer behaviors and skills that influence organic waste management. Due to the lack of awareness of the environmental impacts (for employees) or the scale (for customers), there needs to be a way to incentivize education on sustainability within the operations. Potential areas for ideation included visual aids, designed interactions, or workflow interventions. The manager's role is crucial in setting priority for organic waste reduction for their franchise to showcase the possibility for circularity in the Waffle House model. This can be approached through training, inventory control, and kitchen operations.

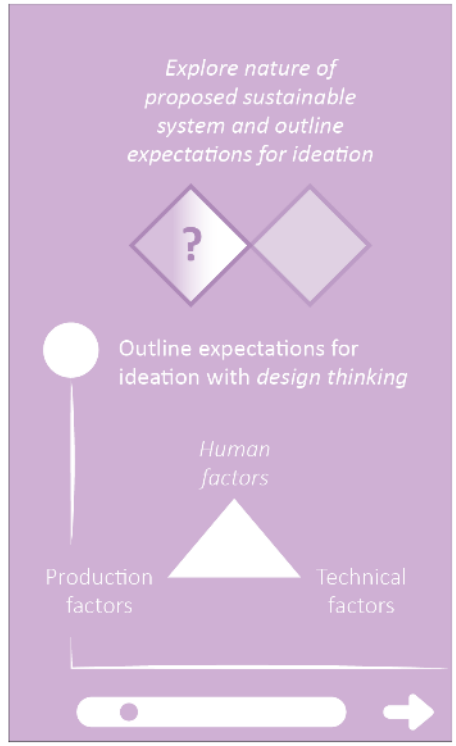


Figure 5.20 Phase Two – Outline Expectations with Design Thinking

When approaching production factors, the focus is on analyzing the sourcing, preparation, and handling of non/organic products within the Waffle House supply chain. Due to the footprint of the store and constraints on inventory, there is already a well-planned system in place to manage first in/out. However, there are still instances during normal operations and holidays that inventory turnover is poor and the Periodic Automatic Replenishment (PAR) levels defined by Waffle House are insufficient due to unexpected spoilage. Looking into the service vendor options, more local sources or just-in-time delivery with a way to track and communicate data could be beneficial.

Additionally, applicable composting services could create opportunities for customer engagement and improved business accountability. Lastly, a factor to consider is how the current menu design contributes to the waste generated, both in the miscommunications that happen when customers place orders and food prices fluctuate requiring update prices. This opens an indirect way to impact the overall system through modular menu designs.

The last factors to approach here are the technical ones that influence and support Waffle House operations and organic waste management. However, when one thinks of this casual family dining restaurant, they typically do not envision it as the most technologically advanced place. Waffle House culture is one that captures the essence of nostalgic Southern hospitality and maintains a quality standard for food and service. Therefore, it is essential to not over-complicate customer-facing design resolutions while ensuring the back of house operations can be monitored for feedback and positive employee morale. There are many curious patrons that want to know about the sustainable practices of places they support and by providing the right levels of transparency can make a community feel more validated in sustainable endeavors.

With these considerations in place and after reviewing the information thus far, the research prompted me to propose the following criteria to provide directions for ideation:

Behavioral Cues
Capacity & Volume
Cost Effectiveness
Compliance & Standards
Contamination & Fail Proofing
Durability & Maintenance
Employee/ Customer Engagement
Environmental Impact
Feedback & Monitoring
Functionality
Handling & Segregation
Storage & Containment
System Integration
Recycling/ Composing Compatibility
Waste Diversion & Processing

Considering how to better align these criteria to the client's objectives, provide opportunities that can be more focused and concise, yet still explore all the dimensions, a Solution Table for this specific Waffle House was created (see *Figure 5.23).* The column headings represent the design objectives to align the solution with the site-specific parameters and the row headings represent key taskscape categories in managing organic waste.

For the purposes of this project the solutions are focused on egg-centric interactions; therefore, this table represents only a portion of possible solutions to reduce and divert organic waste. However, it could be adapted and scaled to other Waffle House operations with additional research that further detail solutions for task interactions targeting other organic waste types. If a designer at another Waffle House wanted to conduct a similar project, they could use the criteria above as starting performance factors that become more specified during their initial meeting.

Figure 5.21 Phase Two – Determine Criteria Considerations

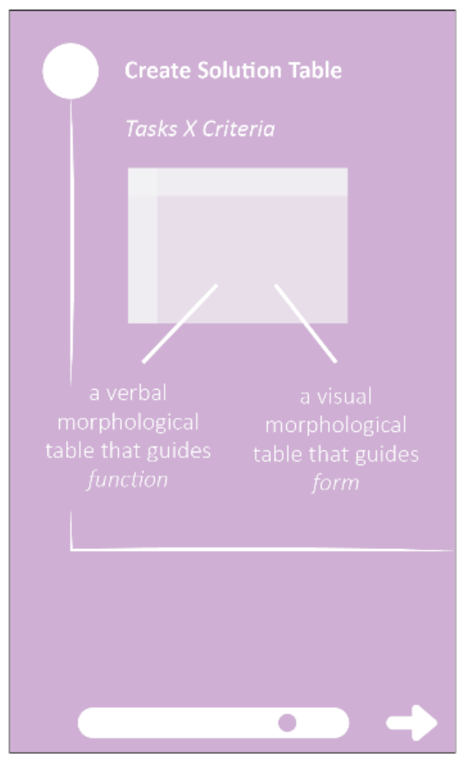


Figure 5.22 Phase Two – Create Solution Table

	Cost Effective	Efficiency	Feasiblity	Optimization	User Friendly
Unloading	Visual labels on incoming inventory	Modular unloading areas	Collapsible unloading tools	OSHA-compliant unloading	Streamlined sorting to waste systems
Inventory Storage Management	Color-coded sections for categories	High-volume storage bins	Affordable organization systems	FDA storage guidelines	RFID tracking for delivery volumes
PAR Level Monitoring (FIFO)	FIFO date tags	Integrated inventory database	Smooth FIFO to waste transition	FIFO Compliant logs	Smooth FIFO to waste transition
Expediting	Order sequence signals	Live order tracking systems (visualization)	Reusable serving tools	Health safety standards for service	Minimize food transfer waste
5 Steps of Service	Prompt-based service cues	Space-efficient serving carts	Ergonomic service kits	Adherence to service quality standards	Sanitary service tools
Pre/Bussing	Table clearing communication	Organic waste collection tools	Expandable waste bins	OW tracking with RFID	Segregated bussing containers
Food Preparation	Maximize prep waste streams	High capacity prep stations	Cost-saving prep equipment	Compost ready expired stock	Clearly labeled disposal points/ methods
Disposal	Affordable waste diversion bins	High volume disposal units	Leak-proof designs	Disposal regulations compliance	Staff waste reduction rewards

Figure 5.23 Solution Table for Waffle House's egg-centric interactions

5.3 Phase Three

Following the creation of the solution table, concept ideation began and started to follow the direction of products and process. At first the product-oriented concepts revolved around transforming existing products to improve functionality for direct involvement in organic waste management. For example, waste bin inserts that aid separation and diversion efficiency or sorting station layouts. Additionally, process concepts began to evaluate current training methods used and how to ensure customer satisfaction while increasing awareness of sustainable initiatives. This presented an opportunity in indirect solutions such as scalable menu book design changes for employee aid or modular menu systems to avoid the waste from their disposal after menu/price changes and improve education of the menu.

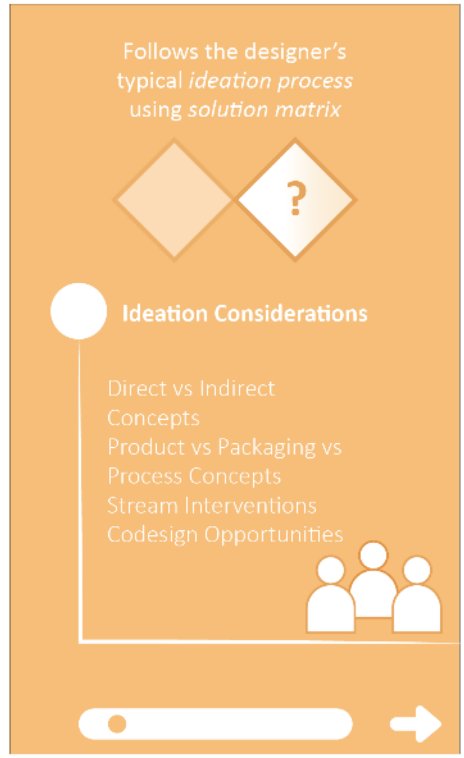


Figure 5.24 Phase Three – Ideation and Refinement

Due to the limitations of time and ability to test physical prototypes, the refinement stage took an untraditional approach to simulate how the packaged sustainable system will act when implemented. This involved taking a step back from round one of ideation where concepts were very specific to a designed product and instead thinking about the system in terms of what is beneficial for the company to know moving forward with a project of this nature.

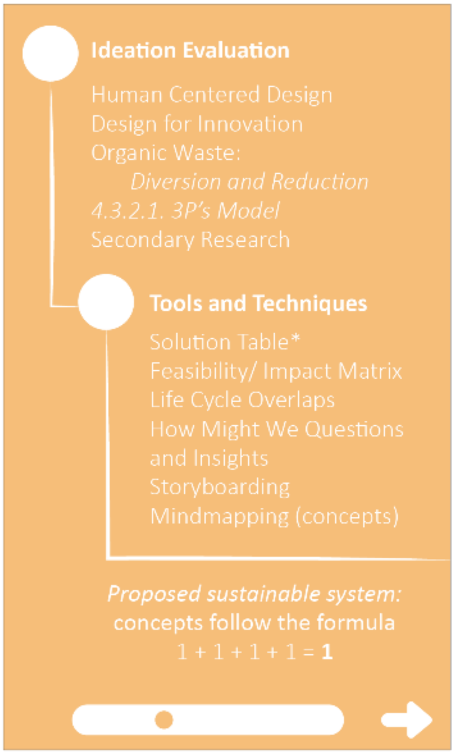


Figure 5.25 Phase Three – Perform Ideation Evaluation/ Tools and Techniques

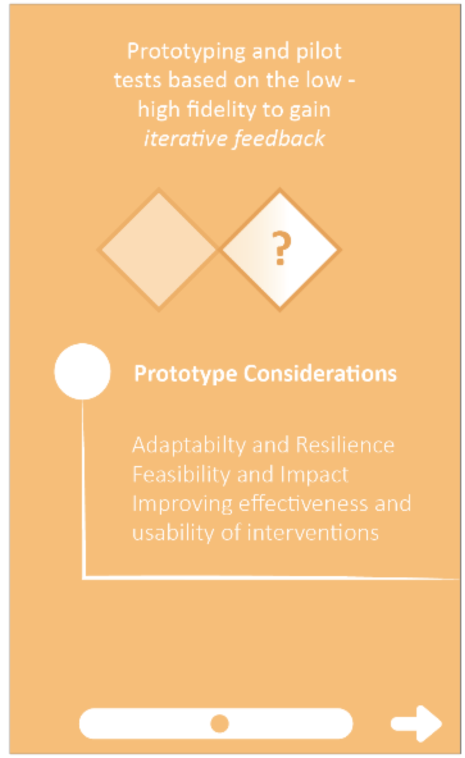


Figure 5.26 Phase Three – Prototyping and Refinement

As established in phase one, the company serves 272 million eggs yearly and the eggshells go straight to the landfill. As this design application is focused on a specific Waffle House in Georgia, secondary research was conducted to find the best intervention points in Alpharetta, GA. This began as an exploration of partnership opportunities with operations who could benefit from the use of recycled eggshells - local animal farms and landscape suppliers in a 5–10-mile radius for minimal transportation cost impact. For animal farms, the research first uncovered over half a dozen chicken farms in the area, see *Figure 5.27*, where additional calcium to their diets could provide stronger, larger eggs and healthier bones. However, upon further consideration it was deemed that most of these operations were too far from this Waffle House location. This points to the need for specialized industrial composting and recycling centers/vendors to support national sustainability.

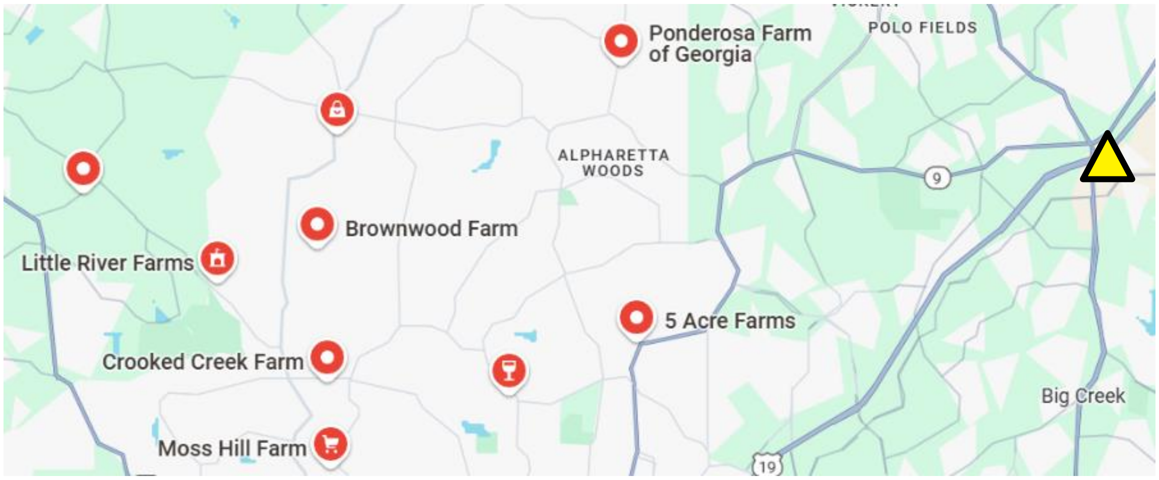


Figure 5.27 Circular applications with animal farms

Additional research discovered a large equestrian community in the Alpharetta/ Milton area, see *Figure 5.28*, with over 200 horse farms (Milton Equestrian Committee, 2024) and even current investments towards Willis Park Equestrian Center where they will host events throughout the year. This is a great opportunity to create a long-term, stable collaboration where adjustments and upgrades to the system can happen over time. Circular interventions can start with working solely with the center or farm and branch out to residential sales as well due to the large number of households that stable horses at their residences. This means that the criteria for the system to include drying and crushing (potentially at the local Waffle House) will support future scaling with a more manageable output product.

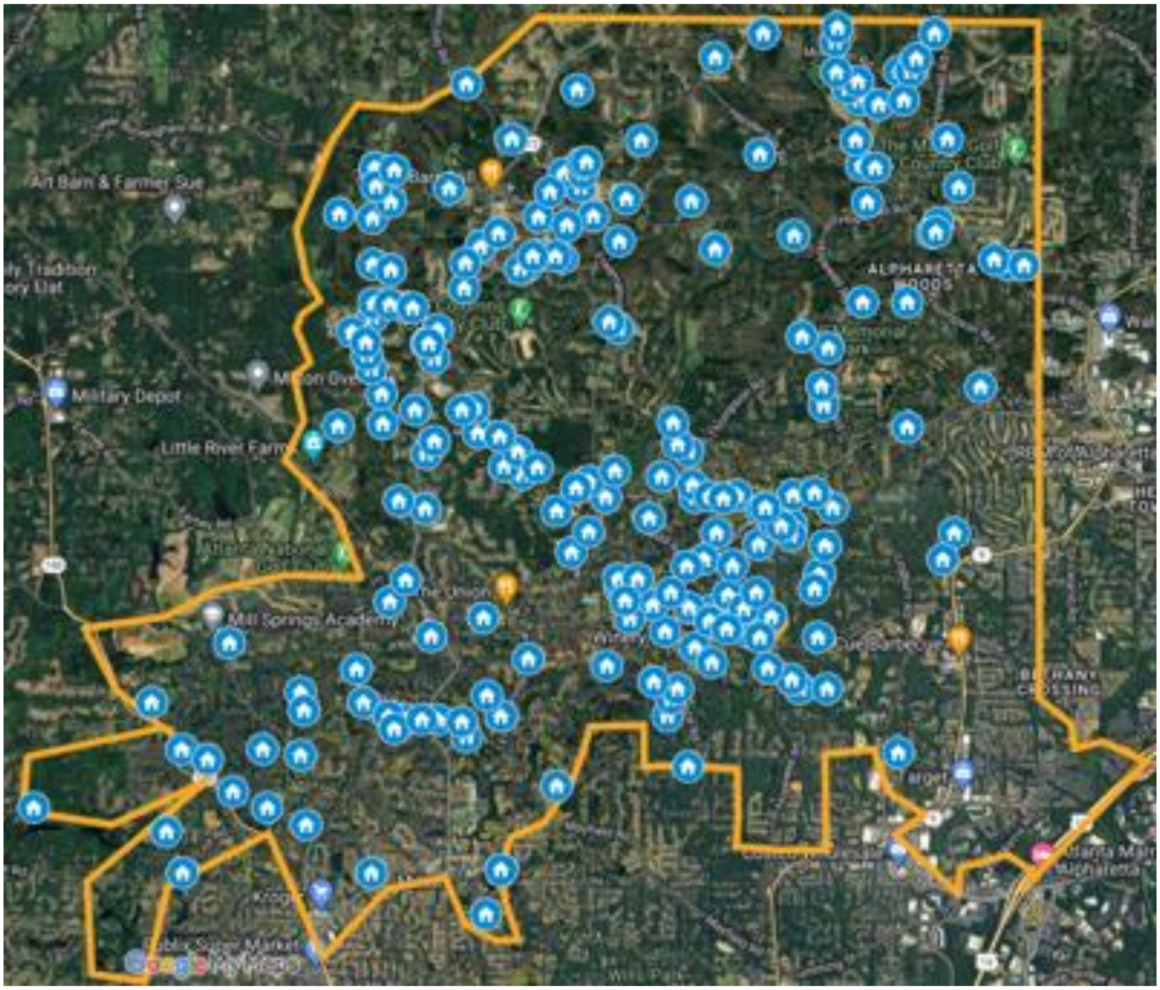


Figure 5.28 Circular applications with equestrian community (Milton Equestrian Committee, 2024)

Lastly for circular applications are the partnerships with landscape supply operations, see *Figure 5.29*. The reason this sector collaboration is beneficial and intuitive is due to their operations already managing brown waste diversion and collection. These operations align with the U.S. waste emissions reduction goals and are already making efforts to close the loop. A partnership would ultimately include the transition and/or addition of infrastructure to process green waste to receive feedstock input from food retail sectors. For the purposes of this project, Waffle House could start with only sending eggshells for processing but eventually turn to other organic materials based on additional inventory analysis being conducted. This begins to frame the scalability of the proposed sustainable system and meet the criteria for current and future government grants.

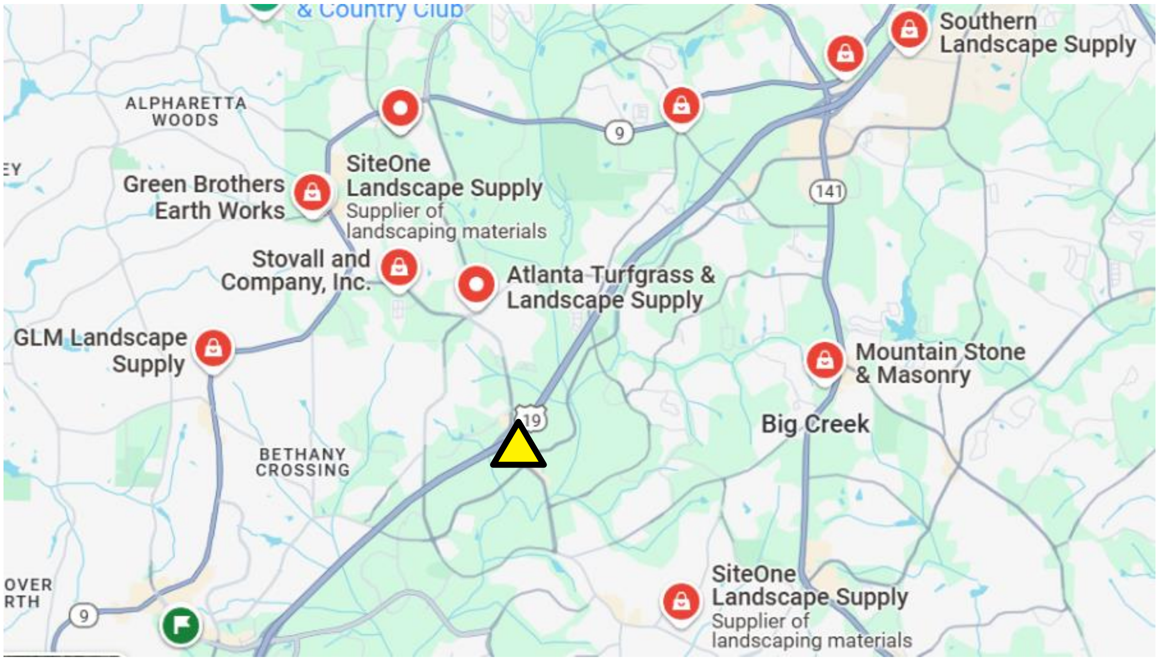


Figure 5.29 Circular applications with landscape suppliers

With these venues for circular applications defined, final systems ideation has been summarized here to ensure this Waffle House will meet the stated objectives and achieve the performance criteria. The proposed system can incorporate two key strategies that include: Training and Engagement Material (TEM) and Collection and Processing Methods.

TEM - training and engagement material is proposed to have four modules to ensure maximum operational efficiency.

Module One starts off with an overview of the proposed system to align all staff about incoming changes and should be a visual representation of specific milestones. In this way, all the process and product focused solutions can be presented with clarity and transparency for all skill levels. *Figure 5.30* begins to outline the possible avenues to explore regarding employee awareness and training based on the defined target organic type.

Module Two will cover the purpose of creating a sustainable experience at Waffle House and how to properly execute this. It will include new customer interaction prompts to ensure that the staff know how to communicate new initiatives to customers and ensure more circular operations within the store.

Module Three will go into depth on the new eggshell operations that begin by providing the corporate stats and collected store stats on waste volume. With this context, it should then explain why the new circular interventions are beneficial to them, the store, and the environment. This would include any downstream interventions such as packaging and details of the integrated workflow. Next it will move into the innovated operations for sustainability which outline new key tasks for employees. This module concludes with in depth information on the points of contact of resources for eggshell diversion as the reference this Waffle House can use as more partnerships are developed.

Module Four will conclude the TEM with how to ensure proper monitoring measures for the system and how to troubleshoot any issues that may arise. This module will be in development as scale tests are implemented and allow for a slow increase in engagement with the proposed system. Additionally, this module will contain the employee incentives and rewards that are available when the system is interacted with. This goes hand-in-hand with correct system monitoring as it will impact how their efforts are measured and ultimately create a reinforcing loop of interactions. Overall, the TEM allow the proposed sustainable system to align with the objectives in being efficient, optimized, and user friendly, see *Figure 5.30* below that illustrates the visual brand language of the Training and Educational Material for this Waffle House.

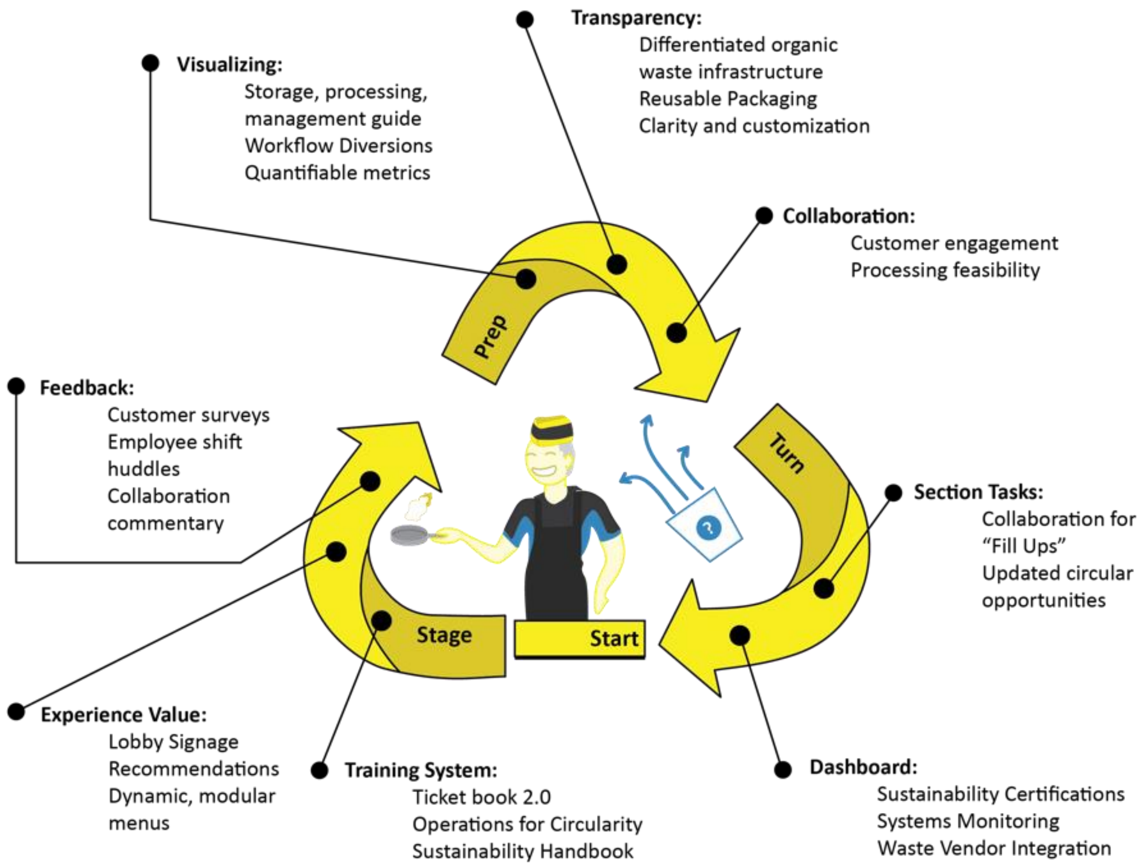


Figure 5.30 visual brand identity for proposed system

Collection And Processing Methods

The next component of the system consists of the updated collection and processing methods based on critical analysis of taskscapes, floorscapes, and egg life cycle. This should include the collection infrastructure currently defined as the secondary bin, point (6), or the cracking stage in the order preparation process. Criteria for innovations on the existing bin include contamination prevention, monitoring measures via weight sensors and RFID, and a form conducive to cleaning. Additionally, it should utilize a simple digital or physical system to communicate data with employees about eggshell quantities collected and be able to track impacts over time to become a tool to support the business's evaluation on ROI. These all align with the design objectives for the proposed sustainable system to be cost effective, efficient, and optimized. Another potential way to impact Waffle House stakeholders is to engage with consumers and actively point out how/ where eggshells are being valorized locally through strategically placed signage, such as on the double-sided doors, near the grill, on the menu, on the table (QR). These strategies would align with the objectives to be feasible and user friendly which will use leverage points to propose a system that can withstand operational complexities, adapt to varying scales of implementation, and maintain durability over time.

Ultimately the goal for the proposed system is to meet the performance criteria. Anticipated outcomes of implementation are as follows:

- Enhanced circularity through the valorization of eggshells into usable resources
- Increased employee engagement in sustainable interventions
- Reduced landfill waste and associated environmental impact over time
- Improved operational efficiency and cost savings through streamlined waste management processes

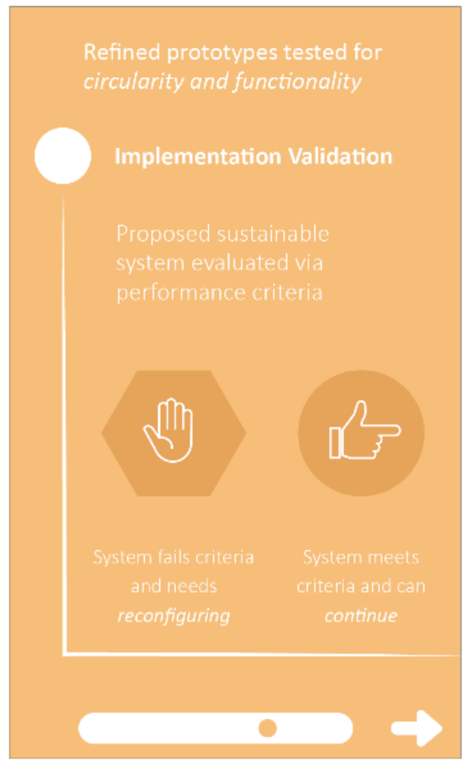


Figure 5.31 Phase Three - Implement and Validate

5.4 Phase Four

This phase summarizes the previous development into an actionable plan for implementation that this specific Waffle House can use and insights on the execution of the developed approach to this project. The systems analysis was used as a starting point for tracking waste loops on a small scale. However, over a longer period collecting data and inputting variables to further detail the system, a long-term use tool would be useful. Overall, the business would need to know how to monitor and track their ROI in terms of initial investment, annual/ quarterly savings, environmental impact, and social benefits for all users.

It is important to note that the software used in this project to simulate the analysis, Vensim, was the free educational version while the plus version costs $169 and the pro version $1,195. The plus version could serve as a higher resolution, lower stakes software to design with. This is also dependent on whether the designer will be involved to set it up or not, which could impact a manager's ability to effectively use the tool.

The last considerations on stakeholder psychology revolve around transitioning the population's current mental model to be more pre-environmental. By ensuring an intuitive

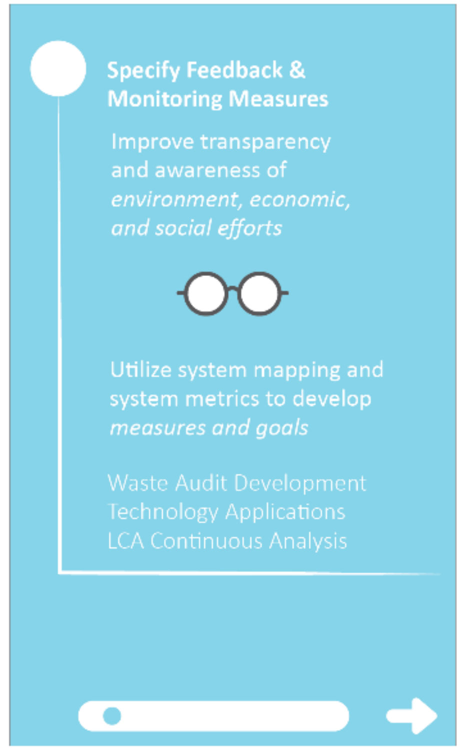


Figure 5.32 Phase Four - Specify Feedback and Monitoring Measures

Figure 5.33 Phase Four – Consider Economic and Psychological Factors

system that integrates smoothly into daily task flows this will minimize resistance to change and aid in habit formation. Providing additional support mechanisms can help reduce any troubleshooting and anxieties that occur, which ultimately build a staff that feel validated and will buy into creating a sustainable experience at Waffle House. This should be reflected through the ROI on social benefit where success metrics support the widespread adoption of interventions.

Lastly, it would be beneficial to create tailored communication that considers accessibility for all stakeholders to ensure inclusivity can be scaled for additional efforts. All these implementation strategies will contribute to long-term system success due to a framework for sustained impact.

The valorization strategies, for now, follow the outlets discussed in phase three circular applications. This includes equestrian-centered and landscaping supply codesign partnerships. The research presented here only discussed the Waffle House operations side of things and used brief conversations with employees to inform potential opportunities; therefore, future strategies should include working with the most appropriate and willing client out of those presented. This starts to build upon the logistics established in the Performance Criteria Phase, where the framework for smooth collection and processing is developed to finalize the collaborative initiative. This can be done by the same designer that is implementing the proposed sustainable solution, or one hired specifically to work with the collaborative party and the two designers communicate these phase four details.

Ideally, working with the Willis Center facility stakeholders would serve as a pilot study to prove viability of circular cross-sector systems and allow the integration of more feedstock input from local food retailers. The valorization strategies for Waffle House would be dependent on efficiency of the processing infrastructure and should be critical of the design to ensure its adaptability to other waste types and scalability to other Waffle House operations. This would start with a low-resolution model to test how different users interact with an egg-centered processer unit, and go through all the necessary criteria evaluation as outlined in phases two and three.

While the deliverables cannot be fully actualized within the timeframe for the writing of this thesis, the project helps showcase the value of the proposed *Circular Approach to Organic Waste Management*. The solutions that were proposed for this Waffle House were due to the insights gained through careful observation and feedback; however, the real benefit is uncovered through the nature of solutions. This approach can be implemented for different stores, by many different designers, and get a different range of viable solutions using this circular approach to organic waste. Furthermore, the same designer can conduct all four phases multiple times and get new results each time by building on their comprehension of the wicked problem. With multiple versions of the project conducted, the designer can begin to see how opportunities overlap and present parallel themes in solutions or see outliers that provide a new direction for holistic ideation.

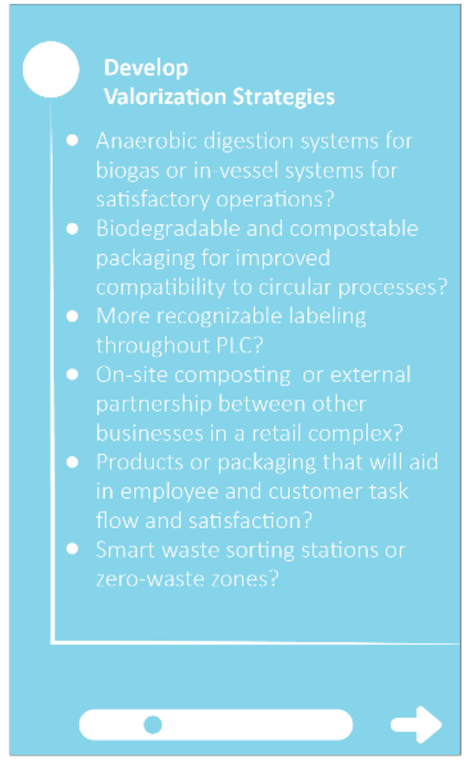


Figure 5.34 Phase Four – Develop Valorization Strategies

Overall, the resolution of the proposed sustainable system is determined by how much time the designer has dedicated towards research and development and how much the client is willing to spend on sustainable interventions. Hence, Phase One Establishing the Stage outlines all the different venues to start looking for and includes a variety of tools to help the designer critically evaluate and analyze the client's environment. The Implementation Phase recommends that solutions for the proposed sustainable system are launched from low to high stakes, thus allowing stakeholders time to buy into the system. Regardless, the anticipated outcome of using this approach will be the creation of more waste stream diversions thus decreasing volume sent to landfills leading to food retail becoming more circular and sustainable.

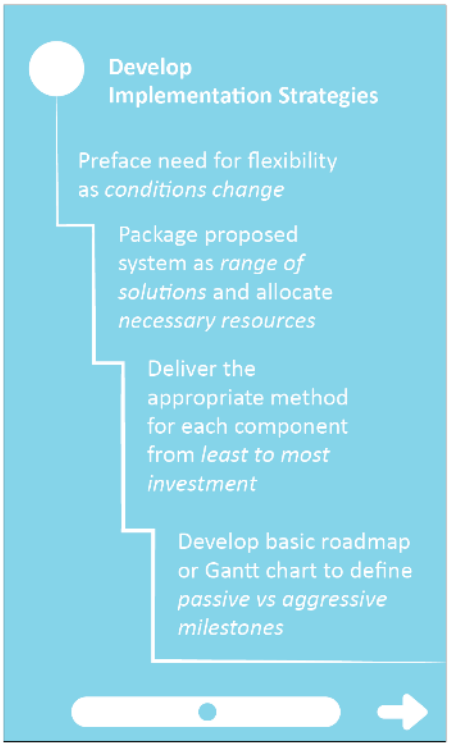


Figure 5.35 Phase Four – Develop Implementation Strategies

Figure 5.36 Phase Four – Finalize Proposal & Handoff

6 Conclusion

This thesis explored how input from diverse industry sectors can shape sustainable practices and presented a comprehensive approach to organic waste management by proposing a four-phase process that highlights circularity and sustainability efforts for food retail sectors. The comprehensive framework is visualized through the Approach Card Set, that was developed to support the designer throughout their design process to evaluate, interpret, and strategize for a project targeting organic waste management. The approach was informed by deconstructing and analyzing the current food system and its typical operations in the United States before shifting to analyzing in real-case study scenarios to uncover current applications and opportunities for innovation. Additionally, the cards were developed through a parallel approach exploring Waffle House as a case study to allow the outcome to be a beneficial and flexible tool to use accordingly.

This paper argued that by shifting away from linear models of consumption and disposal, industry can integrate innovative organic waste diversion techniques that not only reduce environmental impact but also create regenerative systems that see the potential for circularity. With this, true green practices will unequivocally showcase the sustainable efforts of a business and differentiate them from others thus pushing for more social, environmental, and economic responsibility for industry. Overall, this research aims to inspire actionable and reasonable changes that can be generalized and applied holistically to the U.S. food system and empowers designers to address the problem of food waste.

References

1. Allen, D., Johl, A., Linsley, C., & Spoelman, N. (2024, February). *The Fraud of Plastic Recycling*. Center for Climate Integrity. https://climateintegrity.org/projects/plastics-fraud
2. Anderson, K. (2023, October 23). *What is sustainability reporting and why is it important?* Greenly. https://greenly.earth/en-us/blog/company-guide/what-is-sustainability-reporting-and-why-is-it-important
3. Barbrook-Johnson, P., & Penn, A. S. (2022). *Systems mapping: How to build and use causal models of systems*. Palgrave Macmillan. Systems Mapping
4. Becker-Olsen, K., & Potucek, S. (1970, January 1). *Greenwashing*. Springer Nature Link. https://link.springer.com/referenceworkentry/10.1007/978-3-642-28036-8_104#citeas
5. BMUV. (2022, May 16). *Ordinance on the recovery of bio-waste on land used for agricultural, Silvicultural and horticultural purposes.* Federal Ministry for the Environment and Consumer Protection. https://www.bmuv.de/en/law/ordinance-on-the-recovery-of-bio-waste-on-land-used-for-agricultural-silvicultural-and-horticultural-purposes
6. BPI World. *About BPI*. (n.d.). https://bpiworld.org/bpi
7. Brundtland, G. (1987). *Our Common Future: Report of the World Commission on Environment and Development.* UN-World Commission on Environment and Development. https://sustainabledevelopment.un.org/content/documents/5987our-common-future.pdf
8. Buchanan, R. (1992). Wicked Problems Thinking in Design. Design Issues, 8, 5-21. https://doi.org/10.2307/1511637
9. Burnett, N., Malik, X., Smith, L., & Stewart, I. (2024, April 12). *Food Waste in the UK*. UK Parliament. https://commonslibrary.parliament.uk/research-briefings/cbp-7552/
10. Casey, T. (2024, February 7). *Why Waffle House is a Perfect Place for EV Charging Stations*. TriplePundit. https://www.triplepundit.com/story/2024/waffle-house-ev-charging-stations/794426
11. Cedar Grove. (2008). *Bulk Soil & More*. https://cedar-grove.com/
12. Chakraborty, C., Roy, S., Sharma, S., & Tran, T. A. (Eds.). (2021). *The impact of the covid-19 pandemic on green societies: Environmental sustainability*. Springer International Publishing AG.
13. Charter, M., Tischner, U., & Tischener, U. (Eds.). (2001). *Sustainable solutions: Developing products and services for the future*. Taylor & Francis Group.
14. Chen, Y.-T. (2016, November 22). *A Cost Analysis of Food Waste Composting in Taiwan.* MDPI. https://www.mdpi.com/2071-1050/8/11/1210

15. Circular Taiwan Network. (2024). *Composting System for Biodegradable Fresh Produce Bags.* https://circular-taiwan.org/en/case/toaf-leezen-fuyah/
16. Collins, A. (2017, October 24). *Food to the Rescue: San Francisco Composting. Be a Force for the Future.* https://www.nrdc.org/resources/food-rescue-san-francisco-composting#:~:text=Since%20October%202009%2C%20the%20city's,recyclables%2C%20compostables%2C%20and%20trash
17. Congress. (2023, April 19). *S.1194 - Recycling and Composting Accountability Act*. Congress. https://www.congress.gov/bill/118th-congress/senate-bill/1194
18. Connecticut Department of Energy & Environmental Protection. (2014, February 5). *Glossary of Recycling Solid Waste Terms*. https://portal.ct.gov/deep/reduce-reuse-recycle/municipal-recycling-resource-center/glossary-of-recycling--solid-waste-terms
19. Cooks, L. M. (2017). *The End(s) of Freeganism and the Cultural Production of Food Waste*. ScholarWorks@UMass Amherst. https://scholarworks.umass.edu/communication_faculty_pubs/54
20. CRI. (2024, May 24). *Germany.* Container Recycling Institute. https://www.bottlebill.org/index.php/current-and-proposed-laws/worldwide/germany
21. Crump Law, B. (2022, November 9). *What is the polluter pays principle?*. Ben Crump Trial Lawyer For Justice. https://bencrump.com/environmental-justice-lawyer/what-is-the-polluter-pays-principle/#:~:text=It%27s%20difficult%20to%20pinpoint%20the,Development%20(OECD)%20in%201972
22. Design Council. (2024). *Make Life Better by Design*. *We Champion Design.* https://www.designcouncil.org.uk/
23. DSNY. (2024). *Collection Laws for Residents.* New York City Department of Sanitation. https://www.nyc.gov/site/dsny/collection/residents/collection-laws-residents.page
24. Eco-Cycle. (2024, November 14). *The State of Recycling & Composting in Colorado.* https://ecocycle.org/our-programs/zero-waste-colorado/state-of-recycling-composting/
25. EESI. (2017, October 3). *Fact sheet: Biogas: Converting waste to energy*. Environmental and Energy Study Institute. https://www.eesi.org/papers/view/fact-sheet-biogasconverting-waste-to-energy#:~:text=Biogas%20can%20be%20used%20for,sold%20onto%20the%20electric%20grid
26. Elhardt, C. (2022, February 22). *Swiss Population in Favour of Strict Food Waste Rules.* ETH Zurich. https://ethz.ch/en/news-and-events/eth-news/news/2022/02/swiss-population-in-favour-of-strict-food-waste-rules.html
27. ENVAC. (2024, June 14). *Tackling Food Waste: South Korea's Success Story.* Envac group. https://www.envacgroup.com/insight/tackling-food-waste-south-koreas-success-

story/#:~:text=South%20Korea%20has%20made%20significant,process%20food%20waste%20more%20efficiently

28. Environment Agency. (2022, May 17). *SR2021 No 5: Composting in Open and Closed Systems – Waste Recovery Operation*. https://www.gov.uk/government/publications/sr2021-no-5-composting-in-open-and-closed-systems-waste-recovery-operation/sr2021-no-5-composting-in-open-and-closed-systems-waste-recovery-operation#:~:text=The%20total%20quantity%20of%20waste%20in%20storage%2C%20undergoing%20treatment%20and,than%205%2C000%20tonnes%20each%20year.
29. EPA. (2005). *Landfill Methane Outreach Program (LMOP)*. U.S. Environmental Protection Agency. https://www.epa.gov/lmop/lmop-landfill-and-project-database
30. EPA. (2024). *How Does Anaerobic Digestion Work?* U.S. Environmental Protection Agency. https://www.epa.gov/agstar/how-does-anaerobic-digestion-work#:~:text=Anaerobic%20digestion%20is%20a%20process,in%20the%20absence%20of%20oxygen
31. EPA. (2024, October 22). *Zero Waste Case Study: Boulder.* Environmental Protection Agency. https://www.epa.gov/transforming-waste-tool/zero-waste-case-study-boulder
32. EPA. (2024, October 22). *Zero Waste Case Study: Seattle.* Environmental Protection Agency. https://www.epa.gov/transforming-waste-tool/zero-waste-case-study-seattle
33. EPA. *EPA history.* U.S. Environmental Protection Agency. (2024). https://www.epa.gov/history
34. EPA. *Food Recovery Hierarchy.* U.S. Environmental Protection Agency. (2024). https://www.epa.gov/sustainable-management-food/food-recovery-hierarchy
35. EPA. *United States 2030 Food Loss and waste reduction goal*. US Environmental Protection Agency. (2023, August 25). https://www.epa.gov/sustainable-management-food/united-states-2030-food-loss-and-waste-reduction-goal
36. EPA. (2009, February 26). *In: Evaluating, Optimizing, or Ending Post-Closure Care at Municipal Solid Waste Landfills*. Technology Innovation and Field Services Division. https://www.clu-in.org/conf/itrc/pcc_022609/#:~:text=Since%201988%2C%20more%20than%206%2C100%20municipal%20solid%20waste%20(MSW)%20landfills%20have%20closed%20(see%20http://www.epa.gov/msw/pubs/mswchar05.pdf).
37. European Compost Network. (2023, December 5). *Country Report Switzerland 2023.* https://www.compostnetwork.info/download/country-report-switzerland-2023/
38. Feeding America. (2024). Hunger in America. https://www.feedingamerica.org/hunger-in-america
39. FMI. (2023). *Food Industry Facts*. The Food Industry Association. https://www.fmi.org/our-research/food-industry-facts
40. FOEN. (2024, November 28). *Food Waste and Loss.* Federal Office for the Environment. https://www.bafu.admin.ch/bafu/en/home/topics/waste/guide-to-waste-a-z/biodegradable-waste/types-of-waste/lebensmittelabfaelle.html

41. FWS. (2024). *Theodore Roosevelt (1858-1919) The Conservation President*. U.S. Fish and Wildlife Service. https://www.fws.gov/staff-profile/theodore-roosevelt-1858-1919-conservation-president
42. Green Mountain Technologies. (2024, October 17). *Earth flowTM*. https://compostingtechnology.com/in-vessel-systems/earth-flow/
43. IDEO. (2024). *A Global Design & Innovation Company*. https://www.ideo.com/
44. IISD. (2012, June 11). *IISD Sustainable Development Timeline Marks 50 Years of Notable Events, Milestones*. International Institute for Sustainable Development. https://www.iisd.org/articles/press-release/iisd-sustainable-development-timeline-marks-50-years-notable-events
45. Inoguchi, T., Newman, E., & Paoletto, G. (1999). *Cities and the environment: New approaches for eco-societies*. United Nations University Press.
46. Jeong, A., & Yoon, J. (2024, August 9). *How South Korea Recycles 98% of its Food Waste.* The Washington Post. https://archive.ph/2024.08.09-203025/https:/www.washingtonpost.com/world/2024/08/09/south-korea-food-waste-composting
47. Lee, E., Shurson, G., Oh, S.-H., & Jang, J.-C. (2024, January 19). *The Management of Food Waste Recycling for a Sustainable Future: A Case Study on South Korea.* MDPI. https://www.mdpi.com/2071-1050/16/2/854
48. MacBride, S. (2024, March 17). *Is New York City Getting Curbside Organics Done?.* BioCycle. https://www.biocycle.net/is-new-york-city-getting-curbside-organics-done/
49. Milton Equestrian Committee. (2024, March 26). *Milton Equestrian Committee Completes Horse Farm Census*. Appen Media. https://www.appenmedia.com/milton/milton-equestrian-committee-completes-horse-farm-census/article_893752a0-eb93-11ee-ba5b-8fb1523d5b0f.html
50. Misfits Market. (2018). *About US - Organic Grocery Delivery Service: Misfits Market.* https://www.misfitsmarket.com/about-us?redirect=true&promo=MM241010X3PS&utm_campaign=21788681514&utm_source=google&utm_medium=paidsearch-lower&utm_content=168631936277&nw=g&kw=misfits+market&utm_term=716495917147&campaignid=21788681514&adgroupid=168631936277&adid=716495917147&gad_source=1&gclid=CjwKCAjwpbi4BhByEiwAMC8JncRdLSzaLn9VU8KnLIfNs-ZG9_eECYmgtYfCVOcG9mNmBTEyFm8f4xoCN1YQAvD_BwE
51. Morris, J. (2020, August 12). *Seattle's Winning Strategy for Managing Organics*. BioCycle. https://www.biocycle.net/seattles-winning-strategy-managing-organics/
52. Ng, K. S., Yakovleva, N., & Yang, A. (2019, April 17). *Sustainable Waste Management Through Synergistic Utilisation of Commercial and Domestic Organic Waste for Efficient Resource Recovery*

and Valorisation in the UK. ScienceDirect. https://www.sciencedirect.com/science/article/pii/S0959652619312156#sec4

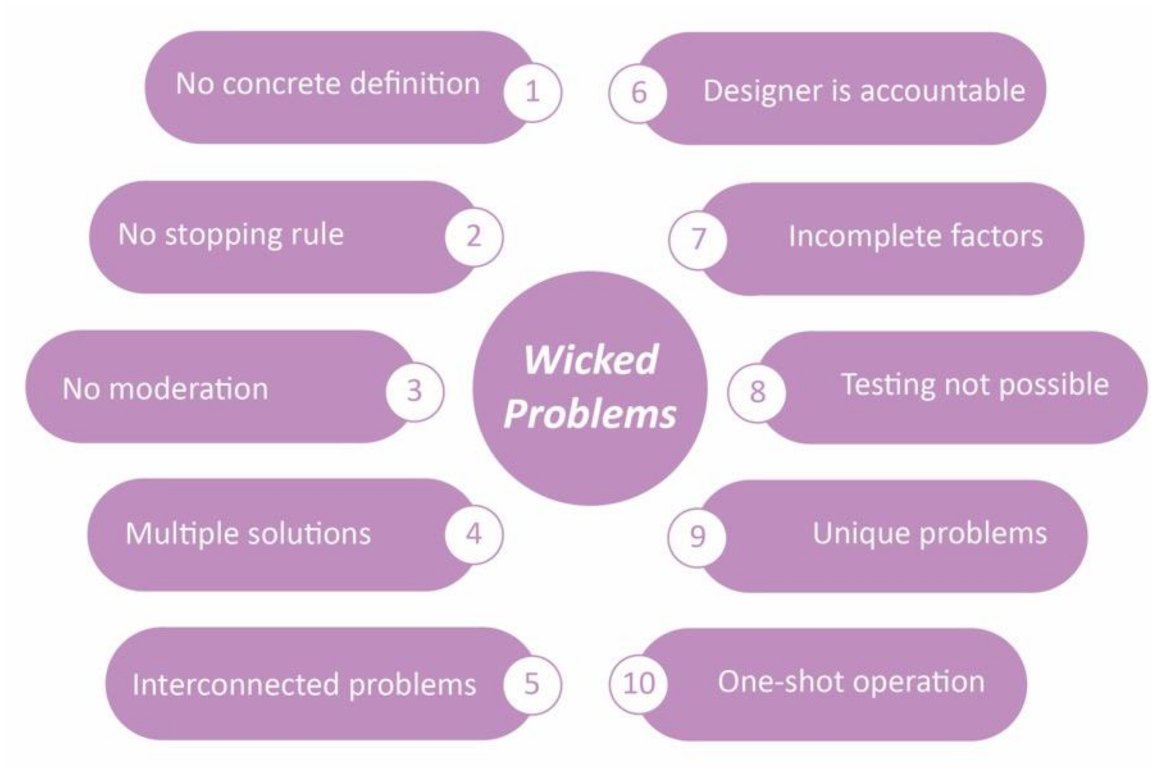
53. Nuwer, R. (2024, August 26). *Japan is Recycling Food Waste Back into Food With Fermentation.* BBC News. https://www.bbc.com/future/article/20240816-the-japanese-farms-recycling-waste-food
54. Okada, Y., & Shimbun, Y. (2023, November 4). *"Smart" Trash Cans Cut Littering in Japan's Former Capital Kyoto.* The Japan News. https://japannews.yomiuri.co.jp/society/general-news/20231104-147513/
55. Okayama, T., & Watanabe, K. (2024, February 8*). Performance of the Food Waste Recycling Law in Japan with Reference to SDG 12.3.* MDPI. https://www.mdpi.com/2313-4321/9/1/18
56. Papanek, V. (1972). *Design for the Real World: Human Ecology and Social Change.* Bantan Books.
57. Pine, B. J., & Gilmore, J. H. (2014, August 1). *Welcome to the experience economy*. Harvard Business Review. https://hbr.org/1998/07/welcome-to-the-experience-economy
58. Rapid Transition Alliance. (2019, June 18). *Taiwan's Transition – From Garbage Island to Recycling Leader*. https://rapidtransition.org/stories/taiwans-transition-from-garbage-island-to-recycling-leader/#:~:text=Today%2C%20an%20integrated%20system%20ensures,for%20the%20recycling%20scheme%20`itself
59. Recology. (2024, July 5). *Recycling Legislation.* Recology Waste Zero. https://www.recology.com/recology-san-francisco/recycling-legislation/
60. Reed, S., & Stibolt, G. (2018). *Climate-wise landscaping : Practical actions for a sustainable future*. New Society Publishers.
61. ReFED. (n.d.). *Food Waste Problem*. https://refed.org/food-waste/the-problem?gad_source=1&gclid=CjwKCAjwpbi4BhByEiwAMC8JnXBN6imo5t4O_zkXdLB4dzUAwBGQN5BbhAD5VjWyHuYfiqCi_W6PMhoCSiYQAvD_BwE
62. Robertson, M. (2014). *Sustainability principles and practice*. Taylor & Francis Group.
63. *RTS*. (2023). *Food waste in America in 2023: Statistics & Facts.* Recycle Track Systems. https://www.rts.com/resources/guides/food-waste-america/
64. Schüch , A., Morscheck, G., Lemke, A., & Nelles, M. (2016, August 4). *Bio-waste Recycling in Germany – Further Challenges.* ScienceDirect. https://www.sciencedirect.com/science/article/pii/S1878029616301001
65. Seven & i. (2024, February 21). *Measures Against Food Loss / Waste and Measures for Organic Waste Recycling.* セブン＆アイ・ホールディングス. https://www.7andi.com/en/sustainability/theme/theme3/recycle.html#:~:text=Ito%2DYokado%20introduced%20a%20%E2%80%9Cgarbage,Prefecture%20on%20a%20trial%20basis

66. Southern Company. (2024, August 27). *Georgia Power Assists Waffle House in Implementing Energy Efficient Blue Frontier Technology*. https://www.southerncompany.com/newsroom/innovation/georgia-power-assists-waffle-house-in-implementing-energy-efficient-blue-frontier-technology.html
67. TRCP. *Our mission*. Theodore Roosevelt Conservation Partnership. (2022, July 19). https://www.trcp.org/mission/
68. Tyson, A., Funk, C., & Kennedy, B. (2023, August 9). *What the Data Says About Americans' Views of Climate Change*. Pew Research Center. https://www.pewresearch.org/short-reads/2023/08/09/what-the-data-says-about-americans-views-of-climate-change/
69. UN. (n.d.-b). *The 17 Goals | Sustainable Development*. United Nations. https://sdgs.un.org/goals
70. UNDP. (2022, November 16). *What Is Circular Economy and Why Does It Matter?*. UNDP Climate Promise. https://climatepromise.undp.org/news-and-stories/what-is-circular-economy-and-how-it-helps-fight-climate-change
71. US Composting Infrastructure Coalition. (2024). https://compostinfrastructure.com/
72. US Food Waste Pact. (2024). *Resources*. https://foodwastepact.refed.org/resources
73. US PIRG. (2022, August 6). *Composting in America*. U.S. PIRG Education Fund. https://pirg.org/edfund/resources/composting-in-america/
74. USCB. (2023, July 1). *Quickfacts: California*. U.S. Census Bureau. https://www.census.gov/quickfacts/fact/table/CA/PST045223
75. USCB. (2024, February 8). *The Great Migration, 1910 to 1970.* U.S. Census Bureau. https://www.census.gov/programs-surveys/sis/resources/visualizations/great-migration.html#:~:text=The%20Great%20Migration%20generally%20refers,million%20Blacks%20left%20the%20South
76. USDA ERS. *Key Statistics & Graphics*. U.S. Department of Agriculture Economic Research Service. (2023). https://www.ers.usda.gov/topics/food-nutrition-assistance/food-security-in-the-u-s/key-statistics-graphics/#:~:text=7.7%20percent%20(10.2%20million)%20of,(8.4%20million)%20in%202021
77. Waffle House. (2020, December 16). *Our story*. https://www.wafflehouse.com/our-story/
78. Waffle House. (2023). Locations. https://locations.wafflehouse.com/
79. WDO. (2024). *Call For Sustainable Design Resources*. World Design Organization. https://wdo.org/resources/call-for-sustainable-design-resources/
80. White, P., St Pierre, L., & Belletire, S. (2013). *Okala Practitioner: Integrating Ecological Design*. IDSA.

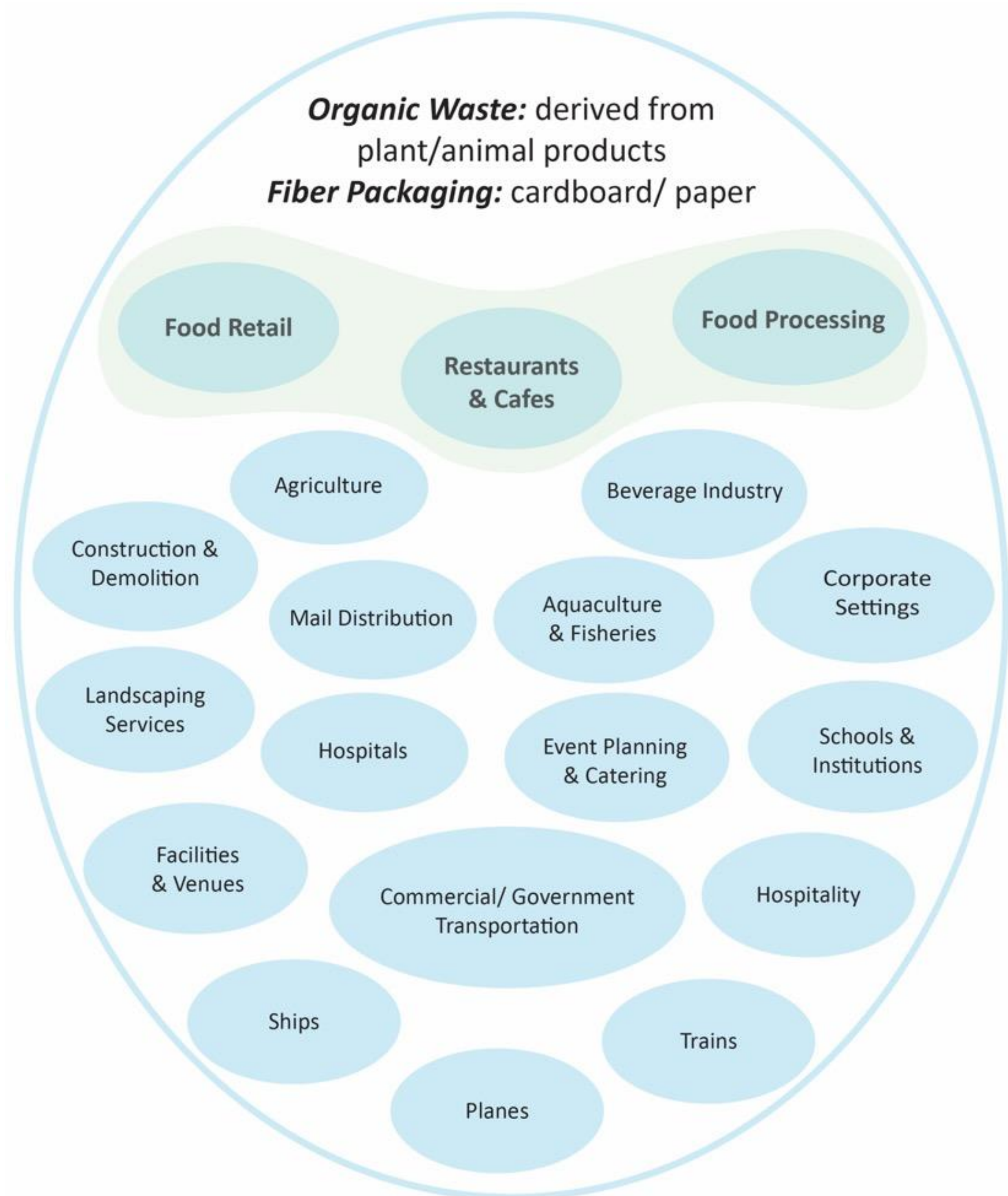
Appendices

Appendix A - Wicked problems: How can we identify and solve these problems through design thinking

illustration adapted from First Loop. (2021, July 7). First Loop. https://www.thefirstloop.com/post/wicked-problems-how-can-we-identify-and-solve-these-problems-throug



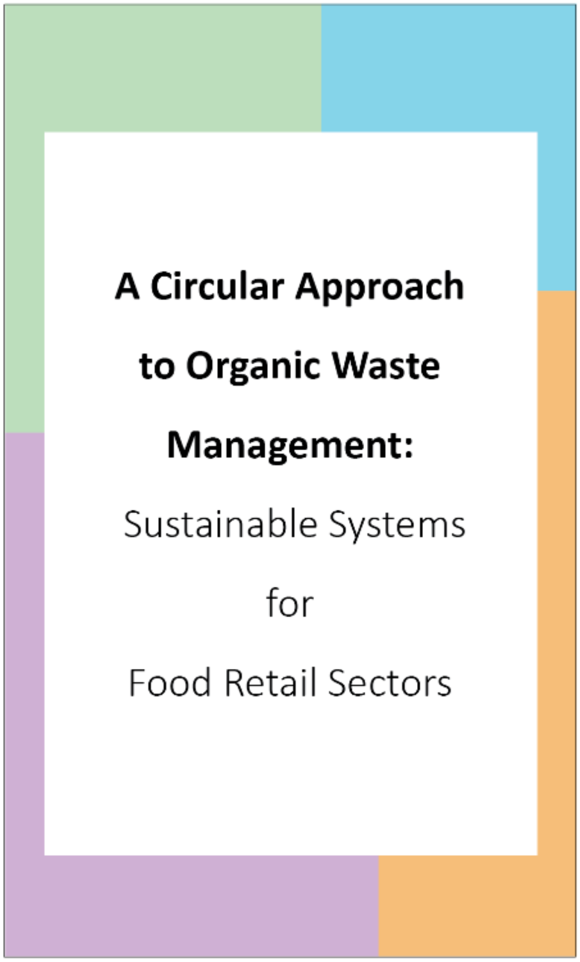
Appendix B - Industry segmentation within the U.S. food system

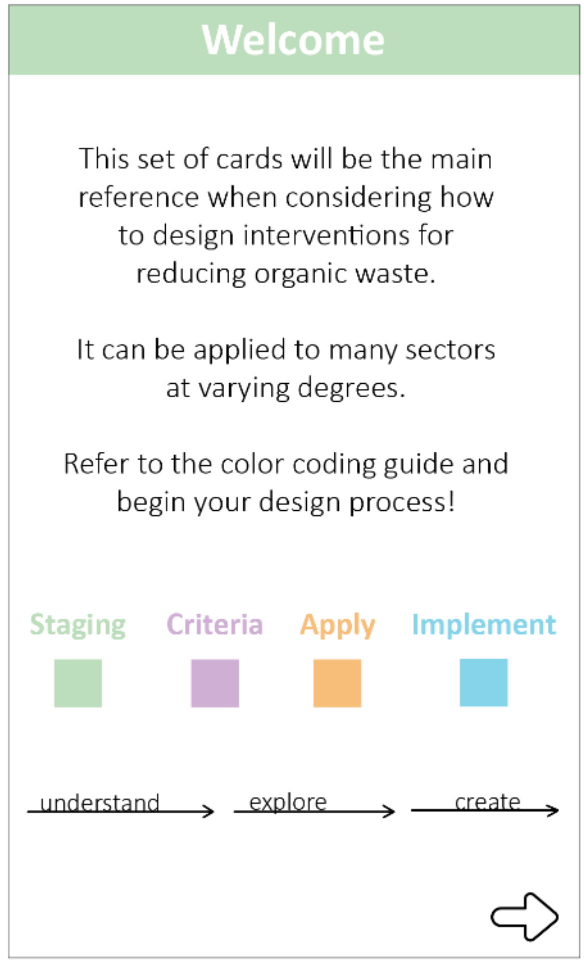


Appendix C - Industry Characteristics Comparison Table

Industry Sector	Type of Waste Generated	Waste Management Practices	Technology Used	Regulatory compliance	Sustainability goals	Challenges	Opportunities
Agriculture	Crop residue, animal manure	Biogas plants, recycling	Vermicomposting	FDA, EPA, local laws	Soil health improvement	Volume capacity managmenet, nutrient management	Close-loop nutrient cycling, bioenergy production
Healthcare	Biodegradable packaging, food waste	Composting, sorting	In-vessel composters	FDA, EPA, local laws	Reduce non-hazardous waste	Sorting, contamination, strict regulations	Biodegradable packaging, on-site composting
Hospitality	Food scraps, kitchen waste	Donation, on-site composting	Anaerobic digestors	Health and safety standards	Zero waste initiatives	Variability in waste types	Food banks network, improvements on sorting technology
Facilities & Venues	Food scraps, expired goods	Composting, recycling, incineration	Compactors, composters	Health and safety standards	Reduce landfill waste	High volume, contamination risks	Collaboration with local composting facilities, waste to energy, reduction strategies
Commercial/ Government Transportantion	Food scraps, recyclable packaging	Anaerobic digestion, incineration	Compactors, incineration	FDA, EPA, local laws	Reduce landfill waste	Variability in waste types, contamination	Improvements on sorting technology, tracking and monitoring, collaboration with composting networks
Schools & Institutions	Food scraps, expired good	Sorting, donation	Compactors	FDA, EPA, local laws	Zero waste initiatives	Volume capacity management	On-site composting, waste to energy, biodegradable alternatives

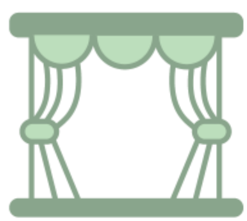
Appendix D - Approach Card Set: Introduction





Appendix E - Approach Card Set: Establishing the Stage I

Phase 1



Establishing the Stage

Objectives: Define scope of project, contextualize and validate, obtain alignment and parameters, conduct preliminary research, conduct system analysis and mapping.

P1

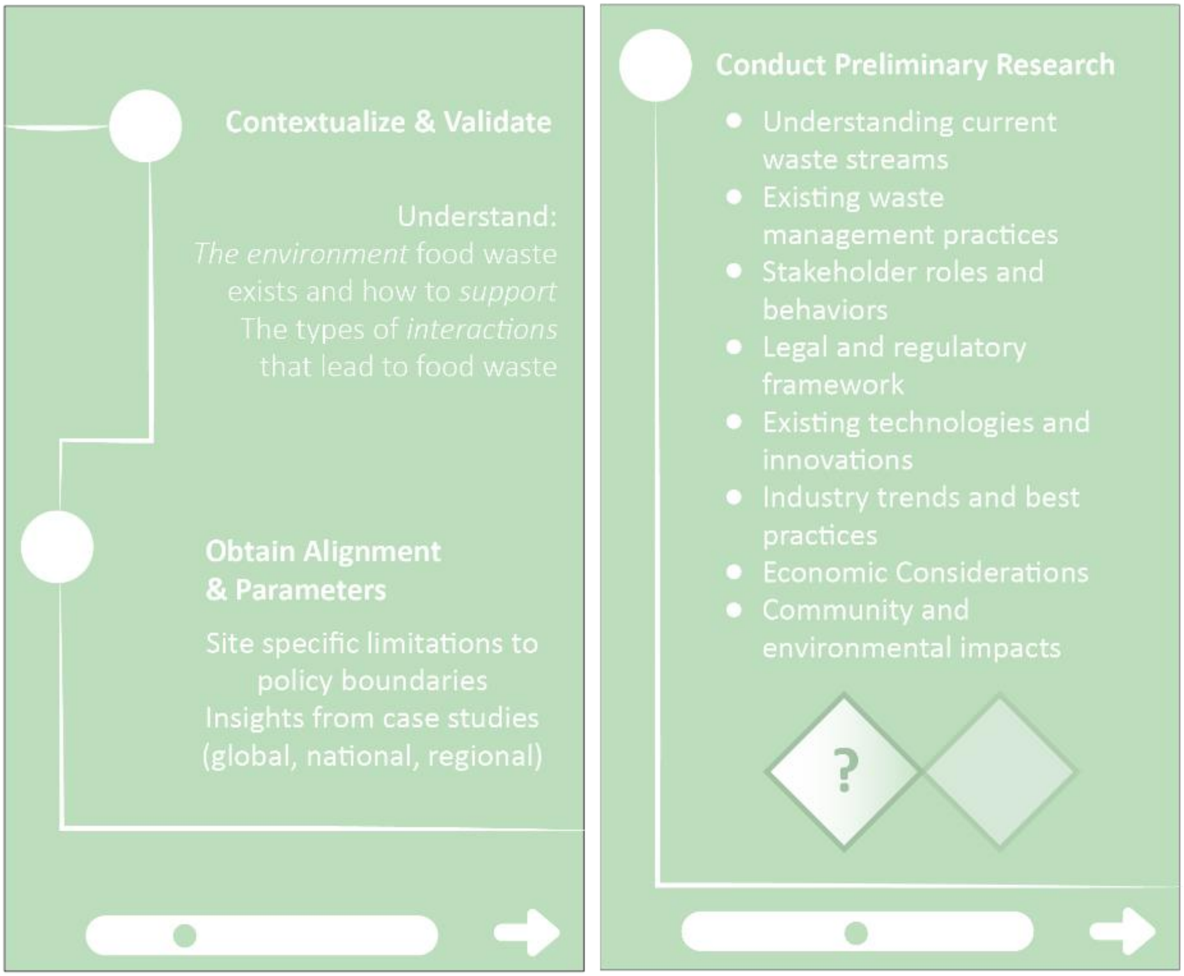
Pre-brief conversation as basis for opportunities, a mutual agreement, and allows for a general idea of the nature of what will be designed.

Define Scope

Starting with 3 guiding questions to the client:

- *Where is the target location(s) for the design solution?*
- *What do you (think you) want designed?*
- *What should it do? Why?*

Appendix F - Approach Card Set: Establishing the Stage II



Appendix G - Approach Card Set: Establishing the Stage III

Appendix H - Interview Card Set I

Current Practices & Procedures	
Notes	On a scale of 1 to 5, how effective do you beleive your current organic waste management practices are? 1 2 3 4 5

Current Practices & Procedures	
Notes	What percentage of your organic waste do you estimate is properly sorted and disposed of? 0-25% 26-50% 51-75% 76-100%

Appendix I - Interview Card Set II

Current Practices & Procedures	
Notes	How frequently does your facility generate organic waste? Daily Weekly Monthly

Current Practices & Procedures	
Notes	How frequently do you measure the amount of organic waste generated in your facility? Daily Weekly Monthly Annually Never

Appendix J - Interview Card Set III

Current Practices & Procedures	
Notes	What would help you the most in improving organic waste management in your facility? Training Infrastructure Partnerships Financial Incentives Other

Current Practices & Procedures	
Notes	What areas of your waste management system do you believe have the most potential for improvement? ☐ Inventory ☐ Supply Chain ☐ Data Collection ☐ Disposal/Sorting ☐ Training/ Engagement ☐ Infrastructure ☐ Product/packaging ☐ Technology ☐ Process ☐ Other

Appendix K - Interview Card Set IV

Awareness & Training	
Notes	How important do you believe it is for your organization to adopt circular practices for organic waste management? Very Somewhat Neutral Not Very Not at all

Awareness & Training	
Notes	How often do emplyees recieve training on organic waste managment practices? Never Yearly Quarterly Monthly Ongoing

Appendix L - Interview Card Set V

Awareness & Training	
Notes	On a scale of 1 to 5, how knowlegdeable do you feel your team is about proper organic waste management practices? 1 2 3 4 5

Awareness & Training	
Notes	How willing is your organization to invest in more sustainable organic waste management practices? Very Somewhat Neutral Not Very Not at all

Appendix M - Interview Card Set VI

Awareness & Training	
Notes	Would you be interested in additonal training or resources to improve organic waste handling? Yes No Maybe

Awareness & Training	
Notes	

Appendix N - Interview Card Set VII

Partnerships & Initiatives	
Notes	Are you interested in exploring more partnerships for waste reduction or recycling? Yes No Maybe

Partnerships & Initiatives	
Notes	If yes, how would you rate the impact of these partnerships on your waste management practices? Very positive Positive Neutral Negative Very negative

Appendix O - Interview Card Set VIII

Partnerships & Initiatives	
Notes	Are you currently working with any internal/ external organizations or initiatives to manage organic waste? Yes No Not sure

Partnerships & Initiatives	
Notes	How familiar are you with the concept of a circular economy? Very Somewhat Neutral Not Very Not at all

Appendix P - Interview Card Set IX

Partnerships & Initiatives	
Notes	How much support do you feel your organization provides for sustainable waste management practices? Very Somewhat Neutral Not Very Not at all

Partnerships & Initiatives	
Notes	

Appendix Q - Interview Card Set X

Recylcing & Composting	
Notes	Does your organization have a composting or recycling program for organic waste? Yes No Considering

Recylcing & Composting	
Notes	If yes, how effective do you find this program? Very Somewhat Neutral Not Very Not at all

Appendix R - Interview Card Set XI

Recylcing & Composting	
Notes	If no or considering, what challenges, if any, do you face in implementing these practices? ☐ Infractructure ☐ Costs ☐ Training ☐ Space ☐ Compatability ☐ Technology ☐ Contamination ☐ Consumer Behavior ☐ Other

Recylcing & Composting	
Notes	

Appendix S - Interview Card Set XII

Technologies & Innovations	
Notes	If yes, how helpful do you find these technologies in reducing waste? Very Somewhat Neutral Not Very Not at all

Technologies & Innovations	
Notes	Do you use any technology or tools to manage/track waste? Yes No Not sure

Appendix T - Interview Card Set XIII

Technologies & Innovations	
Notes	Would you be open to adopting new technologies or systems for waste management? Yes No Maybe

Technologies & Innovations	
Notes	

Appendix U - Interview Card Set XIV

Current Practices & Procedures	
Notes	

Open-Ended	
Notes	

Appendix V - Interview Card Set XV

Open-Ended	
Notes	Are there any data gaps that make it challenging to improve waste management practices?

Open-Ended	
Notes	Have you conducted any cost-benefit analyses on reducing food waste or implementing new waste management technologies?

Appendix W -Interview Card Set XVI

Open-Ended	
Notes	In what ways do you involve or inform customers about your waste management efforts?

Open-Ended	
Notes	How does your waste management strategy fit into your overall sustainability goals?

Appendix X - Interview Card Set XVII

Open-Ended	
Notes	What changes would you like to see in your facility's organic waste management practices?

Open-Ended	
Notes	If you could implement any innovative solution to better organic waste, what would it be and why?

Appendix Y - Interview Card Set XVIII

Open-Ended	
Notes	How do you manage contamination issues when separating organic waste from other waste streams?

Open-Ended	
Notes	What factors influence your decision to send organic waste to composting, recycling, or landfill?

Appendix Z - Interview Card Set XIX

Open-Ended	
Notes	How does employee behavior impact the efficiency of waste management in your establishment?

Open-Ended	
Notes	How do government regulations and policies impact your organic waste management practices?

Appendix AA - Interview Card Set XX

Open-Ended	
Notes	How does your supply chain impact the amount of organic waste generated at your establishment?

Open-Ended	
Notes	How do you think your business could better integrate circularity into its waste management practices?

Appendix BB - Interview Card Set XXI

Open-Ended	
Notes	Have any recent policy changes influenced the way you handle or dispose of organic waste?

Open-Ended	
Notes	In your opinion, what are the most significant opportunities for improving organic waste management in your sector?

Appendix CC - Interview Card Set XXII

Open-Ended	
Notes	What steps have you taken to close the loop on food waste and contribute to a circular economy?

Open-Ended	
Notes	What kind of support or incentives from local or national governments would help improve your waste management efforts?

Appendix DD - Interview Card Set XXIII

Open-Ended	
Notes	How do you see your role in contributing to a more circular and sustainable food system?

Open-Ended	
Notes	What strategies do you have in place to manage waste that occirs due to spoilage or overproduction?

Appendix EE - Interview Card Set XXIV

Open-Ended	
Notes	Are there any specific metrics or goals you aim to achieve regarding waste reduction?

Open-Ended	
Notes	If you had unlimited resources, what changes would you make to your current organic waste management system?

Appendix FF -Interview Card Set XXV

Open-Ended	
Notes	What data do you collect about your waste management practices, and how do you use this information to improve your processes?

Open-Ended	
Notes	Are there any industry-wide initiatives or best practices you follow to reduce waste?

Appendix GG - Interview Card Set XXVI

Open-Ended	
Notes	How do you envision waste management evolving in your industry over the next few years?

Open-Ended	
Notes	How do you think the food retail/production sectors could work together to address the issue of organic waste more sustainably?

Appendix HH - Interview Card Set XXVII

Open-Ended	
Notes	Are there any specific barriers that prevent you from implementing more sustainable waste management practices?

Open-Ended	
Notes	How do you collaborate with other businesses, organizations, or community groups to manage organic waste more effectively?

Appendix II - Interview Card Set XXVIII

Open-Ended	
Notes	Are there any changes in packaging or product design that you believe could help reduce waste?

Open-Ended	
Notes	How does packaging design influence the amount of organic waste generated in your operations?

Appendix JJ - Observation Template I

Pre-Trip Check List

- Appendix printables: observation, spreadsheet, ...
- Extra paper for sketching
- Pencil/ pen/ markers
- Clipboard/ binder/ folder
- Camera
- Voice recorder
- Batteries/ power banks
- Gloves
- Safety glasses
- Identification/ credentials
- References
- Pre-Questionnare
- Backpack/ shoulder bag
- *consider mobility with duration

- Water/ snacks
- Closed toe shoes
- Sweater

Observation Template

Name:

Location:	Date:	Duration:
Services:	Questions:	
Environment:	Concerns:	
Sustainability (goals/challenges):		

Patterns & Behaviors	
Facility	
Equipment	
Workers	

Staff Training	Awareness of practices	Active engagement	When?	
	0 1 2 3 4 5	Yes No Depends		
Generation Sources	Low	Medium	High	
Handling Practices	Distribution	Inventory Man.	Storage	Prevention
	Prep/processing	Labeling	Waste Audit	Weight Metrics
Disposal Methods	1 2 3 4 5 +	1 2 3 4 5 +	1 2 3 4 5 +	
	Sorted bins	Non-sorted bins	Recycling	Shredder
	Composting	Compactor	Incinerator	Waste-to-Energy
Frequency	Collection (daily)	Output Services	Inventory Man.	Odor/ pest

Appendix KK - Observation Template II

Key Activites	Needs	Operations Workflow
Key Events	Opportunities	
Interactions	Improvements	
Incentives	Strengths	Problem Areas
Technology (Basic - Advanced)	Exceptions	

Key Insights	User Experience
General Thoughts/ Comments	Problem Areas

Appendix LL - Sustainability Grade Rubric

Reviewer Name/ Contact:

Date:

Sustainability Grade Rubric

This rubric emphasizes critical factors across EES dimensions to ensure design solutions effectively reduce organic waste, enhance resource efficiency, and create lasting value for a business entity.

Rubric Categories	Score
Proficient	5
Emerging	4
Average	3
Fair	2
Inadequate	1

Scoring Scale	Total
Exemplary	100 - 85
Commendable	85 - 60
Satisfactory	60 - 30
Unsatisfactory	30 - 0

Criteria & Objectives	5	4	3	2	1
Carbon Footprint					
Metrics: Energy sources *(renewable vs nonrenewable)* Operation Emissions/ sq. ft. Transportation Emissions	No tracking or reduction initiatives	Basic tracking or some renewable energy use < 10%	Moderate tracking and renewable energy use < 30%	Significant tracking with moderate renewable energy use > 30%	Comprehensive tracking with significant renewable energy use > 50%
Community Impact					
Metrics: Participation in local initiatives Sign and communication	No participation	Occassional participation	Moderate efforts	Significant efforts	Maximum commitment
Economics					
Metrics: Investments in sustainability Profit/ EES impact balance	No balance	Minimal balance	Moderate balance	Significant balance	Maximum balance
Packaging					
Metrics: Use of compostable, biodegradable, or reusable packaging	No separation or diversion efforts	Minimal waste separation and recycling < 10%	Partial waste separation and recycling < 30%	Significant waste separation and recycling > 50%	Comprehensive waste management > 70%
Waste Management					
Metrics: Diversion methods and rates Secondary use: composting, recycling, programs	No management methods	Minimal management methods	Moderate management methods	Significant management methods	Comprehensive management methods

Appendix MM - Sustainability Grade Rubric II

Reviewer Name/ Contact:

Rubric Categories	Score
Proficient	5
Emerging	4
Average	3
Fair	2
Inadequate	1

Scoring Scale	Total
Exemplary	100 - 85
Commendable	85 - 60
Satisfactory	60 - 30
Unsatisfactory	30 - 0

Criteria & Objectives	5	4	3	2	1

Appendix NN - Taskscape Template: BOH Employees

How to Use

For each user, identify who they are and the various tasks completed throughout a shift. Consider visualizing and overlapping workflows for *BOH opportunities*.

Taskscape Template

Use this during the performance criteria stage (post observation and field studies) to begin evaluating and mapping out employee and consumer flowscapes.

Employee:

Transportation	Management	Ordering	Disposal	Cleaning		

Influences/ Motivations: **Remarks:**

Employee:

Transportation	Management	Ordering	Disposal	Cleaning		

Influences/ Motivations: **Remarks:**

Employee:

Transportation	Management	Ordering	Disposal	Cleaning		

Influences/ Motivations: **Remarks:**

Analysis & Insights:	Target Interventions *Must/Should/Could*:

Appendix OO - Taskscape Template: FOH Customers

How to Use

For each user, identify core values and the various tasks completed to dine out. Consider visualizing and overlapping workflows for *FOH opportunities*.

Taskscape Template

Use this during the performance criteria stage (post observation and field studies) to begin evaluating and mapping out employee and consumer flowscapes.

Customer(s):

Waiting	Ordering	Consumption	Anomalies	Leaving

Influence: Motivations: Remarks:

Customer(s):

Waiting	Ordering	Consumption	Anomalies	Leaving

Influence: Motivations: Remarks:

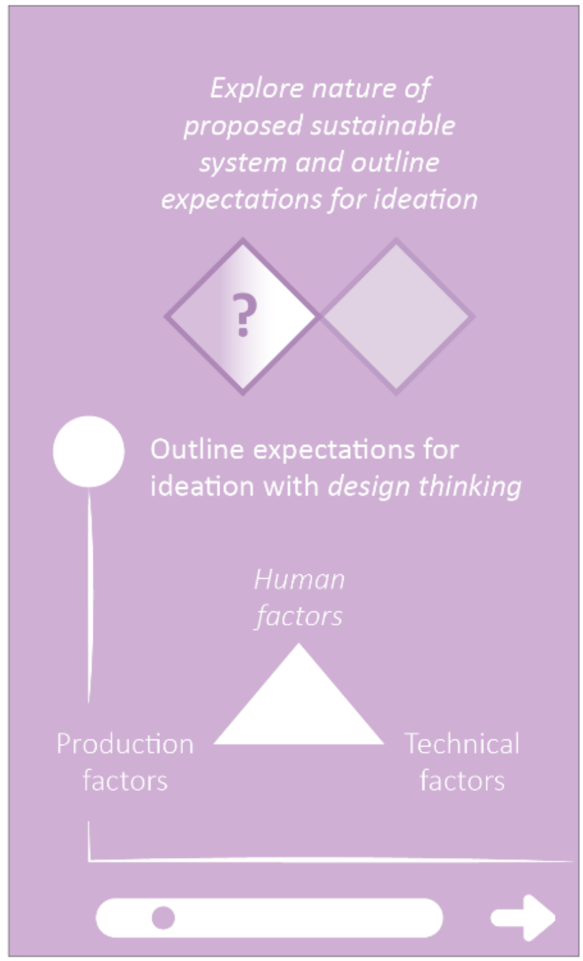
Customer(s):

Waiting	Ordering	Consumption	Anomalies	Leaving

Influence: Motivations: Remarks:

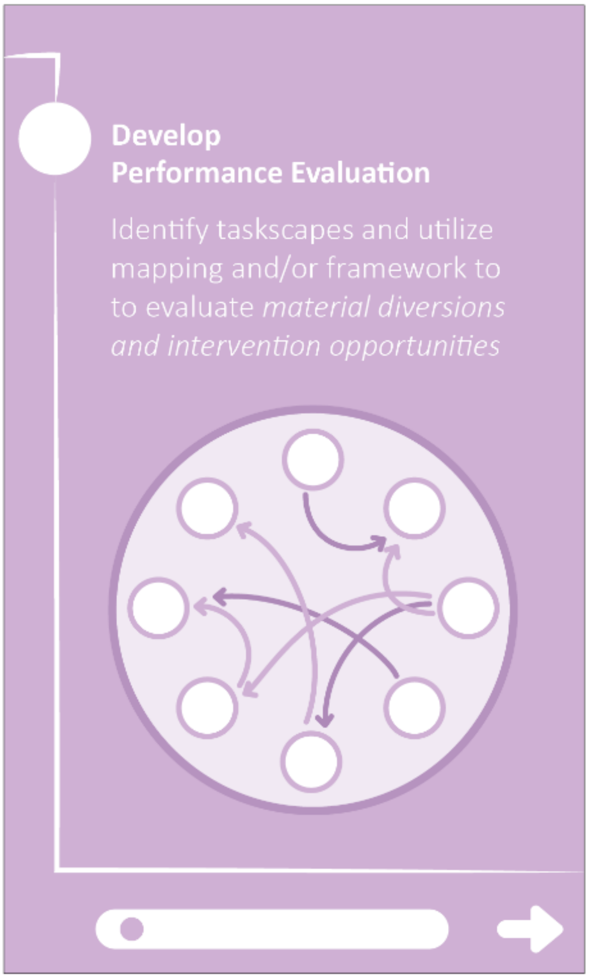
Analysis & Insights:	Target Interventions *Must/Should/Could*:

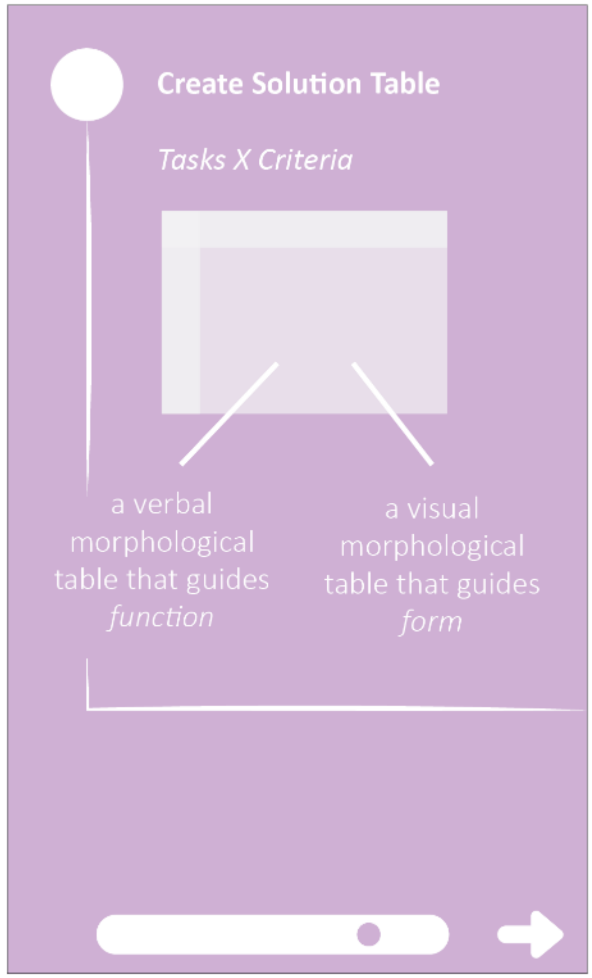
Appendix PP - Approach Card Set: Performance Criteria I



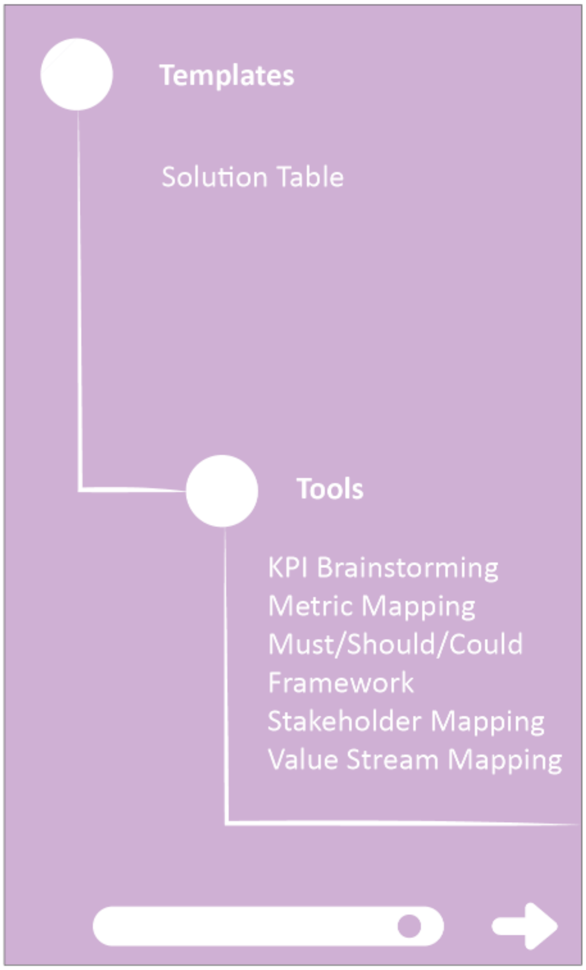
Appendix QQ - Approach Card Set: Performance Criteria II

Appendix RR - Approach Card Set: Performance Criteria III

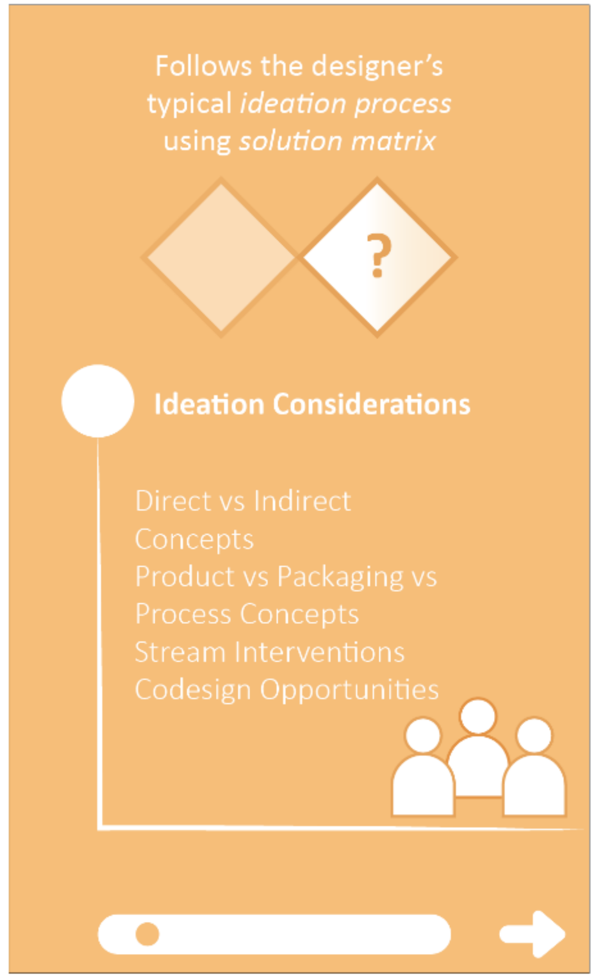




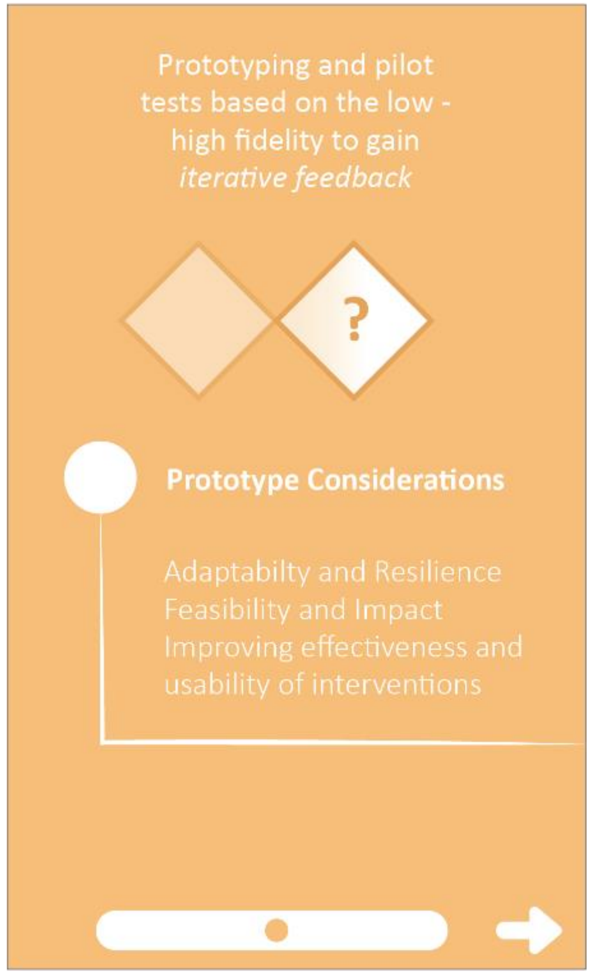
Appendix SS - Approach Card Set: Performance Criteria IV



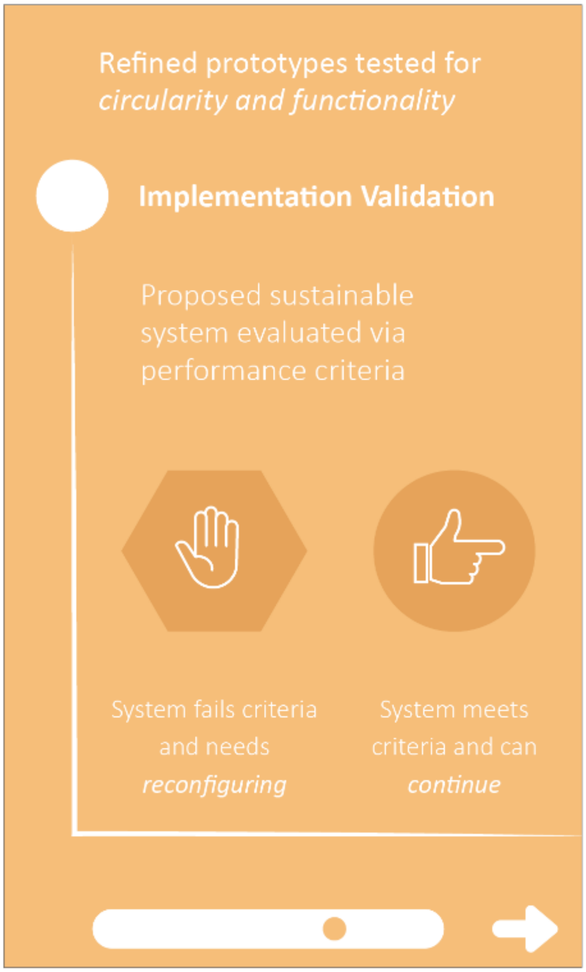
Appendix TT - Approach Card Set: Application I

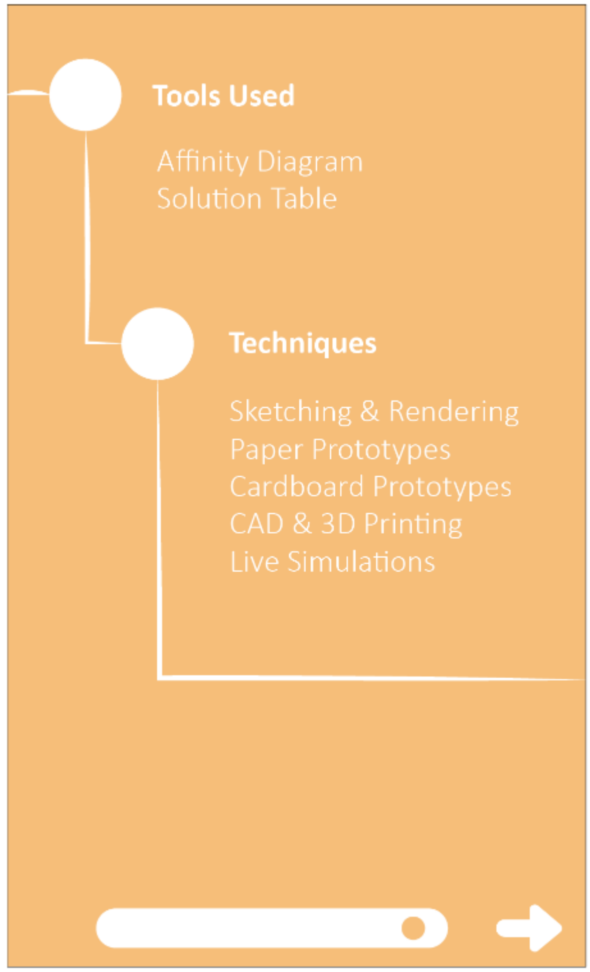


Appendix UU - Approach Card Set: Application II

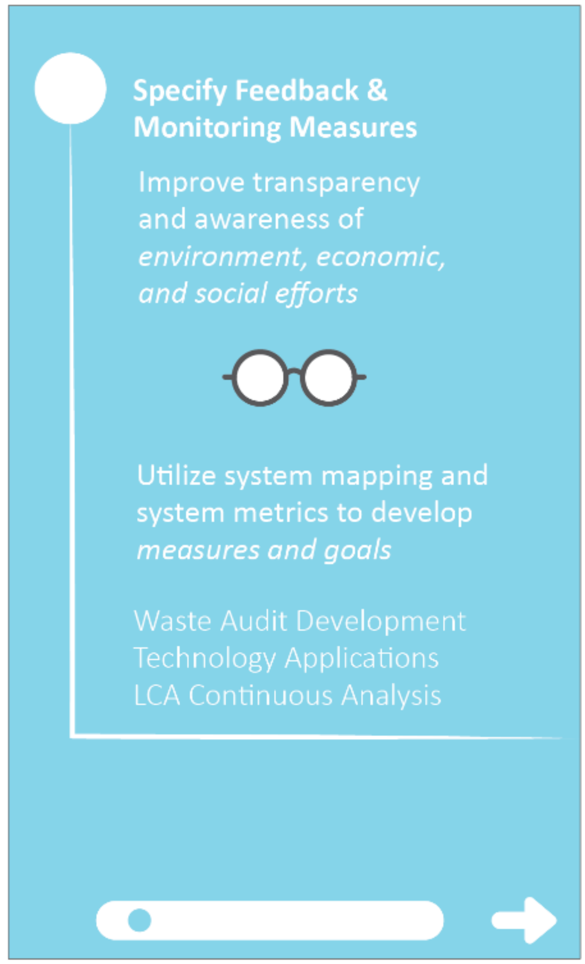


Appendix VV - Approach Card Set: Application III

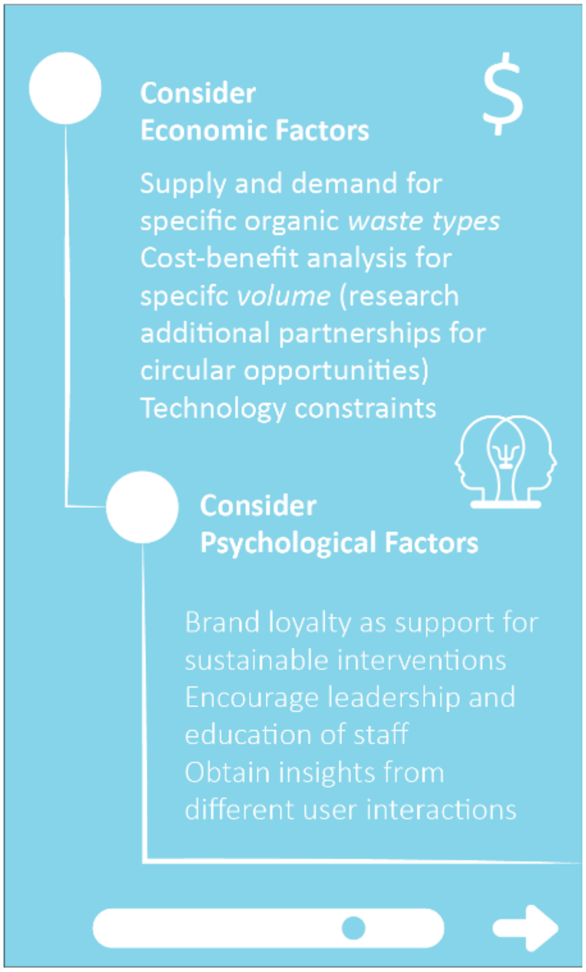


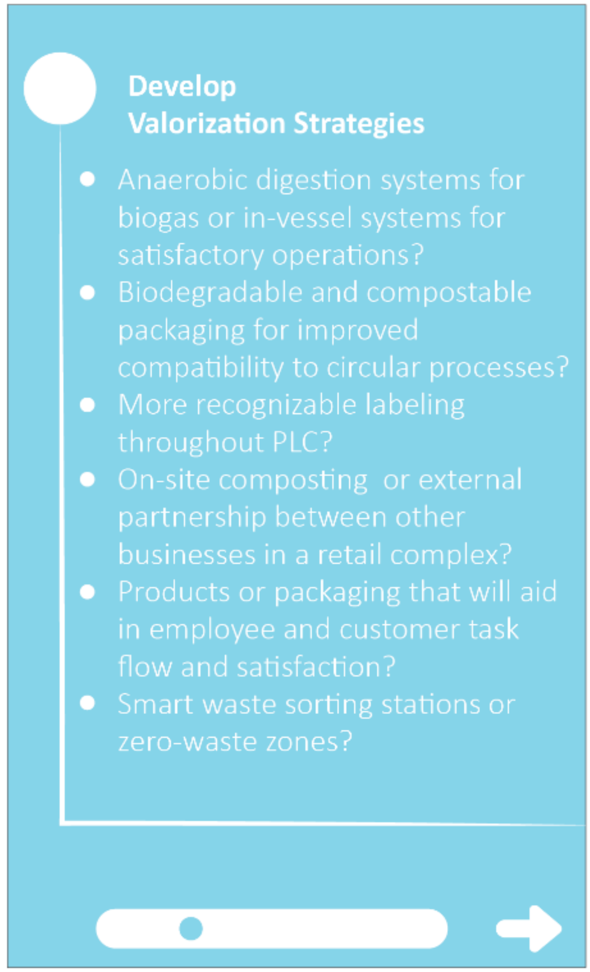


Appendix WW - Approach Card Set: Implementation I

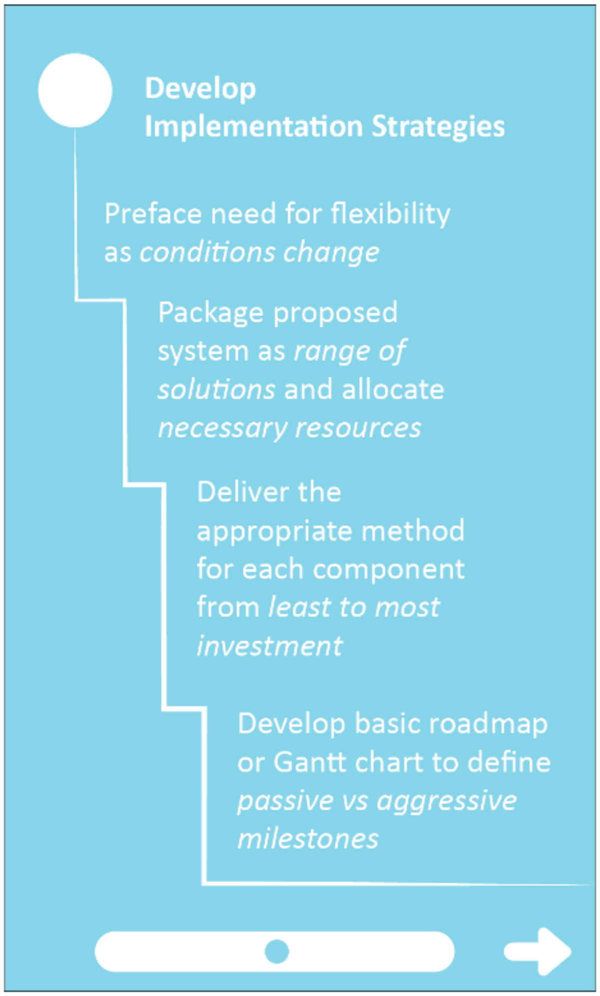


Appendix XX - Approach Card Set: Implementation II

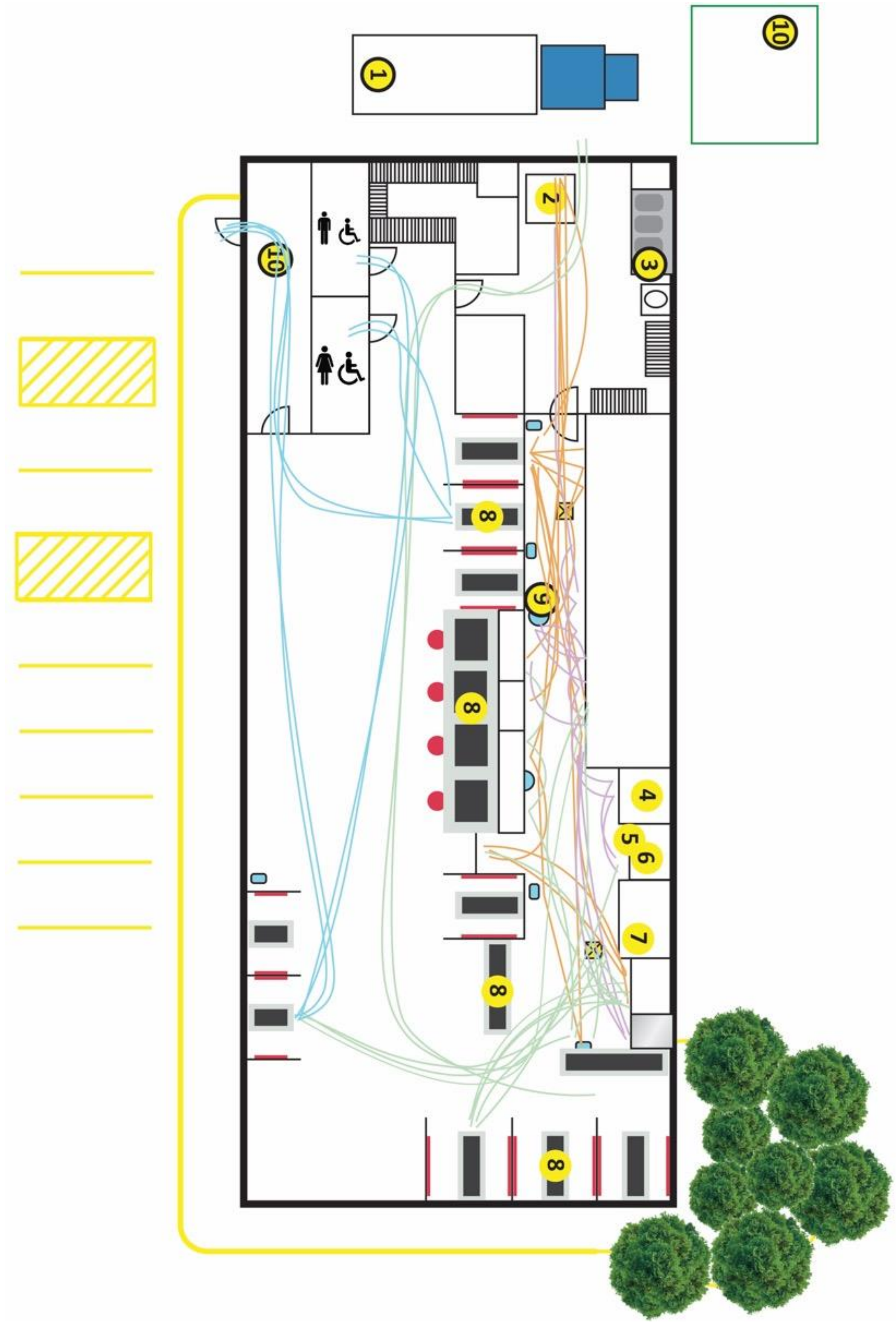




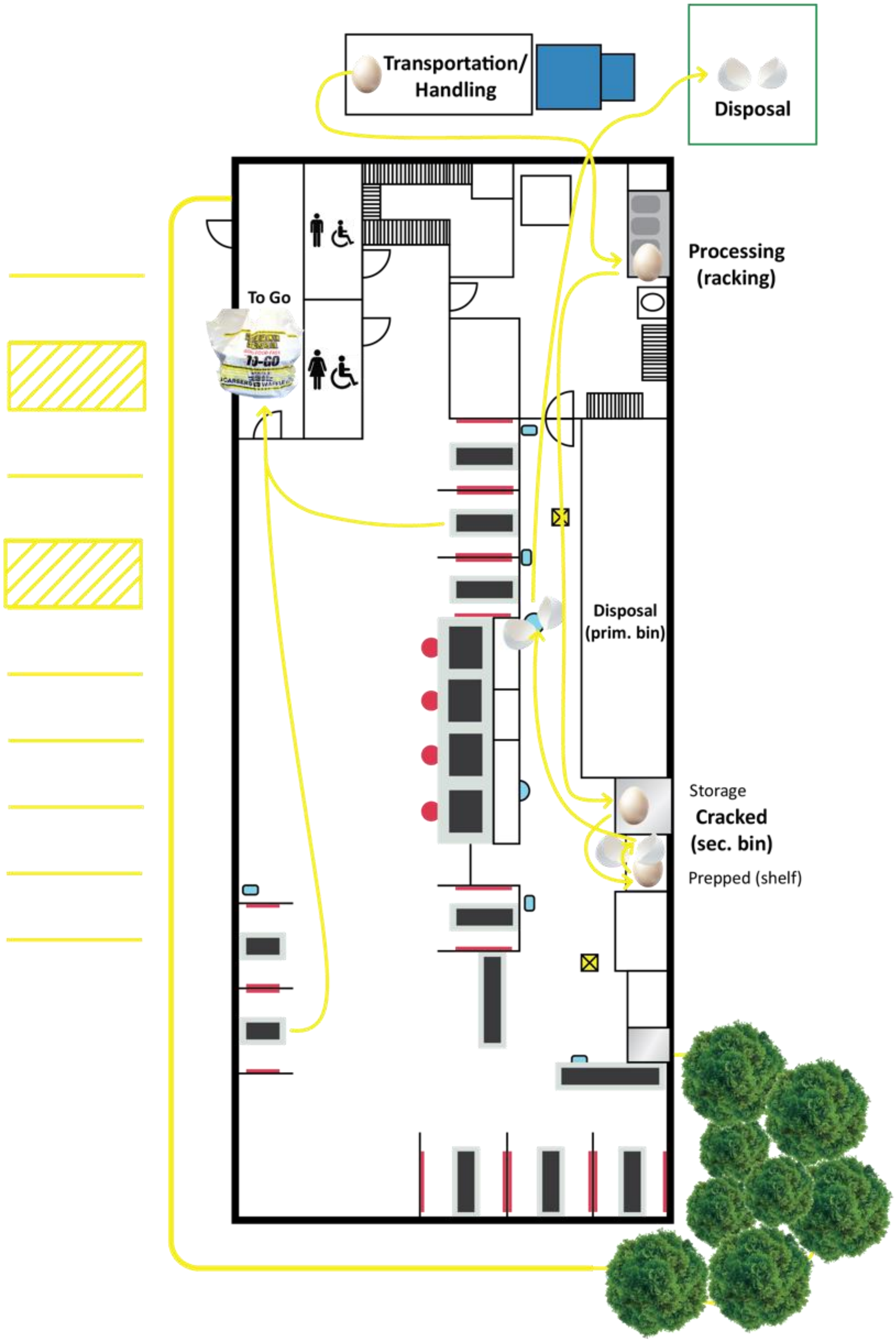
Appendix YY - Approach Card Set: Implementation III



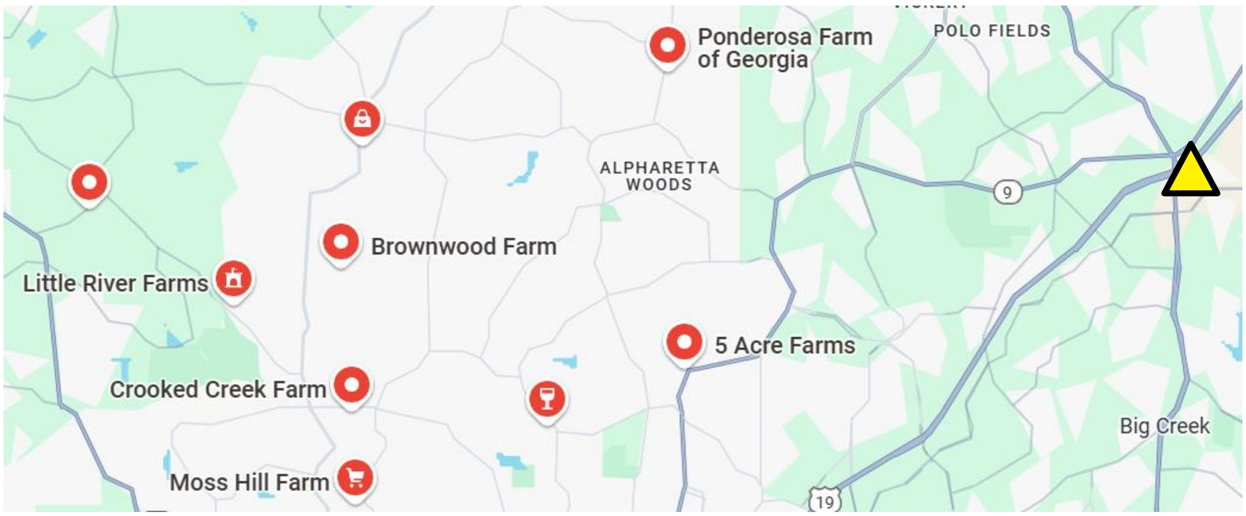
Appendix ZZ - Waffle House Floorscapes



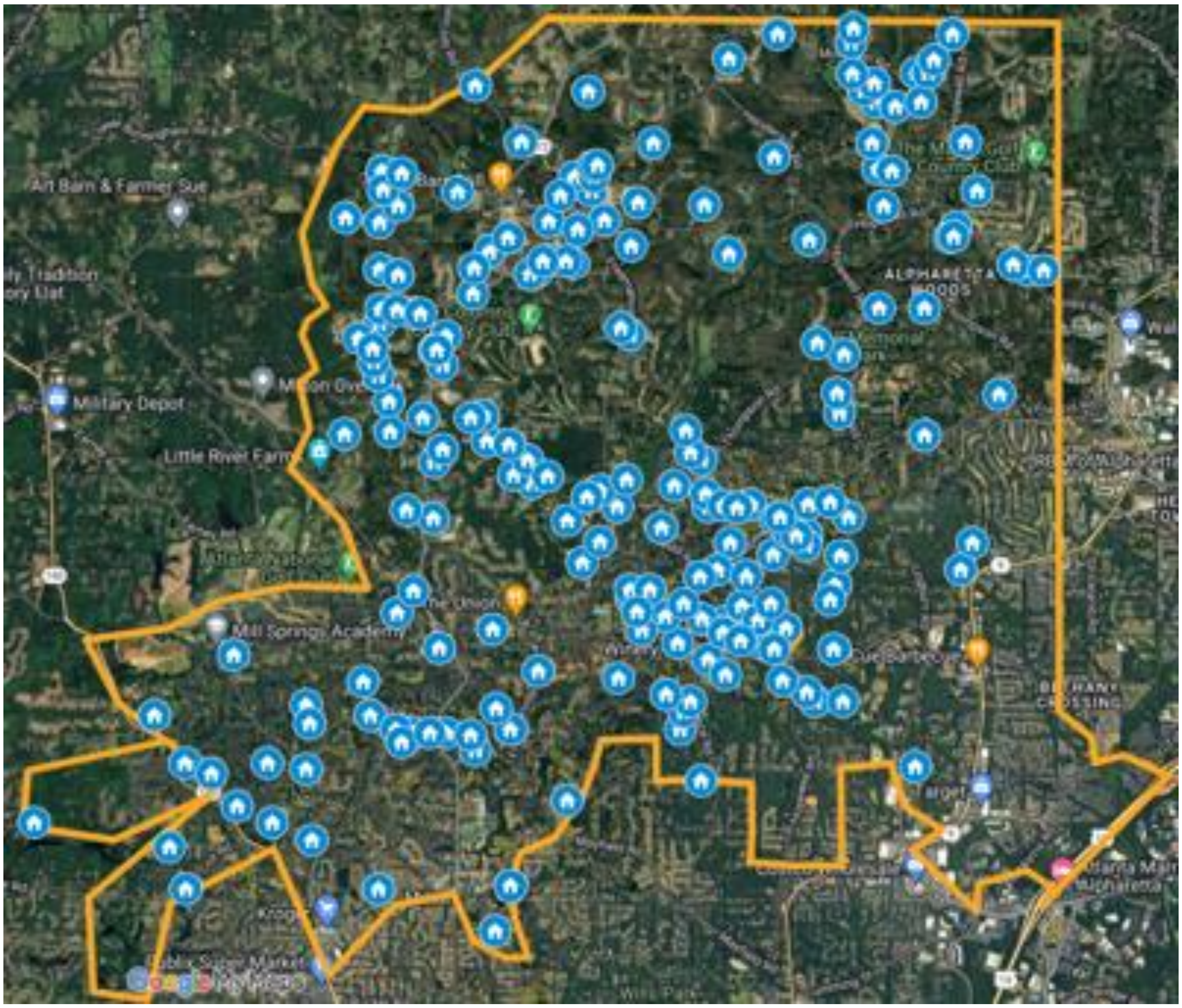
Appendix AAA - Waffle House Egg Life Cycle Analysis



Appendix BBB - Waffle House Circular Applications: General Animal Farms for Organic Waste Valorization



Appendix CCC - Waffle House Circular Applications: Equestrian Network for Organic Waste Valorization



Appendix DDD - Waffle House Circular Applications: Landscape Supply Operations for Organic Waste Valorization