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Exploring the Potential Economic and Sustainability Benefits of Reusable Packaging in the Restaurant Industry

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1. Introduction

Since China implemented its National Sword policy to reduce the amount of waste imported from other countries, the US has been struggling to handle the amount of waste that can no longer be shipped overseas (Wang, 2020). Overburdened municipal waste systems often lead to improper handling of waste, causing recoverable material to be tossed into a landfill (Jiang, 2020). For waste that is not treated appropriately, it can often end up in our oceans, agricultural lands, and even in the bodies of people and animals (Ng et al, 2018) creating both ecological and anthropological health issues. While recent advancements have led to plastics that can break down faster or can be processed through biodigestion and composting facilities, these products rarely work as advertised. A study conducted by the Oregon Department of Environmental Quality (Vendries, 2018) found that most products labeled as biodegradable or compostable often have worse environmental impacts than their traditional plastic counterparts. In addition, while these products can break down, the circumstances under which they behave as advertised are often very specific. Vendries (2018) found that compostable packaging needs to be composted in facilities with specialized equipment which few municipal waste processors have access to. In addition, there is evidence that the finished products from these processes contain harmful chemicals and heavy metals (MacRae, 2021) which can build up in agricultural soils and be transferred to the foods produced on them. Confounding these processes is that consumers must separate biodegradable and compostable materials from normal waste (Jiang, 2020) adding a layer of inconvenience that may prevent most customers from disposing of the material properly. Even disregarding the efficacy of biodegradable and compostable materials, it begs the question of how sustainable can these materials be if they don't fundamentally reduce the amount of waste that is being generated?

The problem of waste material generation is even more pronounced as we start to see the effects the COVID-19 pandemic is having on our waste systems. Zimmerman (2020) reported that some municipalities saw waste production increase as much as 60% over the course of a single month as lockdown mandates began. In particular, the use of disposables grew during the pandemic as concerns over the safety of reusable products (Jiang, 2020) caused both consumers and producers to favor single-use options. While the pandemic was a catalyst for this large influx into municipal waste streams, waste generation was likely headed towards a 60% increase under normal circumstances anyway. In Maine, where the government has identified waste reduction goals, the state has consistently increased its per-capita waste production (State Goals, 2015). In large part, this is attributable to packaging waste increases due to the increasing popularity of online retailing and food delivery leading up to 2019, before COVID-19 even reached the United States (Agarwal, 2020; Zimmerman, 2020). In the US, disposable packaging makes up roughly 36% of municipal waste streams (Coelho, 2020), of which nearly 78% is composed of products used in food and food service industries (EPA, 2015). Reducing even just a portion of this waste source could have large environmental benefits (Coelho, 2020). While most strategies have focused on replacing the material in favor of more green options, those options do not

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reduce the amount of material sent to the landfill. Strategies that aim to reduce the amount of material produced and subsequently landfilled need to be developed in order to effectively reduce the environmental impact of packaging materials.

According to the US hierarchy for waste management and adopted by states, like Maine, the order of preferred waste management strategies is Reduce, Reuse, Recycle, Compost, Waste-to-Energy, and Landfill respectively (State Goals, 2015). Focusing on the second most preferred option on the list, reusable packaging strategies aim to reduce the number of waste packages by extending the useful life of the materials. By making reusable packing with recyclable material producers can utilize two of the top three strategies on the waste hierarchy, further improving the environmental impacts of food packaging on a per use basis (Zimmerman, 2020). Considering that single-use packaging accounts for as much as 30% of a company's CO2 emissions, combining strategies could significantly reduce the emissions associated with normal business operations (Zimmerman, 2020). Strategies for reusable packaging include a host of models that aim to make use of more durable materials to serve multiple consumer orders (Coelho, 2020). This can range from products, such as metal water bottles, which a consumer washes and fills on their own to packaging that is recovered and put back into circulation by a producer. While each reuse system is different, their effectiveness is dependent on a high degree of participation from consumers. Zimmerman (2020) calculated that, in order for reusable packaging to maintain their economic and environmental advantages over single-use alternatives, consumers needed to return the packaging 90% of the time. To achieve such high numbers of participation, reuse systems need to encourage consumers to return the packaging, which is often seen as an inconvenience in the current make-take-waste model of consumerism (Mahmoudi, 2020).

To learn more about these issues, this study looks at the different models and materials used in the restaurant industry. This literature review tries to answer questions regarding the social, economic, and environmental viability of switching to reusable packaging and what factors lead to their success. To do this, we will perform a literature review of available information on lifecycle analysis on the restaurant takeout industry and reuse models. Life Cycle analysis was chosen because of its ability to look at the entire useful life of an object. It is well known that the production costs of more durable packaging, both environmental and economic, are much higher per individual piece. The advantage for reusable packaging is in its ability to be reused multiple times (Mahmoudi, 2020; Zimmerman, 2020), with some materials able to withstand upwards of 1,000 use cycles. The inherent differences in the use qualities of disposable and reusable packaging requires them to be compared on per use impacts rather than solely on total lifetime impacts (Mahmoudi, 2020). Our analysis will focus on four major areas; Social considerations, Economic impacts, Environmental impacts, and Logistical considerations. Social considerations will break down the cultural impacts of switching to reusable packaging including the major factors for encouraging or preventing consumer participation. Economic impacts will look at the economics of switching to reusable systems from the view of consumers, municipalities, and businesses. Environmental impacts will outline the major impacts switching to reusable packaging will have on CO_2 equivalent emissions, water use, and environmental degradation. Finally, logistical considerations will outline the major supply chain and reverse supply chain logistical hurdles of implementing reuse solutions.

2. Methods and Results

Articles were acquired using the search tool *OneSearch* through the University of Maine. *OneSearch* has access to 342 scholarly databases representing billions of published works. Search terms included “reusable container”, “food”, and “LCA”, and were limited to peer reviewed articles published between 7/6/2011 and 7/6/2021. The initial search returned 134 articles and 2 conference transcripts. After eliminating the conference transcripts, duplicates, and articles that had been removed from publication, there were 100 articles left. The abstract of each remaining article was scanned for relevance to the subject matter. A total of 15 articles were then selected for review and represented research on reuse from the 3 different perspectives; supply chain (5), retail (7), and festivals (3).

3. Discussion

a. Social considerations:

When considering social aspects of reuse models, it is important to note what factors lead individuals to participate in the system. As noted by Jiang et al (2020), there is often a discrepancy between the number of people who would like to participate in reuse systems and the number of people who *actually* participate in those systems. While some of this discrepancy can be attributed to a lack of accessible reuse models (Muranko, 2021), there are often other factors involved. For one, specialized packages that contain logos or unique design features can be perceived as souvenirs by consumers (Suskevice, 2021) and taken home rather than placed back into circulation. In this case, companies must choose between a package's marketing appeal and operational utility. Similar to this concept is the idea of Emotional Durability, a term coined to describe the practical durability of an object from the perspective of the individual, who’s personal ideas of that products' physical durability or worth influences its useful lifespan (Woods, 2014). issues surrounding Emotional Durability are likely to be a major complicating factor within reuse systems, as modern conceptions of durability and convenience often cause materials to be thrown out before the end of their useful life (Rigamonti, 2019). Muranko et al (2021) found that exclusively reused products, that is reusable packaging that is owned exclusively by an individual, tend to be thrown away after fewer uses than sequentially reused products (ie. packaging that is returned to a vendor for refurbishment and redistribution). Muranko (2019) described the causes as a lack of knowledge and familiarity with the products' useful lifecycle by the individuals who participate in exclusive reuse and a corresponding decrease in value of that packaging to the individual.

In order for reusable packaging systems to be effective at reducing environmental impacts, it is necessary for consumers to be active participants in the process (Muranko, 2021). This represents a major divergence from the current model of make-take-dispose, which requires very little effort or thought on the part of the consumer. As such, the increased complexity and effort required to participate in reuse systems can present enough logistical challenges to discourage consumers from participating (Suskevice, 2021). In order to combat this effect, providers of reusable packaging can use incentives or deterrents to increase participation (Suskevice, 2021). Researchers have found that clear marketing and effective communication can help make these systems less confusing (Muranko, 2021). Other studies suggest that clear communication around the indirect costs of tossing packaging, may help increase willingness to participate (Voroskoi, 2020). Woods et al (2014) also note that reusable packaging systems are not likely to succeed unless they maintain the users current quality of life. This, perhaps more than any other reason, may be the key to the success of reusable packaging systems. If reusable packaging does not maintain or improve quality of life by reducing customer inconvenience, it is not likely to be adopted by the general public.

While quality of life may have a large impact on participation rates, the need to redesign the packaging for reuse may present opportunities for producers to design for quality-of-life improvements.

Zampori et al (2013) noted that chicken packaging trays made from aluminum could be designed to decrease cooking times, increase kitchen safety due to decreased contamination issues, and could be reused. The quicker cook times and decreased amount of packaging and utensils used to cook the chicken proved to be both economically and environmentally advantageous to the users (Zampori et al, 2013). Packages may also be designed to protect the foods better, leading to a decrease in food waste due to damage or spoilage (Ingrao, 2021) and allowing consumers to spend less time and money acquiring fresh food. Indeed, even subtle design features of packaging can lead to decreases in waste. Comps-Posino (2021) found that larger food packages are often associated with greater amounts of food waste while Ingrao (2021) found that containers filled to 70% of their capacity were more visually pleasing to customers and lead to less food waste. These findings suggest that designing packages to match proper portioning can influence users in subtle ways to increase customer satisfaction while reducing food waste and the costs associated with such food waste.

b. Economic considerations:

In considering the financial and economic implications of reuse models, we take a look more broadly at the municipal implications then narrow our scope to commercial entities and finally end with the impacts on consumers. In the US, 33% of all waste is made up of single use packaging and, in the EU, 38% of all plastics are made into packaging materials (Ingarao, 2016). In the US, this equates to about 39 million tons of waste per year, a large portion of which are byproducts of the restaurant industry (EPA, 2015). Globally, 380 million tons of plastic packaging are created annually of which 24% are used to package food and between 5 and 13 million tons of which will end up in the oceans (Suskevice, 2021). In terms of global operations, the US restaurant industry accounts for nearly 35% of all disposable food service ware (Woods, 2014). According to Sharma (2020) all this leads to the US spending 6.5%, or $1.4 trillion, of its GDP per year collecting and treating waste. In Maine, the effects of China's national sword policy were drastic. Before 2017, waste managers in Maine could sell recycling for $10-30 per ton, but this soon turned into a cost of $100 per ton (Clark, 2021) after China stopped accepting waste imports. It is estimated that Maine municipalities now spend between $16 and $17.5 million per year handling packaging waste (Clark, 2021). Even transitioning a modest 20% of single use plastics to reusable packaging could represent large savings for municipalities and the US.

Reuse strategies do, however, represent an inherent change to municipal waste systems. While it is most effective to establish reuse systems with a localized center of sorting and redistribution (Ingrao, 2021), municipalities may not have the capacity to incorporate the correct infrastructure. Additionally, as municipal waste management depends on consumer participation, municipal reuse solutions would require proper participation to be effective. Muranko (2021) notes that reusable packaging, especially items designed to be exclusively reused, are often more difficult for municipal waste managers to process and require specialized equipment to recover. In Maine, where there is an established bottle redemption program, in which it costs taxpayers roughly $2.4 million annually to reconcile for improper participation (Clark, 2021). While most of this cost is associated with fraudulent activity, it does highlight the importance of a consumer base that is willing to participate.

For reusable packaging to be a viable option, it has been estimated that customer participation must exceed 90% (Zimmerman, 2020). In order to achieve this level of participation, reuse models must properly incentivise and communicate with their customers (Muranko, 2021). While discounts for participating do work to incentivize customers, it's been found that charging customers on a deposit or subscription service basis tends to incentivise greater return rates (Muranko, 2021). In particular, deposit systems, which place a refundable charge per container used, tend to be the most effective (Suskevice, 2021). However, no reusable system is particularly effective when used as an optional alternative to single use packaging. In a study of reusable cups at music festivals, Suskevice (2021) found that concert goers would prioritize the convenience and low-cost of single use cups over reusable cups

when the two systems were presented together. For consumers, it appears there is an inherent conflict between doing what they feel is right and doing what is convenient. When this conflict also presents financial implications (ie. losing a single use cup costs nothing while losing a reusable cup means losing their deposit) then the incentive is to choose the option that is perceived as cheaper and more convenient. This presents a particular dilemma for businesses as choosing to transition their packaging slowly could result in an economic failure of the reuse system due to low participation rates.

For businesses transitioning to reuse models, the increased complexity of logistics and corresponding increase in manual labor needs could represent significant cost increases (Accorsi, 2013). While these costs can be offset by decreased expenses, in the long term, on packaging and transportation, studies in Europe suggest that there may be a cost increase of 0.06 Euro per kilogram of food (Accorsi, 2013). As restaurant takeout and delivery services are set to grow to $102 billion, minimizing these costs will be important to the long-term success of reuse models (Gallego-Schmid, 2019). Possible solutions to defray the increased labor costs include manufacturing intelligent packaging designs (Zampori, 2013; Ingrao, 2021) to minimize material and product losses, passing the cost onto consumers through subscriptions or deposits (Muranko, 2021), and centralizing collection and redistribution activities. As noted by Muranko (2021), by making collection and redistribution activities originating from a single point of orientation, it creates a system that is easier to use by the consumer and it puts the decision of packaging lifetime into the hands of trained professionals. Both of these factors lead into the single most important factor of reuse success; high return and reuse rates on a per package basis (Zimmerman, 2020).

c. Environmental factors

Environmental analysis of reusable packaging versus disposable packaging can be tricky due to the differences in how they are used. Because a simple cradle-to-grave comparison of reusable versus disposable products does not accurately depict the lifetime utility of the product, it is necessary to evaluate the environmental impact on a per use basis rather than per item (Suskivice, 2021; Woods, 2014; Zampori, 2013; Ingarao, 2016; Ingaro, 2021; Accorsi, 2013; Comps-Posino, 2015). The first aspect to consider is what the environmental impact of the material is. Many studies indicate that reusable polypropylene (PP) containers are the best choice for widespread integration into reusable systems (Accorsi 2014, Harnoto 2013). This is mainly due to the balance this material strikes between durability and ease of manufacture. In addition, aluminum and other metals can provide specific advantages during their use cycle because they can allow for design features that enhance cleaning and heating capabilities (Zampori, 2013). While glass containers can provide advantages after just a few uses, their high production impacts, increased weight, and fragility make them poor candidates for reusable packaging when compared to common plastic and metal alternatives (Ingarao, 2016). However, when considering products that contain more than one material, glass replacements tend to be harder to recycle or recover during the end of life processes (Muranko, 2021) but are, nonetheless, treated like glass by consumers due to their similarity.

A key factor in the comparison between disposable and reusable packaging is that reusable containers tend to require more material to produce (Comps-Posino, 2021) and therefore impact the environment more on a per unit basis. The increased durability from using more material, however, helps the impact of reusable packaging to be spread amongst a much longer useful lifetime (Ingrao, 2021; Muranko, 2021; Woods, 2014; Zampori, 2013). For example, an analysis of 360 single-use compostable clamshells created 85.5 kg CO2 equivalents (CO2e) while one reusable clamshell used 360 times created 1.27 kg CO2e (Harnoto, 2013). According to Harnoto (2013) reusable clamshells' environmental impact is favorable compared to the equivalent amount of single-use clamshells after the 14th use in every metric other than water use. Using more durable materials, such as stainless steel,

necessitates that the package is used more times for its per use environmental impacts to be beneficial, but the materials greater durability can outweigh the environmental costs (Comps-Posino, 2021). Throughout the literature, the number of reuses a package lives through is key to the advantages reusable systems can realize.

Unlike disposable packaging, reusable packaging has several methods to improve environmental practices. While disposables can really only improve emissions and water use through the production and end-of-life processes, reusables can realize efficiencies throughout its entire life cycle (Zampori, 2013). For instance, implementing different wash cycles during can greatly reduce, or increase, a reusable package's water and energy consumption (Gallego-Schmid, 2018; Potting, 2015). The use stage of reusable packaging accounts for 63% of its contributions to climate change, of which the wash stage has the largest impact (Comps-Posino, 2021). Further, designing reusable systems to be geographically relevant can greatly reduce emissions from transportation use. While disposable packaging represents set delivery routes that flow continuously in one direction, usually over long distances (Ingrao, 2021; Ingarao, 2016), reusable packaging systems that minimize redistribution travel distances can reduce use stage transportation emissions by up to 80% (Muranko, 2021).

i. Logistical considerations

Each model of reuse consists of a specific makeup of 1) consumer behavior, 2) reusable product, and 3) reuse enabling infrastructure (Muranko, 2021). Reusable products come with two main modes of intended use (Muranko, 2021); exclusive reuse and sequential reuse. Exclusive reused items require each individual consumer to own and care for the packaging (Muranko, 2021) with the provider of goods and services interacting with the packages only to refill it. Sequential reused products require providers to establish infrastructure that handles the collection, cleaning, and redistribution of the packaging to future customers (Muranko, 2021). Muranko et al (2021) describe three types of infrastructure; infrastructureless which are reserved for exclusive modes of reuse; infrastructure for returns only which typically utilize a third party vendor; and infrastructure for returning and washing. For the restaurant industry, there are four main systems that emerge from the combination of infrastructure and modes of reuse; deposit systems (Suskivice, 2021); subscription based systems (Muranko, 2021); reward systems; and charge systems. Deposit systems entail collecting a deposit for the packaging which is returned to the customer when the packaging is given back (Suskivice, 2021). Subscription based systems charge users on a period basis, allowing them to check out a set number of packages at a given time (Muranko, 2021). Reward systems are most commonly used in conjunction with exclusively reused packages and rewards users by discounting their purchase (Muranko, 2021). Charge systems can work opposite to or in conjunction with rewards systems by charging users for using disposable packaging or charging them for failing to return reusable items (Muranko, 2021).

Success in reuse systems is dependent on their ability to slow the lifecycle of packaging materials by increasing their useful life (Muranko, 2021). Therefore, in evaluating the success of reuse systems, we must look at how effective each system is in increasing the number of uses before the package is discarded. In the literature, it is clear that businesses that provide the infrastructure to reuse packaging tend to benefit from increased packaging use cycles (Muranko, 2021) due to the expertise of staff trained to identify damaged units and repair or replace them as necessary. Logistically, keeping enough packaging on hand in sequential reuse systems can pose challenges for industries where there are intermittent and intense surges in traffic (Potting, 2015), such as large music venues. Exclusive reuse systems, in contrast, typically benefit from needing no backstock and simple logistics which are easy for consumers to understand (Accorsi, 2013; Voroskoi, 2020). Important in all systems of reuse is clear communication and proper supply and labor management (Accorsi, 2013; Muranko, 2021; Suskivice, 2021) which can be hard for smaller businesses. Additionally, the reverse product logistics that require the packaging be transported from a collection site to a wash site and then distributed to businesses

increases the risk of packaging breakage during transit and handling (Ingarao, 2016). For businesses, these issues can present a significant barrier to establishing successful reusable packaging systems.

At the heart of this issue is the concept of convenience, it is simply more convenient for consumers and businesses to think of packaging as separate from the product and throw it away as soon as it has served its initial purpose (Muranko, 2021). In order for reuse systems to be successful, a change needs to occur in our collective conceptualization of what packaging it. One step towards this is to recognize that disposable packaging represents an inherent loss to society (suskivice, 2021). By throwing packaging away after one use, society is planning for the obsolescence of that material and all of the money, labor, and utility that it represents (Potting, 2015). By incorporating packaging into the cost and process of a product, we obscure the costs of the packaging (Voroskoi, 2020) by conceiving it as part of the product to be consumed. Separating the costs of packaging from the products they contain, reusable systems change this conception, making the packaging perceived as a product onto itself (Muranko, 2021). To ease this transition, third party vendors can be utilized. By creating reuse packaging systems that are managed separately from the consumable product and owned by a different company, it can be more clear to consumers that the packaging needs to be treated separately from the product and allows for a consolidation of program communications and logistics (Muranko, 2021).

4. **Conclusions**

In theory, reusable packaging can provide many advantages compared to disposables. While environmental impacts need to be scrutinized on a per use basis, the impact of packaging can be reduced by including reuse systems into our current restaurant models (Muranko, 2021; Vorovskoi, 2020; Harnoto, 2013). While these effects are clear if the reuse systems are utilized properly, the consequences for low participation rates presents the potential that the more durable reusables can create worse environmental impacts than their disposable counterparts (Potting, 2015; Suskivice, 2020) due to their high production values. Reusables systems can improve their environmental impacts by improving washing techniques (Gallego-Schmid, 2018; Potting, 2015) and transportation routes (Ingarao, 2016; Ingrao, 2021). However, the increased logistical complexities do represent challenges for businesses in creating models that work financially (Accorsi, 2013). While some of these costs can be passed onto consumers, if prices are too high or are presented in conjunction with cost free alternatives then consumers are not likely to participate (Suskivice, 2021; Muranko, 2021). In order for reusable packaging to be more widely accepted, it may be necessary for consumers to conceptualize packaging as separate from the product and to realize the inherent loss disposable packaging represents (Suskivice, 2021).

While this study reviewed available literature, there is a large gap in existing literature that pertains to the subject matter. For this reason, future research is needed to increase confidence in the results. Reusable packaging systems are relatively young operations, especially in the restaurant industry. Future studies creating original research on reusable packaging in restaurants is needed before robust conclusions can be made regarding viability of reuse systems as a whole.

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