Best Practices in Technology-Based Solutions for Food Redistribution

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Executive Summary

Nearly 12 percent of households in the United States report food insecurity, which is defined as not having reliable access to appropriate food, in quantity or quality (Coleman-Jensen, Rabbitt, Gregory, & Singh, 2017). Meanwhile, in the United States alone, food waste makes up as much as 40 percent of all food produced each year (Hall, Guo, Dore, & Chow, 2009). One method of food waste reduction that seeks to address both the issues of food waste and food insecurity is food redistribution, which refers to the process by which food that might have otherwise gone to waste is made available for human consumption through practices such as donation (Resource Efficient Scotland, 2018).

In recent years, many technology-based solutions for addressing food insecurity and food waste through redistribution have emerged as a potentially efficient way to address the two overlapping issues (Corbo & Fraticelli, 2015). With a growing number of technology-based redistribution platforms available worldwide, it is important to explore the best practices of these platforms to assess the viability of such technologies as methods for addressing food insecurity and food waste. The purpose of this study is to understand whether technology-based solutions in redistribution can have a significant impact in increasing donations of food and diverting food from landfills.

In this study, I evaluate two app- and web-based platforms used for food redistribution as individual case studies based on six criteria: effectiveness, efficiency, accessibility, equity, organizational capacity, and environmental sustainability. As technology is constantly changing, gathering data directly from the platforms provides some information about current practices. Semi-structured interviews with the operators of the platforms provides further and potentially more updated information about how the platforms meet each of the six criteria.

The primary successes of the California and Connecticut based organizations lies in their ability to mediate donations, thus relieving many time and labor constraints of both donors and recipient organizations. With the increasing ubiquity of technology, platforms such as the those evaluated are able to appeal to both donors' and recipients' preference for convenient and accessible ways to decrease their waste or increase their donations. Though redistribution may not be the most efficient way to combat the environmental challenges of food waste, and while

donation alone will not solve the problems of either waste or food insecurity, technology-based solutions as methods of food redistribution are aptly poised to address immediate need in the interim, while longer-term solutions are pursued.

Ultimately, though the two platforms evaluated demonstrate some success in utilizing technology as a means to redistribute food, it is difficult to determine the significance of technology-based food redistribution as a method of addressing food waste and food insecurity without further research. Future research should focus on comparison of platforms across sectors and a deeper understanding of the costs of operations in both the private and the public sectors. Additionally, further research must focus on the equity of such platforms as a method of reducing food waste and, in particular, addressing food insecurity. Future research should work to understand the scalability of these platforms in order to equitably serve food insecure populations.

Problem Definition

Introduction

Nearly 12 percent of households in the United States report food insecurity, which is defined as not having reliable access to appropriate food, in quantity or quality (Coleman-Jensen, Rabbitt, Gregory, & Singh, 2017). Meanwhile, according to the Food and Agriculture Organization (FAO) of the United Nations, about one-third of food produced annually goes to waste (Gustavsson, Cederberg, & Sonesson, 2011)[1]. In the United States alone, food waste[2] makes up as much as 40 percent of all food produced each year (Hall, Guo, Dore, & Chow, 2009).

Much of the current literature on food waste cites national or global hunger and food insecurity statistics, implying that waste is an important issue because of the number of people who could benefit from the food that is currently being discarded (Parfitt, Barthel, & Macnaughton, 2010; Gustavsson, Cederberg, & Sonesson, 2011; Buzby & Hyman, 2012). These statistics attempt to emphasize the scope of food waste as a challenge that must be addressed, an emphasis reflected in the USDA's articulation of the issue, which states that wasted food could help families in need (USDA, 2017). However, there is not an inherent connection between the reduction of waste to the mitigation of food insecurity and hunger (Parfitt, Barthel, & Macnaughton, 2010). In studies that are not specifically targeting the issues of hunger and food insecurity, the relationship of those issues to the issue of food waste is often as a moral justification for reducing food waste rather than a plan for addressing food insecurity (Parfitt, Barthel, & Macnaughton, 2010; Buzby & Hyman, 2012), which does not ultimately result in a mitigation of food insecurity.

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[1] Though edible food is wasted all along the food supply chain (FSC), quantifying and defining that waste across the supply chain can be a challenge (Parfitt, Barthel, & Macnaughton, 2010; Buzby & Hyman, 2012; Papargyropoulou, Lozano, Steinberger, Wright, & Ujang, 2014; Gustavsson, Cederberg, & Sonesson, 2011)

[2] Most of the current literature adheres to the FAO definition of food waste as edible material intended for human consumption that is discarded or lost at any point in the FSC (FAO 1981; Parfitt, Barthel, & Macnaughton, 2010; Papargyropoulou et al., 2014; Gustavsson, Cederberg, & Sonesson, 2011).

One method of food waste reduction that seeks to address both the issues of food waste and food insecurity is food redistribution, which refers to the process by which food that might have otherwise gone to waste is made available for human consumption through practices such as donation (Resource Efficient Scotland, 2018). Instead of focusing on food waste as a strictly environmental challenge, redistribution attempts to address both environmental and social goals of food waste reduction. While food redistribution and donation alone will not solve the problem of either waste or hunger, they are methods that can address immediate need while long-term solutions are considered and enacted (Leib, Rice, Berkenkamp, & Gunders, 2017).

In recent years, many technology-based solutions for addressing food insecurity and food waste through redistribution have emerged as a potentially efficient way to address both of the challenges (Corbo & Fraticelli, 2015). With a growing number of technology-based redistribution platforms available worldwide, it is important to explore the best practices of these platforms to assess the viability of such technologies as methods for addressing food insecurity and food waste. In order to understand whether technology-based solutions in redistribution can have a significant impact in increasing donations of food and diverting food from landfills, it is important to evaluate the attributes and to address the potential barriers of these technologies.

Goals

In an effort to target the social and environmental goals of food waste reduction, technology-based food redistribution platforms match or direct food donors to recipient organizations (ReFed, 2016). While working to ensure that food that is produced is available to those in need, redistribution platforms also target the environmental goals of reducing food waste by diverting that food from landfills (RePlate, 2018). In order to address the overlapping issues of food insecurity and food waste, food redistribution platforms aim to increase the ability of donors to redistribute their food effectively and efficiently (ReFed, 2016). By keeping information about available food updated in real-time, food redistribution platforms strive to connect donors and recipients in a way that is accessible to both groups (Food Rescue US, 2017). By aiming to increase efficiency in communication and delivery, these platforms strive to maximize the limited capacity of recipient organizations to manage donations (ReFed, 2016; RePlate, 2018). Donors and recipients have different motivations for engaging with food

redistribution platforms, and different needs when it comes to donating or receiving donations, and may not have all of the resources they need create a successful partnership. Food redistribution platforms aim to provide the resources that donors and recipients need so that food can successfully reach end recipients and donors are encouraged to continue donating excess food (ReFed, 2016).

At each step of the food supply chain (FSC) there is potential for reduction, recovery, and/or redistribution of edible food waste to address both the problems of food waste and food insecurity (Phillips, Hoenigman, Higbee, & Reed, 2013; Papargyropoulou et al., 2014; Schneider, 2013). However, there are many methods of reducing food waste that do not necessarily involve a link between mitigating waste and mitigating food insecurity. A discussion of waste reduction must include a primary focus on waste recovery and redistribution if it also claims to address the growing challenge of food insecurity. In order to do this, it is necessary to distinguish between waste that can be recovered and food that can be redistributed (Midgley, 2013)[3]. Food waste redistribution is a method of reduction (Schneider, 2013; Phillips et al., 2013), but referring to reduction alone does not equal redistribution of food to those in need (Parfitt, Barthel, & Macnaughton, 2010). Though food redistribution and donation of excess food alone will not solve the problems of either waste or hunger, they are methods that can address an immediate need while long-term solutions are considered and enacted (Leib, Rice, Berkenkamp, & Gunders, 2017).

Trends

Food donation can have significant ecological, economic, and social impacts, but those benefits are difficult to fully understand because exact data quantifying the amount of food donated does not currently exist (Schneider, 2013). Similarly, because it is difficult to understand how food arrives at donation, determining the success of legislation encouraging donation in

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[3] Several definitions distinguish between food loss and food waste, with food loss happening early in the FSC as a result of practices in harvesting, transportation, and storage, and food waste referring to the disposal of the food related to retailers' and consumers' behaviors (Parfitt, Barthel, & Macnaughton, 2010; Gustavsson, Cederberg, & Sonesson, 2011). Midgley makes a similar distinction in stating the necessity of distinguishing between waste that can be recovered but is not necessarily fit for human consumption and food that can be redistributed to those in need (Midgley, 2013).

either reduced waste or reduced food insecurity would be impossible (Cohen, 2006). Though donation of food to those in need does play a role in diverting some food from landfills, it is difficult to differentiate between those donations which are initially intended as charitable donations and those which divert food from landfills (EPA, 2013)[4].

It is often difficult to assess the success of redistribution platforms because the nature of donation is such that those organizations receiving donations are willing to engage with the platforms, but are also often unable to pay for the services (Mair & Martí, 2006). Additionally, donors and recipients have different motivations and needs when it comes to donating or receiving food. Donors might participate as a means of corporate social responsibility, to improve their brands' perception in an attempt to influence consumers, or for regulatory purposes (Bhattacharya & Sen, 2004; Babiak & Trendafilova, 2011). Meanwhile, the motivations of recipients is primarily to increase donations for the populations they serve. However, in the case of both donors and recipients, redistribution platforms are most effective when used to arrange transportation, with many platforms coordinating volunteers or drivers for pickups and deliveries (ReFed, 2016). This saves both donors and recipients time and money.

The diverse methods of quantifying waste and identifying priorities in how to reduce waste make the effectiveness of redistribution and donation difficult to assess as methods of reducing waste (Schneider, 2013; Papargyropoulou et al., 2014). However, current estimates show that approximately 576 million pounds of food are donated each year that might have otherwise gone to waste (EPA, 2013). Though redistribution may not be the most efficient way to combat the environmental challenges of food waste, it is able to "compete" against solutions with strictly environmental goals because of the added social benefit of ensuring that food goes to feeding people (Midgley, 2013).

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[4] In measuring the success of food redistribution as a method of food waste reduction, it is important to make the distinction between donation of excess food that would have otherwise gone to waste and food that is initially intended as donation. Food that is initially intended for donation does not divert food from landfills and should therefore not be included in the calculations of redistributed food. However, the distinction between these two types of donations is difficult to measure (EPA, 2013).

Conditions

Accessibility. Redistribution faces a number of barriers to operationalization, many of which stem from the fact that most redistribution practices are exogenous to the existing practices of both donors and recipient organizations. Though most organizations that accept food donations expect and rely on those donations as a part of their practices, there is an uncertain availability of food in both type and quantity (Alexander & Smaje, 2008; Midgley, 2013; Schneider, 2013). This makes redistribution unreliable as a sole mechanism for addressing food insecurity.

Access to donations can be limited to more densely populated areas (Midgley, 2013), and can even be significantly more cost-effective in areas with a higher concentration of potential donors (Phillips et al., 2013), raising questions about the accessibility and equity of redistribution. There is some indication that donation is occasionally built into the practices of certain businesses, however, donations often rely on social relationships between actors (Midgley, 2013).

Capacity. Organizations also face challenges in their capacity to accept and distribute food donations, but also in the time and labor needed to manage donations, with many organizations relying on volunteer labor (Alexander & Smaje, 2008). While volunteers may increase the capacity of an organization to accept and distribute donations, the increase in labor is not necessarily tied to an increase in effectiveness (Eisinger, 2002). Though literature on nonprofit organizational capacity suggests that the effectiveness of organizations is often tied to the presence of a paid staff person and not necessarily to the number of volunteers (Eisinger, 2002), many redistribution platforms attempt to combat the time, labor, and transportation constraints of food recovery and redistribution through the use of volunteers (ReFed, 2018) and accessing the sharing economy in the hopes of efficiently providing excess food to as many people as possible (Food Rescue US, 2017).

Additionally, redistribution of food is tied not only to the capacity of suppliers of food to preserve and donate their food waste, but also to the perishable nature of food (Phillips et al., 2013). That is, redistribution of food waste must consider the time and labor involved in donating, as well as the speed with which this labor must be available in order to contend with

the realities of perishable food (Phillips et al., 2013). Time is often identified as a barrier to reducing food waste through donation (Papargyropoulou et al., 2014; Schneider, 2013; Phillips et al., 2013).

Current Legislation. Despite current policies in place offering guidance and incentives to producers, distributors, businesses, and corporations for donating edible food waste, the fact that up to 40 percent of food produced annually in the United States is ultimately wasted indicates that there are barriers to the implementation of these policies (Hall et al., 2009). The Bill Emerson Good Samaritan Food Donation Act (1996) is aimed at encouraging the donation of food that would otherwise go to waste by providing liability protections for both food donors and those who distribute donations. Despite the fact that there have been no lawsuits against a food donor either before or after the enactment of the law, many companies cited and still cite the fear of liability as their primary barrier to donation, indicating that their actual concern stems more from concern for their brand and reputation than any real threat of liability (Cohen, 2006). Today, the Emerson Act's barriers to implementation include a lack of clarity regarding the donation of food past its "best by" label, as well as the requirement that food first be donated to a nonprofit and then distributed to those in need in order to receive the liability protections (Leib et al., 2017).

In addition, despite federal tax incentives for food donations, many smaller businesses or growers find that the tax credit is not worth the administrative burden of filing (Gorski, Siddiqi, & Neff, 2017). This is in keeping with Phillips et al.'s study, which found that redistribution of food waste depends on capacity to preserve and transport donations (Phillips et al., 2013). Both the Emerson Act (1996) and federal tax incentives for donation also encounter the barrier of unclear food safety regulations with regard to food donations (Leib et al., 2017). The lack of readily available information about these policies adds another layer of background research that businesses must perform before donating (Leib et al., 2017). This is in addition to the time and labor needed to preserve and transport donations at all (Phillips et al., 2013; Schneider, 2013).

Donors might engage with technology-based food redistribution platforms for a variety of reasons. In California, while regulations surrounding Assembly Bill 1826 (2014)[5] and Senate Bill 1383 (2016)[6] are slowing being implemented, businesses may look to reduce their organic waste to deter their mandatory participation in composting programs or to comply with upcoming mandated participation in food recovery practices, while at the same time benefiting from the potential tax benefits of donation (Gorski, Siddiqi, & Neff, 2017). While participating in donation practices might result in costs similar to those incurred by mandatory organics recycling, with donation, businesses are able to not only receive tax benefits, but also to improve the perception of their business (Bhattacharya & Sen, 2004). Though corporate social responsibility practices do not always result in increased revenue for a business, participation in activities that indicate social goodwill might lead consumers to be willing to overlook negative information about a business (Bhattacharya & Sen, 2004, Babiak & Trendafilova, 2011). In the case of food donation, positive brand image in the face of potential negative events may be more incentive for participation in food redistribution than the liability protections promised by the Emerson Act (1996).

Evaluation of Technology-Based Redistribution Platforms

In recent years, many technology-based solutions for addressing food insecurity and food waste through redistribution have emerged as a potentially efficient way to address both the environmental and social goals of food waste reduction (Corbo & Fraticelli, 2015). With a growing number of technology-based redistribution platforms available worldwide, it is important to explore the best practices of these platforms to assess the viability of such technologies as methods of addressing food insecurity and waste. The purpose of this study is to understand whether technology-based solutions in redistribution can have a significant impact in increasing donations of food and diverting food from landfills.

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[5] Assembly Bill 1826 requires businesses that generate a certain amount of waste per week to arrange for recycling services for their organic waste, according to a tiered implementation schedule (AB 1826, 2014).
[6] Senate Bill 1383 is a plan to reduce greenhouse gas emissions that includes a requirement for organic waste generators to participate in organics recycling programs and a mandate that generators of edible food participate in food recovery practices (SB 1383, 2016).

In an effort to target the social, environmental, and economic goals of food waste reduction, food redistribution platforms attempt to utilize technology in a way that can effectively address these overlapping issues (Carbo & Fraticelli, 2015). Though there are technology-based redistribution platforms that engage at all levels of the FSC, most target the distribution, retail, and consumer stages of the FSC (Carbo & Fraticelli, 2015), likely because it is easier to identify food at these stages as explicitly intended for human consumption, and therefore perhaps easier to identify as potential food that could be donated as opposed to food in the production or processing stages of the FSC. Additionally, 31 percent of food loss and waste arises from the retail and consumer stages of the FSC, amounting to roughly 133 billion pounds of food in 2010 (USDA, 2010), making the retail and consumer stage an ideal place for reducing food waste through redistribution technologies.

Redistribution technologies connect donors and recipient organizations, using up-to-date information about the availability of food to improve the efficiency of relationships between the two (ReFed, 2018). One tool redistribution technologies attempt to capitalize on is accessing the sharing economy, which attempts to balance the priorities of environmental, economic, and social actors by connecting resources directly with consumers through the simplified sharing of goods made available through emerging technologies, and thus addressing the sustainability and economic concerns of consumers and at the same time providing a social benefit (Daunoriene, Draksaite, Snieska, & Valodkiene, 2015; Hamari, Sjoklint, & Ukkonen 2016; Roh, 2016). With regard to the sharing economy, redistribution can utilize collaborative redistribution in the physical act of donation, as well as collaborative consumption in its sourcing of volunteers and mediators of those donations (Roh, 2016).

Research on the sharing economy suggests that effective technologies based on sharing and collaborative consumption should not be involved in the exchange (Hamari, Sjoklint, & Ukkonen 2016). However, many redistribution technologies often rely on the presence of a mediator to ensure the successful transfer of food from donor to recipient organization (Alexander & Smaje, 2008; Midgley, 2013; Corbo & Fraticelli, 2015). A potential challenge in accessing the sharing economy in food redistribution is understanding how to maximize

organizational capacity and economic sustainability in a transaction model that involves donation rather than purchase.

Another aspect of food redistribution technologies that might serve to address the sustainability concerns found in the sharing economy model are that the platform operators engage in social entrepreneurship practices. The concept of social entrepreneurship focuses primarily on the process of innovation and collaboration of resources to address social challenges and serve as a catalyst for social change (Alvord, Brown, & Letts, 2004; Mair & Martí, 2006), or "the pursuit of sustainable solutions to neglected problems with positive externalities" (Santos, 2012)[7]. It is often difficult to assess the success of redistribution platforms because the nature of donation is such that those organizations receiving donations are willing to engage with the platforms, but are also often unable to pay for the services (Mair & Martí, 2006). In this way, food redistribution platforms are distinguishable as social entrepreneurship endeavors because of the focus on creating value for society rather than capturing value for the platform, as well as the focus on creating sustainable solutions for combating food waste with the positive effect of addressing food insecurity (Santos, 2012).

Often, individual organizations do not have all of the resources they need to address social problems, and must therefore seek innovative strategies to work together (Mair & Martí, 2006). Food redistribution technologies attempt to close the gap between donor and recipient organizations in a variety of ways, from helping to create direct partnerships between the organizations to acting as a third party facilitator of food donations, coordinating pickup and delivery through the platforms (ReFed, 2016).

Criteria

In this study, I evaluate two app- and web-based platforms used for food redistribution as individual case studies. The applications and websites will be evaluated based on six criteria:

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[7] It is important to note the difference between social entrepreneurship and social activism. While the goal of social activism is to influence social movements through actions that influence or force change, social entrepreneurship focuses on developing sustainable solutions to problems (Santos, 2012). Though there may be overlap between the two, social entrepreneurship aims to increase positive externalities, while social activism works to decrease negative externalities (Santos, 2012).

effectiveness, efficiency, accessibility, equity, organizational capacity, and environmental sustainability (see Appendix for Table 1).

Effectiveness. The effectiveness criteria assesses the ability of the platforms to redistribute food to both divert waste from landfills and provide food to those in need. In an effort to address both food waste and food insecurity, food redistribution platforms attempt to utilize existing resources effectively (Food Rescue US, 2017). The platforms aim to use technology as a tool to maximize the use of existing excess food to address the existing problems of food insecurity and food waste (ReFed, 2016). In order to evaluate the platforms' effectiveness in redistribution, I consider the amount of food recovered, the amount of food donated, and whether the platform is able to access the sharing economy.

Efficiency. The efficiency criteria evaluates the viability of the platforms in redistributing food with their available resources. Food redistribution platforms strive to improve efficiency by allowing donors and recipients to communicate about available food with up-to-date information (ReFed, 2016). In order to understand whether the platforms are able to help facilitate these partnerships efficiently, I assess the amount of food redistributed per dollar spent and the cost of overhead to run the platform.

Accessibility. The accessibility criteria looks at the cost of the platform to both donors and recipients, the number of recipient organizations reached, and the number of platform users. Because the platforms aim to address food insecurity, which is intricately tied to food access, it is important that the platforms be evaluated on the availability of the platform to users and the ability of intended users to utilize the platform to donate food or receive donations.

Equity. The equity criteria assesses the ability of the platforms to address fairness and inclusivity in their practices. I evaluate the types of organizations donated to, the populations served, and the types of geographic locations served by the platforms in order to understand who the platforms are reaching.

Organizational Capacity. The organizational capacity criteria evaluates the ability of the platforms to accomplish their missions (Eisinger, 2002). I look at the number of volunteers, paid staff members, types of donors the platform outreaches to, and support for the platform's

mission by donors and volunteers in order to assess the capacity of the platforms as tools for redistribution.

Environmental Sustainability. The environmental sustainability criteria looks at the food miles, or distance traveled, of the donations in order to determine whether the resources used in transporting donations supports the goals of environmental sustainability present in the efforts of the platforms to reduce food waste.

Cases

This study evaluates two apps/websites: The California-based platform and the Connecticut-based platform. I chose these platforms in order to evaluate both app-based and web-based platforms. The California-based organization, founded in 2016, operates as a web-based platform to connect donors with excess food to recipient organizations in need of food through the use of Food Rescuers. The Connecticut-based organization, founded in 2011, operates as an mobile application with a web-based version available to connect donors with excess food to recipient organization through the use of volunteer site leaders and drivers.

The platforms are currently in-use, active platforms with publicly available information about their usability and reach to both donors and recipients. In order to assess the platforms in a range of locations, I chose platforms that operate in different locations. The platforms are also both available in numerous cities nationwide. Though there is variance between the platforms surrounding costs to food donors, each of the platforms is free for recipient use and both platforms accept both perishable and nonperishable foods.

Data Collection

The data for this study was collected through the publicly available information about the platforms and through semi-structured interviews with operators of the platforms (see Appendix for Table 2). For both of the platforms, there is information available on the platforms themselves about the methods, price, and food recovery success of the apps and websites. Interview questions are designed to assess further and more up-to-date information about the impact and practices of the platforms and the viability of technology-based redistribution platforms in addressing food insecurity and food waste (see Appendix for interview protocol).

Evaluation

In order to understand whether technology-based solutions in redistribution can have a significant impact in increasing donations of food and diverting food from landfills, it is important to evaluate the current state of these platforms and address the potential barriers of these technologies. As technology is constantly changing, gathering data directly from the platforms provides information about current practices. Because the success of the platforms relies heavily upon use by outside individuals, the information publicly available on the platforms is a representation of how the app or web-based platform is marketed to potential users, and the number of platform users is a depiction of how the platforms are able to attract users. Semi-structured interviews with the operators of the platforms provides further and potentially more updated information about the amount of food recovered and donated, as well as further insight into the practices of the platforms outside of what is publicly available, such as their tracking and usership.

There are a number of limitations to this study. First, because of the rapidly changing nature of technology, many less successful platforms are not available to be evaluated. Therefore, by design, my evaluation focuses on those platforms that have been successful enough to remain active, which limits comparison. Next, though food redistribution platforms exist in both the public and the private sector, I was not able to obtain interviews with operators of applications in the private sector, which again limits the ability to compare best practices across sectors.

Because the platforms rely on self-reported information, either what is available on their sites or what is reported to me, I am not able to fully assess the failures of the applications. In addition, because these platforms operate as mediators of recovered food between donors and recipients, I have available only the information provided to me about the people and organizations using the platforms, not necessarily what those using the platforms think about their experience. Finally, because food cannot be donated directly to recipients in most states, the platforms are used to facilitate the donation of food to nonprofits. Therefore, the platforms can only provide a snapshot of the amount of food recovered and redistributed, not necessarily the amount of food that is ultimately provided to individuals experiencing food insecurity.

Results

Effectiveness. To date, the California organization has helped to recover 2 million pounds of food that would have otherwise gone to waste and donated 1.67 million meals. Donations are tracked through the web platform, through an algorithm that tracks trays and the pounds of each tray. Currently, the California organization does not track food once it has reached recipient organizations beyond conversations with those organizations, but aims to track these metrics in the future. Through the organization's conversations with the recipients, it appears that the vast majority of donated food is utilized and not ultimately wasted.

While many redistribution platforms attempt to combat the constraints of food redistribution and access the sharing economy through the use of volunteers, the California organization instead works to build capacity by creating jobs for Food Rescuers in the communities where their platform is available. Food Rescuers are contracted workers who communicate directly with donors and recipient organizations to schedule pickup and delivery of food donations. Thus far, the California organization has created 46 jobs for local community members as Food Rescuers directly contracted through their organization. In the San Francisco Bay Area, Los Angeles, and New York City, Food Rescuers are contracted directly by the California organization, but until they establish markets in a particular area, they partner with third party partners for drivers in those areas.

The Connecticut organization has helped to recover 37 million pounds of food that would have otherwise gone to waste and donated 26 million meals. Donations are tracked through the app by volunteer rescuers who close the rescue and record how much they pick up and deliver. The Connecticut organization knows who has received the donation, but they do not actively track what is done with the food.

The Connecticut organization's application coordinates volunteers to transfer food directly from point A to point B. Each location where the app is active has a site leader who coordinates with donors to learn when they have donations available and to manage special requests. The site leaders that work in the communities where the app is active then populate a schedule and the volunteer rescuers sign up to pick up and deliver food. Site leaders are mostly

volunteers, but some work for or are partnered with larger organizations that the Connecticut organization partners with that do food recovery work in different locations.

Efficiency. Neither application tracks their food from a cost perspective and did not provide much information about the overall costs of operation. Beyond the fees for donors, which help with the cost of redistribution and paying the Food Rescuers, the California organization relies on grant funding to pay for the other associated costs of running the organization, including maintaining the online platform.

Accessibility. The California organization does charge donors for pickups, either a monthly fee for a set number of pickups or a price per pickup. Donors can schedule either recurring or on-demand pickups depending on the needs of the business. Currently, the California organization works with 80 recipient organizations total, and with about 20 of those organizations on a regular basis. There are 118 active donors, which includes anyone who has scheduled a pickup since November 2018, with many of those platform users acting as repeat donors.

There is no charge to donors or recipients in the Connecticut organization's model. The Connecticut organization works with about 800 recipient organizations nationwide and with more than 1,000 small donors, most of which are recurring donations. The Connecticut organization picks up food from donors anywhere from once per week to seven days per week.

Equity. To connect with recipient organizations, the California organization initially began by reaching out directly to organizations, but now, through word of mouth and community engagement, recipient organizations either reach out directly to the California organization or fill out a form available on the website. Once an organization has gotten in contact, the California organization will reach out to assess their capacity to accept donations, including how much food they can accept, how often, and if there is refrigeration available.

The California organization's platform has been utilized in more than 300 cities nationwide, but the most concentrated efforts to establish markets are in the San Francisco Bay Area, Los Angeles, New York City, Toronto, Boston, Seattle, and Austin. The organization works with a variety of recipient organizations, including soup kitchens such as GLIDE

Memorial in San Francisco, food pantries that serve meals, youth programs such as Hack the Hood in Oakland, and other nonprofits.

The Connecticut organization relies primarily on pre-existing relationships that their partner organizations have with local receiving agencies in locations where the app is active. The organization partners with food recovery organizations in the locations where the platform is active, so that the donations are made to the receiving agencies served in those areas. The Connecticut organization is active in several locations nationwide, with sites in 17 locations in California, Connecticut, Washington, D.C., Florida, Indiana, Kansas, New Mexico, North Carolina, Ohio, Oregon, South Carolina, Utah, and Virginia.

Organizational Capacity. The California organization has seven full time staff members in their main office in Berkeley, and 10-13 Food Rescuers contracted through the organization at a given time, though they partner with third party companies for drivers in locations where they have less established markets.

Thus far in their operations, the California organization has worked primarily with tech companies as donors, doing their best to access a market that they had contact with and knowledge of the need for an avenue for donation. In order to engage donors, the California organization's platform provides each donor with a dashboard to show what they have contributed using both environmental and social justice metrics. They offer resources on the platform to educate donors about the goal of reducing food waste, not just redistributing it. The California organization focuses on building trust with donors, and also makes sure to engage with both donors and recipient organizations to ensure that recipients are not overloaded with donations.

The Connecticut organization has about 5,300 volunteers nationwide. They recruit volunteers by word of mouth in communities where the app is active. They have three full time staff and two part time staff, and rely a lot on the work of their site leaders and volunteers. For donations, the Connecticut organization reaches out to restaurants, markets, farmers markets, corporate dining, and any other food purveyor, relying primarily on word of mouth and community engagement for outreach.

The Connecticut organization finds that their volunteers are engaged in the work because they can see the direct impact of the work they are doing. They pick up food waste and deliver it to receiving agencies, and can therefore see both the environmental and the social impact. Many volunteers end up "adopting a rescue," meaning that they pick up food from recurring donors and deliver to the same receiving agencies, and can appreciate the longer-term impact of their work. In addition, many volunteers go on to volunteer at receiving agencies that they have delivered to.

Environmental Sustainability. The California organization does not officially track the food miles of their donations, but is confident that most donations do not travel more than five miles from donor to recipient.

The Connecticut organization operates under a "grocery to home" principle when considering food miles, meaning that food does not travel more than 20 minutes from donor to recipient.

Conclusion

The primary successes of the California and Connecticut based organizations lies in their ability to mediate donations, thus relieving many time and labor constraints of both donors and recipient organizations. With the increasing ubiquity of technology, platforms such as the California and the Connecticut organizations are able to appeal to both donors' and recipients' preference for convenient and accessible ways to decrease their waste or increase their donations. Both the California and the Connecticut based organizations successfully access the sharing economy to facilitate donations, both with paid drivers and unpaid volunteers. A major difference between the two platforms is the cost to donors. However, though the Connecticut organization has recovered significantly more food than the California organization, it is difficult to determine if this is due to the lack of cost to donors found in their model or simply due to the fact the the Connecticut organization has been established for longer.

Ultimately, though the two platforms evaluated demonstrate some success in utilizing technology as a means to redistribute food, it is difficult to determine the significance of technology-based food redistribution as a method of addressing food waste and food insecurity without further research. Future research should focus on the comparison of platforms across sectors and a deeper understanding of the costs of operations in both the private and the public

sectors. Understanding the costs of operations will work towards determining the cost efficiency of technology-based redistribution platforms and provide a greater understanding of the significance of the method as a whole.

Additionally, further research must focus on the equity of such platforms as a method of reducing food waste and, in particular, addressing food insecurity. While these platforms help to donate widely to organizations within the areas they operate, it is important to note that the platforms are primarily available for use in large metropolitan areas. Future research should work to understand the scalability of these platforms in order to equitably serve food insecure populations. Though redistribution may not be the most efficient way to combat the environmental challenges of food waste, and while donation alone will not solve the problems of either waste or food insecurity, technology-based solutions as methods of food redistribution are aptly poised to address immediate need in the interim, while longer-term solutions are pursued.

Appendix

Table 1: Criteria Alternative Matrix

Goals	Impact Categories	California App	Connecticut App
Effectiveness	1. Amount of food recovered 2. Amount of food donated 3. Accessing sharing economy	1. 2 million lbs 2. 1.67 million meals 3. Creates jobs for Food Rescuers (drivers) /partners with local companies for drivers in the locations they operate	1. 37 million lbs 2. 26 million meals 3. Accesses share economy with volunteer driven drivers who pick up and deliver food.
Efficiency	1. Food redistributed per dollar 2. Cost of overhead to run the platform	1. Not tracked in this way and no real sense 2. The pricing of the app helps with the direct costs of redistribution and drivers, the rest is grant funded	1.Not tracked in this way 2. "No cost to donors and recipients" - Additional information not provided
Accessibility	1. Cost to donors 2. Cost to recipients 3. Number of recipient organizations 4. Number of platform users	1. Pricing: - Pay for each pickup: $50/ pickup – 10 trays per equivalent per pickup -4 pickups/month: $160/month – 10 trays or equivalent per pickup; $50 every additional pickup -12 pickups/ month: $480/month – 10 trays or equivalent per pickup; $50 every additional pickup Unlimited pickups/month: contact for pricing 2. None 3. 80+ unique recipient organizations; donates to ~20 organizations on a regular basis 4. 118 active users who have scheduled a pickup since November 2018.	1. None 2. None 3. 800 nationwide 4. 1000+ nationwide

Equity	1. Types of organizations donated to 2. Populations served 3. Types of geographic locations served	1. Ranges: soup kitchens, food pantries, youth programs, open to donating to any nonprofit partners that serve food 2. Open to donating to any nonprofit partners that serve food, specific examples given include Glide Memorial in San Francisco, ECAP in Emeryville, and Hack the Hood, all of which serve diverse populations 3. Primary locations: San Francisco Bay Area, Los Angeles, New York City, Toronto, Boston, Seattle, Austin; have operated in 300+ cities nationwide	1. Community soup kitchens, food pantries, shelters, other hunger relief organizations 2. Reflective of the populations the receiving agencies serve 3. Several locations nationwide, Sites in 17 locations in CA, CT, D.C., FL, IN, KS, NM, NC, OH, OR, SC, UT, VA
Organizational Capacity	1. Number of volunteers 2. Number of paid staff 3. Types of donors outreached to 4. Support for platform mission (donors) 5. Support for platform mission (volunteers)	1. None 2. 7 full-time staff in main office, 10-13 contracted Food Rescuers 3. Mostly tech companies, some beverage companies 4. Each donor has a dashboard to show what they've contributed from an environmental and a social justice perspective, focus on building trust with donors 5. Not applicable	1. ~5,300 registered volunteers 2. 3 full-time staff, 2 part-time staff 3. Restaurants, markets, farmers markets, corporate dining, any food purveyor 4. Impact reports, word of mouth, community engagement 5. They can see the direct impact of work they're doing because they pick up food waste and deliver it to receiving agencies, so they can see the environmental impact and social impact
Environmental Sustainability	1. Food miles	1. Within 5 miles or less	1. No more than 20 minutes; "grocery to home" principle

Table 2: Measurement Table

Concept	Impact Category	Data Collection Method
Effectiveness	Amount of food recovered	Available information on the platform/Interview question #4
Effectiveness	Amount of food donated	Available information on the platform/Interview question #5
Effectiveness	Accessing the sharing economy	Available information on the platform/Interview question #6, 7
Efficiency	Food redistributed per dollar	Interview question #8
Efficiency	Cost of overhead to run the platform	Interview question #9
Accessibility	Cost to donors	Available information on the platform/Interview question #10
Accessibility	Cost to recipients	Available information on the platform/Interview question #11
Accessibility	Number of recipient organizations	Available information on the platform/Interview question #12
Accessibility	Number of platform users	Interview question #13
Equity	Types of organizations donated to	Interview question #14

Equity	Populations served	Interview question #14
Equity	Types of geographic locations served	Available information on the platform/Interview question #15
Organizational Capacity	Number of volunteers	Interview question #16
Organizational Capacity	Number of paid staff	Interview question #17
Organizational Capacity	Types of donors outreached to	Interview question #18
Organizational Capacity	Support for platform mission (staff)	Interview question #19
Organizational Capacity	Support for platform mission (volunteers)	Interview question #20
Environmental Sustainability	Food Miles	Interview question #21

Interview Questions

1. How does your organization define food rescue/recovery and redistribution?

2. How does your platform collect food from donors?

3. How does your platform connect food to recipient organizations?

    - In the beginning, Replate reached out to connect with recipient organizations

    - Now, there's a form available on the website that recipient organizations can fill out

    - The recipient organization can also reach out directly to Replate

    - Once an organization has reached out/filled out the form, Replate will reach out to assess the organization's capacity, refrigeration, etc.

4. To date, how much food has your platform helped to recover/divert from landfills?

5. How does your platform track the amount of food you recover? Do you do anything to track the recovered food once it has been donated to recipient organizations?

6. Does your organization use your platform to access volunteers in recovery in redistribution? How so?

7. Do the volunteers help to pickup and deliver donations?

8. What is the cost of redistributing food via this platform?

9. What is the cost of overhead to run the platform?

10. What is the cost of using the platform to food donors?

11. What is the cost of using the platform to food recipients?

12. How many recipient organizations does your platform work with?

13. How many unique donors have used your platform? How many repeat donors?

14. What types of recipient organizations are reached by your platform? What populations do those organizations serve?

15. Where does your platform operate? Does the platform operate different in different locations? How so?

16. How many volunteers does your organization work with, if any?

17. How many paid staff does your organization have?

18. How does your organization outreach to potential donors? What kinds of donors do you

    outreach to?

19. How do you engage donors in your platform's mission?

20. How do you engage volunteers in your platform's mission?

21. On average, how far does food travel from donor to recipient organization?

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