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Food waste disposal: How social factors influence individuals' willingness to make behavioral changes

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Abstract

Behavioral studies are a growing field of research within waste management practices which have explored facets of individual and social barriers that influence disposal behaviors. Food waste composting programs, however, are a newer management practice being introduced throughout the United States that are often overlooked in these behavioral studies. To reduce this gap, I systematically reviewed behavioral studies literature on individual and social barriers associated with household food waste disposal and factors that influence disposal. In this research, I provide a general overview of the main social factors influencing household composting behavior and key solutions to overcome initial barriers. The results identify a broad range of factors that impact individual composting behaviors. It reveals that ability to compost change in response to socio-economic differences such as level of education, household size, and employment status. These situational aspects in turn create a lack of accessibility to necessary knowledge and resources, as well as lack of time to perform composting at home. Findings suggest that effective information provision and infrastructure may increase individuals' willingness to participate in separate food waste disposal if it is perceived convenient and socially approved. These findings enrich understanding of common behavioral patterns demonstrated by individuals in relation to effective participation in waste management practices. It provides practical information for states like Vermont who have already created legislature banning food scraps from landfills and would want to encourage more people to compost food waste.

Key Words: Behavioral change, behavioral practices, composting, food waste disposal, social change

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1 Introduction

Despite increasing efforts to divert food waste from landfills, food waste generation continues to be the single largest material stream landfilled in the United States, making up 22 percent of total municipal solid waste (U.S. EPA, 2019a). In 2015, the US EPA and USDA called for 50 percent food waste reduction in the United States by 2030 (U.S. EPA, 2019b). With increased political pressure, it is important that waste management programs be provided with the necessary information to improve their systems and help reach this goal.

Removing food waste from landfills will not only free up space for non-recyclable materials, but significantly reduce greenhouse gas emissions. When food is composted, the organic material is converted into soil carbon, ultimately preventing landfill methane emissions, in addition to preserving other valuable nutrients food waste contains that can be used to improve soil quality once the finished compost is ready (Project Drawdown, 2020a). Food waste trapped in landfills produces methane, which is 84 times more potent than carbon dioxide emissions in the first twenty years after its release (Hamburg, 2020). A third of the world's food produced is never eaten, and approximately eight percent of global greenhouse gas emissions comes from food waste alone (Project Drawdown, 2020b). Cities around the world have been working to incorporate separate food waste disposal infrastructure into their waste management schemes in order to reduce emissions, as well as energy and resource loss.

Food waste diversion from landfills has been successful in many areas with programs providing communities with the necessary curbside collection and/or drop off infrastructure services, as well by encouraging composting practices to be performed directly at home. The state of Vermont created the nation's first statewide legislature banning all food scraps from landfills under Act 148, otherwise known as the Universal Recycling Law, which goes into effect July 2020 (VT ANR, 2020). Vermont is not alone; California, Connecticut, Rhode Island, and Massachusetts have also since passed state laws to keep food waste out of landfills. In addition, a number of cities including New York City, San Francisco, Austin, and Seattle have long before started efforts diverting food scraps from landfills (Harvard Food Law and Policy Clinic, 2016). Yet, the vast majority of states still do not have such food waste bans or laws. It is crucial to provide resources to not only increase food waste diversion from landfills throughout the country, but to do so in an effective manner. While these programs can serve as a useful starting place, infrastructure alone is not enough to encourage all individuals to change food waste disposal behavior. In Costa Mesa, California, 34 percent of sample households in one study contributed little to no food-separation, even after curbside collection carts were distributed to each house (Geislar, 2017). Waste management programs often overlook the social factors that influence individual behavioral patterns.

A systematically reviewed academic literature is required to better understand which social factors play the most significant role in determining food waste behavioral choices, and which interventions are successful in removing these social barriers. This research caters to such a need by exploring what social factors influence individuals' willingness to make behavioral changes. The findings indicate willingness to participate ultimately comes down to time, interest, and convenience. Cultural and socio-economic factors, social norms, and social stability all play a crucial role in influencing behavior, in addition to actual knowledge of the issue and services available. Factors such as one's employment, household size, age and education have all posed as challenges that may limit one's ability to participate in separate disposal behavior (Wu, Liu and Brough, 2019; Mattar, Abiad, Chalak, Diab, & Hassan, 2018; Zhang, Duan, Andric, Song & Yang, 2018). One's perceived social norms (Sussman & Gifford, 2013; Refsgaard & Magnussen, 2009) can also be influenced by such factors, determined by the communities in which individuals live and the type of people they surround themselves with. Stable neighborhoods (Dahlén & Lagerkvist, 2009) can have a positive influence on behavioral change. When certain members are already participating in the separate food waste disposal, it can influence others' perspectives by deeming such behavior as socially approved (Shearer, Gatersleben, Morse, Smyth, & Hunt, 2017). In order to increase individual participation in separate food waste disposal, studies have found that effective information distribution can help remove these barriers, especially when the community specific needs and interests are considered (Steg & Vlek, 20089), on top of the services and resources that may already be available to properly separate food waste.

Even when services are in place, it does not necessarily mean everyone is aware of them or why it is important to participate in them (Knickmeyer, 2020). It is essential to not only have the resources available, but to ensure this information is actually reaching the desired audience (Bernstad, 2014). These findings concur with common behavioral trends seen within other waste management practices and provide practical information for states like Vermont who have already created legislature banning food scraps from landfills and other states who are working to create their own composting schemes.

2 Methods

This study systematically reviewed and synthesized the literature on common behavioral patterns and social barriers associated with household food waste disposal. I first describe how I selected the papers in my sample, then how I coded for influential social factors and effective solutions within those papers (Gladkikh, Gould & Coleman, 2019).

2.1 Selection protocol for papers

For the purpose of exploring social factors that influence food waste disposal behavior, I will adhere to the State of Vermont's ANR's (2020) definition of food scraps as:

Pre- and post- consumer food waste that is derived from processing or discarding of food and that is able to be used through one of the following options: food donation for people in need, animal feed, composting, or anaerobic digestion.

My criteria for inclusion in this review are as follows. First, food waste disposal behavior needed to be specifically addressed in the study, however, Mattar et al. (2018) clearly note that understanding food wasting behavior is essential for understanding disposal behaviors. Hence, in this paper I explore reasons for food waste generation to a greater extent than actual food waste disposal behaviors. Second, I explore social factors that influenced these food waste disposal behaviors (e.g., socio-demographics, convenience, and knowledge). Third, the study discussed practices which improved food waste disposal behaviors and helped individuals overcome these initial social barriers. By following these simple guidelines, I excluded: studies that broadly addressed waste disposal behavior; studies about food waste disposal behavior that did not consider the influence of social factors; and studies about food waste behavior that did not observe a need for separate food waste disposal practices.

I designed a set of search terms to account for the variety of ways papers might reference social factors that influence food waste disposal behavior (see Table 1). The following list consists of terms I compiled that might be used to represent "food waste disposal": "food recycl*", "food waste management", "household food waste", "food waste collection", "compost*". The second list consists of terms I compiled that might be used to solicit influential social barriers: "behav*", "pro-environment* behav*", "barrier*", "challenge*", "obstacle*", "difficult*", "issue*", "problem*". I combined terms from each list throughout my searches (e.g. "food waste disposal" AND "behav*" AND ("barrier" OR "challenge*")). To increase relevance of search results, I decided to not use "organic" in the search terms in replace of food because it represented a broader category of waste beyond that of food scraps.

I conducted one search in February and March 2020 using two online databases: Academic Search Premier and Agricultural and Environmental Science Collection. I included peer-reviewed studies published in English through March 2020; I did not limit the search by date or geographic scope. The selection process consisted of four steps which followed the Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) protocol (Moher, Liberati, Tetzlaff, Altman, & the PRISMA Group, 2009). In the first step, I screened titles of around 250 results and selected papers that seemed relevant to my study. However, I stopped screening if there was a block of 25 consecutive irrelevant results. After screening titles and removing duplicates, 91 papers moved to step two. In the second step, I read the abstract to decide whether the study was likely to meet my research criteria. After reading abstracts, 40 papers moved to step three. In the third step, I read papers in detail. Nearly 60 percent of the papers in step three (24 papers) met the three criteria detailed above. The other 16 papers I read in detail did not: 6 papers did

not consider the influence of social factors, 5 papers did not consider separate food waste disposal practices, and 5 discussed general waste management. In the fourth step, I reviewed the reference lists of the 24 papers that resulted from step three to identify additional studies that might be relevant. My final sample comprised of 27 papers, with the 24 identified through the database search and 3 papers through the reference lists (Figure 1).

2.2 Coding for influential social factors on behavior

Once I had my sample of papers, I coded for social factors that influenced food waste disposal behaviors. As a first step, I compiled a comprehensive list of different factors that influenced behavior based off the research I found. I used Whishaw, Bergdall, and Kolb's (2006) definition of social factors, referring to "all influences that affect an individual's or group's behavior". Important to note is that not all of the reviewed papers had separate food waste disposal infrastructure installed; rather, they reported common social constructs that influence food wasting behaviors and discussed which practices could be put in place to remove barriers. Within these reports, I made certain that the need for an interdisciplinary collaboration in solving the larger food waste issue was addressed.

I analyzed the papers on my own. In doing so, I created a list of terms used to code for each social factor which can be found in Table 2. Using the list of acceptable terms, I read the articles, looking for evidence of social factors that influenced food waste disposal behaviors and classifying them according to the framework. In many cases, social factors were identified verbatim; for example, "results emphasize the importance of *convenience* ... as important factors for household waste recycling (Bernstad, 2014, p.1317)" was coded as "convenience". In other cases, I interpreted the language to identify the factor; for example:

Results suggest that the less one feels *capable* of composting, the less compatible composting is with one's lifestyle, and the less *accessible* composting is perceived to be, the less control the individual feels over his or her decision to compost (Taylor & Todd, 1997, p.619) was also coded as "convenience", highlighting the importance of an individual's capability and accessibility to performing composting behavior. Another example interpreted as the need for *social approval* was, "much effort must be made to establish a positive *social reputation* as well as a *common practice*," (Mosler, Tamas, Tobias, Rodríguez & Miranda, 2008, p.538), insinuating that composting behavior will be better received if perceived as a common and socially accepted practice. After coding was completed, I enumerated the papers that addressed each of the factors, as well as the suggested interventions provided.

In addition to identifying social factors, I recorded countries where these studies took place. I also noted the types of food waste disposal infrastructure studied, if possible, as well as the data collection method, location, and sample size (see Table 3).

3 Results

The 27 papers I reviewed, published between 1997 and 2020, describe research undertaken in variety of countries from all over the world. Studies involved various food waste disposal infrastructure designs, including curbside collection, drop-off collection, and home composting practices. The papers examined different types of social factors that influenced composting (see Table 4 for distribution of social factors across papers and Figure 2 for percentages). The social factors I deemed most influential were *cultural and socio-economic differences; knowledge, attitude and interest; social approval; and convenience*. The solutions I found most effective in reducing initial barriers include *community specific interventions, feedback provision, effective information distribution, and infrastructure and material provision*. In the sections that follow, I provide a brief summary of the location types (see Figure 3) in which the studies took place and the infrastructure types (see Figure 4) in which were studied, then summarize my results for each social factor and effective solutions to eliminate or reduce these barriers. See Table 5 for a categorized list of key determinants.

3.1 *Study sites*

The majority of studies (74%) were conducted in developed countries. Seven studies, however, were conducted in developing countries, including Cuba, Lebanon, Malaysia, Vietnam, and China. The majority of studies (67%) were also conducted in urban locations, with only two studies who also considered rural areas, as well five papers that did not specify the type of area the research took place. In one study that did address food waste behavior in rural areas found these households showed a higher tendency to eat all food prepared compared to those in urban areas, thus contributing less food waste generation (Mattar et al., 2018). Considering my small sample size and the lack of research from rural areas and developing countries, I draw no conclusions on whether certain social factors might have stronger association with specific location types.

3.2 *Infrastructure types*

The majority of studies (50%) conducted research revolved around curbside collection strategies. Nine (45%) papers examined home composting practices, and only one (5%) discussed drop-off collection services. Not all studies, however, specifically researched locations with food waste disposal infrastructure. These studies were not included in the data (see Figure 4) when calculating the distribution of infrastructure type studied. Only two studies addressed systems that provided different disposal options available to residents, both of which included curbside collection and home composting (Andersson & Stage, 2018; Mosler et al., 2008). It is not as easy to gage, however, where home composting is actually taking place considering this practice does not necessarily require infrastructural services be provided. One study mentioned the insignificant role social norms play on home composting behaviors because these practices are done in the privacy of one's home and neighborhood participation are not visible (Edgerton, McKechnie, & Dunleavy, 2009). Considering an insignificant amount of studies compared different food waste disposal infrastructure, I draw no conclusions on whether certain social factors might have stronger association with specific infrastructure types.

3.3 *Social factors*

To best understand behavioral patterns that promote composting, it is necessary to examine which determinants underlie particular behaviors (Steg & Vlek, 2009), thus, I look into which factors promote or inhibit food waste disposal behavior. Factors influencing separate waste disposal have been studied from different theoretical perspectives (Knickmeyer, 2020). Individual behaviors cannot fully be understood without acknowledging the influence particular social contexts have in framing said behaviors.

3.3.1 *Cultural and socio-economic differences*

Various studies started on food waste disposal behavior started from the assumption that individuals cultural and socio-economic differences have an underlying influence on the choices they make (e.g. education, household size, employment status, income, and/or age). Education has proven to be successful in influencing other factors associated with food waste disposal behavior such as an individual's knowledge and awareness of the larger food wasting issue, as well as their interest in it (Wu et al., 2019; Mattar et al., 2018). Fonseca (2013) argued the main factors contributing to food waste were age, gender, marital status, and employment. Household size also had an influence on individual's willingness to participate in food waste disposal behavior (Wu et al., 2019; Mattar et al., 2018; Zhang et al., 2018). There was a positive correlation between household size and income with the amount of household food waste generated (Zhang et al., 2018; Mattar et al., 2018; Fanelli, 2019). Mattar et al. (2018) also discovered that employment status led to an increase in food waste production, while higher levels of education led to a decrease. The younger population, individuals between the 18 to 34-year-old age range, claimed to have less time and were less likely to participate in the curbside collection. Looking further into age, variables such as age of children

are equally as important as age of adults. Retired individuals or families whose children have left home were more likely to participate in home composting compared to families with young children (Edgerton et al., 2009). Fonseca (2013, p.190) agreed that the oldest of individuals were more likely to separate food waste, however, countered the household size argument claiming larger households were less likely to separate food waste. Perceived costs were discussed in a number of studies as the ultimate determining factor for an individual's food waste disposal behavior. Perceived costs however do not always align with the actual price individuals have to pay (Refsgaard & Magnussen, 2009). Individuals are more willing to pay if they feel like they're saving money (Werf, Seabrook, & Gilliland, 2019). But Zhang et al. (2018) argues that the cost issue can be removed even before disposal if people are willing to alter their consumer behavior, buying less and thus wasting less too. What a reasonable cost or price for separate food waste disposal is not necessarily understood, cost-effective solutions were emphasized a necessity (Andersson & Stage, 2018).

3.3.2 Knowledge, attitude, and interest

A wide range of studies discussed the role individual knowledge, attitudes, and interest play in influencing behavior. First, scholars have examined the importance of the issue of food waste itself (Edgerton et al., 2009). These studies revealed that the greater understanding individuals have of the issue of food waste as a whole (Mattar et al., 2018; Grandhi & Singh, 2016) and the consequences of food wasting behavior (Refsgaard and Magnussen, 2009), the more likely they are to separate food waste. Being aware of the "how-to" of separating food waste according to the infrastructural practices available and/or used (Mosler et al., 2008; Sussman & Gifford, 2013; Taylor & Todd, 1997; Loan, Takahashi, Nomura, & Yabe, 2019; Kawai & Huong, 2017) and the specific services and resources available to them also makes it that much easier for individuals to participate in behavioral changes. Moral obligations and values also affect individual interest, influencing their willingness to change behaviors (Zhang et al., 2018; Bernstad, 2014; Karim Ghani, Rusli, Dayang Radiah, & Idris, 2013). One article, in particular, addressed the importance of an individual's interpretation of food waste disposal behavior, noting that it is not necessarily seen as "pro-environmental" by everyone (Edgerton et al., 2009). However, to some environmental concern was a key influencer (Miliute-Plepiene & Plepys, 2015).

3.3.3 Social approval and neighborhood stability

Socially approved behavior was another key determinant of food waste disposal behavior discussed among researchers (Shearer et al., 2017). One individual's behavior has the power to influence others to behave similarly if this behavior is perceived as a social norm (Sussman & Gifford, 2013; Refsgaard & Magnussen, 2009; Evans, 2011), subjective norm (Werf et al., 2019), or otherwise seen as a common behavior or practice (Mosler et al., 2008; Comber & Thieme, 2012). Normalization proves as a powerful tool for influencing typical non-separators to participate in separate food waste disposal behavior (Bernstad, 2014). However, Edgerton et al.'s (2009) study found that social norms were not a significant determinant when looking specifically at home composting behavior. Individuals were, however, more motivated in another study if they felt socially responsible for reducing food waste (Kim, Rundle-Thiele, Knox, Burke, & Bogomolova, 2020). In one study looking at a curbside collection service, they found that when individuals were aware that their neighbor's efforts were not effective, they were less willing to improve participation themselves (Nomura, John, & Cotterill, 2011). In addition, solidarity on a street level had a positive impact on individuals' willingness to participate, more so when streets were smaller and more significant than the impact the area as a whole had on behavior. They described this more as a collective norm, which in turn inspired collective action. Andersson and Stage (2018) describe this same concept, arguing that the belief recycling is good for society can increase participation. Li, Huang, and Harder, (2017) went further to discuss the importance of community trust that secures this social normativity.

3.3.4 *Convenience*

The importance of convenience was also commonly addressed throughout research. More specifically, providing simple practices that are easy, repetitive and effortless to perform (Wu et al., 2019). When looking specifically at one composting study, there was a significant positive correlation between participation and convenience (Edgerton et al., 2009). Convenience can be an issue with one's personal routine in which hours of operation may be a barrier (Li et al., 2017; Karim Ghani et al., 2013) as well as the location. Having bins and services directly provided to homes made it more convenient for them to start participating (Geislar, 2017; Miliute-Plepiene & Plepys, 2015). They also discussed the importance of available time which can be that much harder when families have children. Time can also be a barrier for those who have longer commutes, heavier workloads, longer work hours, and larger households (Mattar et al., 2018). Disability within household can restrain people from being able to participate, incapable of actually making the physical effort (Mosler et al., 2008). The importance of habit was also discussed and how they are not always so easy to break, even when other barriers may be broken down.

3.4 *Effective solutions*

There are a variety of effective solutions which can help eliminate barriers and successfully promote behavioral change. Action can be influenced by social support and by providing modeling behaviors (Steg & Vlek, 2009). Interventions must take into consideration both the social and material context of food practices, as well as the particular individuals and communities you are working with (Evans, 2011). By understanding the specific factors which prevent behavioral change in particular communities, it will be much easier to understand exactly which solutions will be most effective.

3.4.1 *Community specific interventions*

No two places are entirely the same, and thus, a number of researches suggest the importance of acknowledging the community's specific needs when working to change behavior. When it comes to informing a community about a public issue, it's important to frame the message in a way that the desired audience can actually relate to (Bernstad, 2014). Not only considering whose attention must be gained, but also what additional factors may prevent them from receiving the message such as language barriers and interests. Kim et al. (2020) even suggested to pay close attention to the most commonly wasted food items in order to target these messages even further. Metcalfe, Riley, Barr, Tudor, Robinson, and Guilbert (2012) suggested exploring different household relationships with waste to gain a better sense of how management might work best for them. Change cannot be successfully made unless changemakers have a greater sense of the individual needs that exist within the community they are working with (Refsgaard & Magnussen, 2009).

3.4.2 *Feedback provision and community sharing*

The use of providing feedback within communities as well as opening up discussion between community members also proved effective in changing behavior. Li et al. (2017) discovered that several people believed the food waste that was being collected was in fact being mixed back with the trash and discussed the need for providing greater awareness of how food waste was actually being handled to eliminate this misconception. Nomura et al. (2011) simply compared and shared the food waste behavior disposal rates between households in their study leading to a 2.8 percent increase in participation. The feedback provided is most effective when it is consistent and creates a sense of identity within the community, encouraging others to behave similarly to their neighbors. Mosler et al. (2008) suggested providing feedback through symbolic public recognition to those who were considered good contributors. Feedback shared amongst community members themselves is also effective when open discussions are implemented (Refsgaard & Magnussen, 2009). When individuals hear their peers are continuing to separate,

despite possible challenges, drives them to continue their own efforts as well (Geislar, 2017). By placing people in a group setting, individual differences are more likely to diminish, and consideration of the community's best interest will become more understandable. Providing these experiences also opens up an opportunity for shared learning and possible changes in perceptions simply from new information that not all participants may have been aware of before.

3.4.3 Effective information distribution

Considering a lack of knowledge and awareness posed a major barrier for individuals, it was evident throughout a variety of research how important effective information distribution is. Education campaigns stands as one useful tool to share knowledge (Fonseca, 2013), whether that be through coaching, mentoring or civic courses (Wu et al., 2019). Researches also discussed the importance of actually reaching the expected audience and community members actually obtaining the resources made available to them (Bernstad, 2014). For instance, Shearer et al. (2017), found providing visual prompts like stickers on bins increased the opportunity for food waste infrastructure to be noticed, and increased participation in separate food waste disposal. Kim et al. (2020) brought the possibility of designing an application sharing recipes teaching people how to reuse leftover foods rather than throw them away. The waste companies themselves have the opportunity to take responsibility for effective information provision (Mosler et al., 2008), whether that be directly in route with collection crews or at the drop-off locations (Shearer et al., 2017), as well as by policy makers and directly through educational campaigns. Geislar (2017) brought up the importance of incorporating community members already participating as a reference group when trying to communicate to instill normalization and allow for public engagement. Actually demonstrating how to compost through workshops could also deem effective to individuals who have not yet been exposed to such practices (Refsgaard & Magnussen, 2009). In a home composting study, due to the lack of composting knowledge, there was a clear desire for access to official sources to be distributed for those who were willing to continue participation despite initial barriers (Tucker, Speirs, Fletcher, Edgerton & McKechnie, 2003).

3.4.4 Infrastructure and material provision

Providing the necessary services, facilities, and resources is another useful solution to increasing food waste separation. With convenience as a significant barrier, it is essential to directly provide households with the necessary equipment to separate their food waste (Shearer et al., 2017), as well as the necessary infrastructure to actually dispose of it (Bernstad, 2014). Even the bin designs can impact participation. Design can include the color, shape, and size of the bins, as well maximizing the overall bin cleanliness (Li et al., 2017). Collection services in one study provided compostable bags in order to prevent waste from leaking and smelling and made the recycling site more attractive (Metcalf et al., 2012). It is also crucial to provide effective program design (Wu et al., 2019) that considers the location and accessibility of infrastructure. Incentivizing waste disposal proved another beneficial strategy to increase participation. In Andersson and Stage's (2018) study, weight-based tariffs helped reduce the amount of mixed-waste disposed of by households. In Li et al.'s (2017) study, participants gained points when they sorted waste that could be exchanged for useful goods such as eggs. Despite the availability of supportive infrastructure, Geislar's (2017) study highlighted that infrastructure alone is not enough to encourage change because 34 percent of the sample households still contributed little to no food waste separation. When considering how infrastructure be put into place, researchers discussed the effect that policy regulation could have in order to ensure all other solutions were properly being enforced and particular social barriers were being addressed. Metcalfe et al. (2012) considered the combination of material provision and regulation through policy objects in order to materialize policy and ultimately make individual behavioral change more obtainable. Regardless, Kawai & Huong (2017) argue the government's action is necessary in order to increase participation and accurate separation. Wu et al. (2019) argued policy design should focus on younger people's awareness and willingness to participate in community affairs considering this age group is among those less willing to participate in behavioral change. They also

highlighted policy marketing as an effective form of education that could be considered in campaigns. Despite this, Shearer et al. (2017) explained how policy change is not enough on its own because behavioral change can still be hard to tackle when it is not already a habit.

4 Discussion

I reviewed 27 papers that explore individual food waste behavior to document the diversity of social factors that influence individuals' willingness to separate food waste at disposal. These papers explore the interaction of individuals with food waste from all over the world, primarily in urban settings in developed countries. The majority of research that studied food waste disposal services examined curbside collection and home composting practices, while one looked at drop-off services. They collectively report evidence that individual behavioral choices are influenced by socio-demographic situations, individual knowledge and interest, social norms, and perceived level of convenience, and that the most commonly reported factors, addressed in 56% of the papers, were knowledge, awareness and interest.

Below, I connect this study to waste management scholarship, discuss potential contributions specifically to improving source separation at homes, and offer limitations and directions for future research.

4.1 *Implications for waste management scholarship*

My results contribute to waste management scholarship in several ways. First, they demonstrate the importance of addressing food waste separately from all other types of solid waste. Separate food waste disposal is not yet a common practice in the majority of waste management schemes in the same way that recycling is. The negative repercussions of putting food waste in landfills is also not as easily understood as the impacts recyclable waste such as plastic may have. People's relationship with food waste differs than with that of other types of waste, and awareness of other disposal options for food waste other than trash disposal is far less heard of. Food waste disposal programs are not always as simple as recycling programs because practices such as home composting require more than simply source separation. While it is useful to look into other waste management solutions as a starting point, enough composting programs have been established to demonstrate why influencing separate food waste disposal is not entirely the same as other recycling behavior. Considering the lack of research on frameworks designed specifically for composting programs, however, I have related my findings back to general household waste separation behaviors.

My analysis showed that individual food waste disposal behavioral choices are influenced by a variety of social factors. Evidence of this variety supports the position that social factors have a fundamental influence on behavior (Knickmeyer, 2020; Steg & Vlek, 2009), and that supportive infrastructure alone is not enough to encourage behavioral changes (SF Environment, 2013). A crucial step in incorporating social factors into decision-making is to recognize and consider the different aspects that may affect individual behavior, and to attend to these diverse values, interests, and lifestyles (Dahlén & Lagerkvist, 2009). Individuals are more likely to make choices with the highest benefits and lowest costs to their own lives (Steg & Vlek, 2009). Previous research has found differences among influences reported from the same services across different socio-demographic backgrounds (Grasso, Olthof, Boevé, Corné, Lähteenmäki, & Brouwer, 2019), and argue these consequential differences should play a role in intervention strategies. The negative relationship between employment and participation in food waste reduction could be related to the fact that these individuals have less available time to consider their actions with their food (Qi & Roe, 2016). My findings also support Qi and Roe's (2016) claim that higher education leads to a greater level of awareness, thus explaining why certain individuals may be more knowledgeable of this issue than others. By increasing educational programs within schooling, children can be exposed to the necessary information, and the message can be ingrained at a young age (Knickmeyer, 2020). My findings suggest that situational and social aspects such as the lack of means to receive a higher education, the lack of free time due to excess work hours, and the lack of access to necessary information play a larger role in influencing

behavioral choices than service providers realize, even if indirectly causing barriers such as lack of knowledge, social approval, or convenience.

Another interesting point related to the influence of different backgrounds on behavior included communication barriers. Communication barriers not only impact non-English speakers, but those who cannot understand the meaning behind the message. Steg and Vlek (2009) considered questions such as, how people process information and what measures influence thought and actions, in order to more adequately attain the right attention. My results support the idea that communication strategies are key to effectively distributing information and removing barriers. Strategies are more effective when specific audiences are addressed, familiar language is used, and the problem is relatable to the targeted communities (WHO, 2017). The distribution of information in several languages within communities of high ethnic diversity is also recommended so non-native residents needs are accounted for (Timlett & Williams, 2009). When suggesting the importance of community partner collaboration, my findings also acknowledge the importance of designing culturally appropriate media and services, so these communities are not only accounted for, but addressed in a respectful and considerate manner (GMWDA, 2015). Local culture and context proved to be a key determinant of social norms. Current waste disposal behavior can also be perceived as a social trend which in itself influences social norms and can impact individual behavioral choices (Knickmeyer, 2020). More specifically, Dahlén and Lagerkvist (2009) discussed the influence neighborhood stability and relationships have on creating these social norms. Thus, it is essential that programs not only provide supportive infrastructure and consider the individual social barriers but are also aware of the specific community needs as the determinants for these barriers can differ greatly from one place to the next.

Finally, the results of my review advocate not only for separate food waste disposal frameworks, but separate frameworks for individual types of disposal infrastructure as well. While the significance of social norms was arguably powerful on the majority of practices, a few cases in which home composting was studied proved the opposite. While scholarship agrees with the majority of studies on the importance of modeling behavior and framing information as socially acceptable in order to successfully encourage pro-environmental behavioral change (Schultz, Nolan, Cialdini, Goldstein, & Griskevicius, 2007), that is not necessarily the case for behavior that is done in the space of one's own backyard. When considering the issue of convenience, previous research agrees inconvenience costs such as effort, time, and location pose as barriers for individual participation (Lee, Choi, & Koo, 2017; Roustana, Bolton, Lundin, & Dahlén, 2015). However, research does not consider how these challenges may differ depending on infrastructure type. Home composting requires a greater amount of effort and time as far as handling the waste, however it can be done in the convenience of one's home without necessarily needing services to be provided. Drop-off services require individuals to be able to get to wherever their local waste entity may be at whichever time services may be open. And curbside collection may add in additional costs that not everyone wants or is able to pay. Property close collection services separated twice as much waste as drop services did in Dahlén and Lagerkvist's (2009) study, however, this was not specific to food waste. While these concerns are previously addressed, to what extent they impact specific composting programs is not fully understood.

4.2 Limitations and future research

As the first systematic review specifically on composting behavior, this study has several limitations. I acknowledge that my selection criteria might have more broadly included food waste behavior rather than simply behavior regarding separate food waste disposal. I wanted to examine the role social factors play in behavioral choices made and there was a significant lack of research solely on existing composting schemes. This is also a broader issue connecting with the issue of food wasting as a whole and it is important to consider why individuals are wasting in the first place in order to understand how programs can cater to educational services to effectively sort and reduce the amount of waste produced as well. Interdisciplinary collaboration is needed to effectively address this issue because food waste disposal behavior problems are not just infrastructural problems; they are also socio-cultural, psychological, environmental, and technological problems. There is a simultaneous need for food waste minimalization as

separately collected food waste (Bernstad, 2014). During my search, I made sure to exclude studies without infrastructure in place that did not consider the importance of separate food waste disposal as a solution to the problem.

My review was also limited in its location type. The majority of my studies were conducted in urban settings in developed countries. Very few compared the differences in barriers faced between rural and urban settings to draw substantial conclusions as to whether or not the type of location plays a significant role in particular behavioral choices. Considering home composting schemes were more common in rural areas, it is not easy to determine how much food is actually being wasted, especially when these studies relied heavily on qualitative research like surveys and interviews that didn't actually measure the amount of waste being separated. Although the majority of waste produced worldwide comes from developed countries, that does not mean developing countries do not also need to consider modern waste management schemes (Mosler et al., 2008).

Another possible limitation is the lack of comparison between infrastructure types. Most notably, drop-off food services are barely covered in this research. While it is more challenging to measure the intake of individual participation in these services, it is the only available service in some areas. It is clearly evident that the three main practices I examine pose unique challenges of their own.

The results of this review reveal a gap in waste management scholarship with regard to separate food waste disposal practices. Research specifically on factors impacting food waste disposal is key to removing this disparity. More research studying the comparison of similar infrastructure between rural and urban communities would also be useful as the majority of research is skewed towards urban settings. Future research should be done comparing different infrastructure types in one region to see how barriers may differ, as well as how effective one may be over the other. It could be useful to look further into behavioral patterns in developing countries as well, so generalizations made primarily from developed countries do not overlook the additional challenges these countries may face.

5 Conclusion

In this review, I describe studies that demonstrate a wide range of social factors that influence separate food waste disposal behavior, though I note that not all studies specifically examine separate food waste disposal services in practice. Some studies addressed a greater need for reducing overall food wasting behavior rather than focusing on disposal behavior (Mattar et al., 2018 and Kim et al., 2020). However, the majority of studies discussing disposal practices acknowledge the issue of food waste as a whole and discuss ways to account for food waste reduction before disposal is even necessary. Thus, while proper disposal of the waste is crucial, waste reduction must not be forgotten in the process. My findings can be useful to scholars examining both pro-environmental behaviors and food waste disposal, as well as to those who work directly in the waste management field. The collection I found supports the effort in food waste disposal scholarship to recognize and address the broad range of social factors that influence individual disposal behavior, and to expand research beyond effective infrastructure and legislation alone (Knickmeyer, 2020). It also supports the substantial need for more scholarship to explore social factors prohibiting participation in existing food waste disposal schemes, as well as explore food waste disposal behavior in developing countries and rural areas.

I hope that my review encourages further inclusion and consideration of social influences in pro-environmental behavior and food waste disposal assessments. Certainly, I do not suggest separating food waste from trash disposal is the ultimate solution to solving the food waste problem; reducing unnecessary food waste production before it needs to be disposed of is central to the success of environmental conservation and protection, as well as food security (Fonseca, 2013). Yet this review suggests that acknowledgement of social influences and community-specific needs are imperative in addressing the food wasting issue, in addition to commitment to effective information distribution and resource provision in food waste disposal strategies. By providing a more holistic resolution, these factors can complement existing environmental and human health approaches to addressing the demand for energy and resource conservation, greenhouse gas emission reduction, and strengthened food security.

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Appendices

Table 1. PRISMA protocol. Search terms and restrictions applied for each database.

Database	Search Terms	Total Search Results
Academic Search Premier	(food waste disposal OR food recycl* OR food waste management OR household food waste OR food waste collection OR compost*) AND (behav* OR pro-environment* behav*) AND (barrier* OR challenge* OR obstacle* OR difficult* OR issue* OR problem*)	134
Agricultural and Environmental Science Collection	(food waste disposal OR food recycl* OR food waste management OR household food waste OR food waste collection OR compost*) AND (behav* OR pro-environment* behav*) AND (barrier* OR challenge* OR obstacle* OR difficult* OR issue* OR problem*)	110

Figure 1. Flowchart of search process.

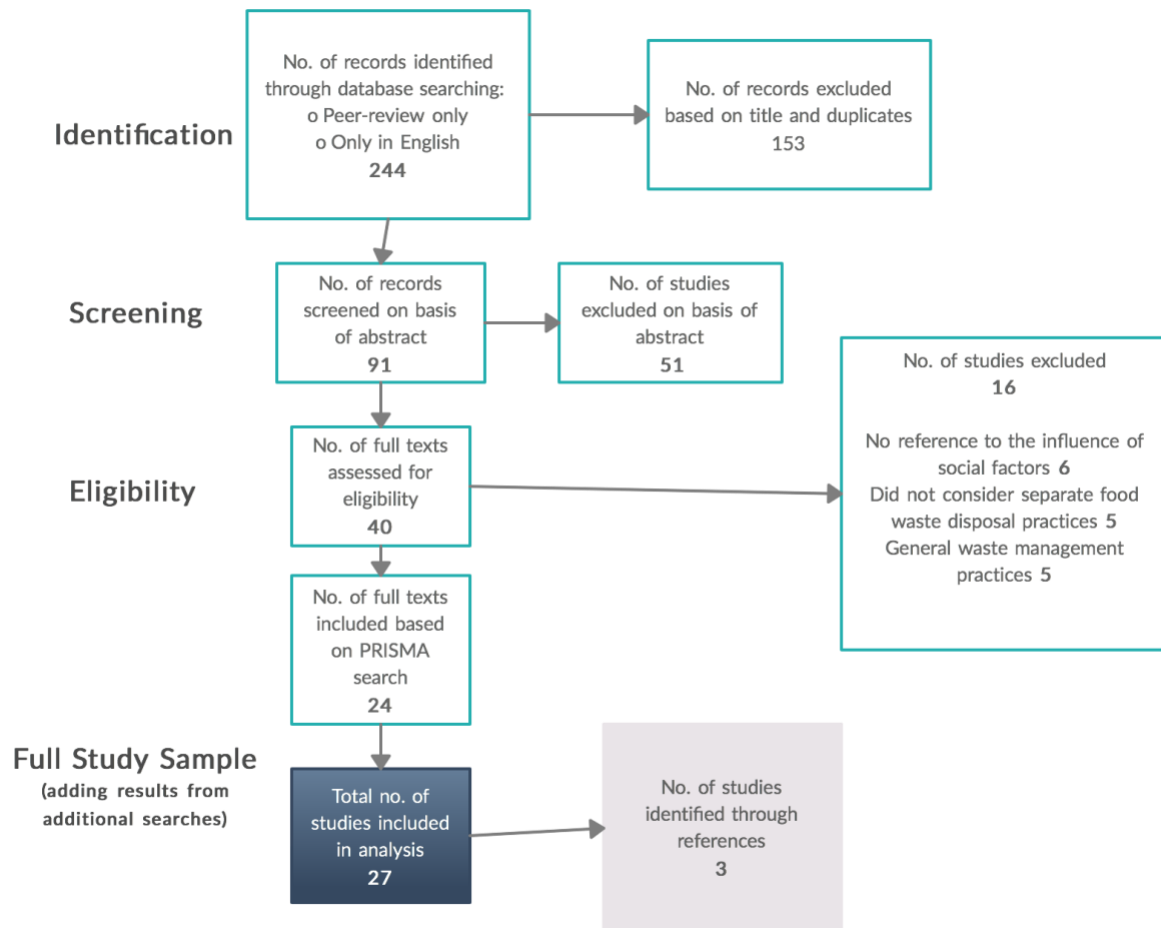


Table 2. The social factor typology used in this study and restrictions applied for each.

Social Factors	Terms Affiliated
<i>Cultural and Socio-Economic Differences</i>	education, household size, employment status, income, costs, ethnicity, language spoken, age, number of children, gender, property ownership, AND/OR marital status
<i>Knowledge, Attitude, and Interest</i>	knowledge, attitude, awareness, interest, understanding, moral obligation, value, willingness, interpretation, intention, motivation, AND/OR perception
<i>Social Approval</i>	social approval, social norm, social support, common behavior, common practice, normalization, social responsibility, subjective norm, social contexts, social influence, social trend, social reputation, neighborhood relationships, solidarity, collective norm, AND/OR community trust
<i>Convenience</i>	convenience, perceived behavioral control, habit, simple, easy, effortless, capability, amount of time, accessibility, quick, AND/OR clear

Table 3. Data sources selected for review.

Publication	Data Collection Methods	Location	Location Type	Sample Size
Andersson and Stage, 2018	Data analysis	Sweden	Entire country	263 municipalities
Bernstad, 2014	Case study (repeated treatment)	Malmö, Sweden	Urban	1632 households
Comber and Thieme, 2012	Explorative study, focus group interviews, questionnaires	United Kingdom	Urban	22 participants
Edgerton et al., 2009	Survey	Scotland		345 respondents
Evans, 2011	Ethnographic study, interviews, diary records	South Manchester, England	Urban	19 households
Fonseca, 2013	Literature review, focus groups, survey, interviews	Lisbon, Portugal	Urban	542 participants
Geislar, 2017	Longitudinal field experiment, survey	Costa Mesa, California, United States	Urban	370 respondents
Kim et al., 2020	Co-Design, survey, audit	Australia		21; 414; 197 participants
Li et al., 2017	Case study, non-participant observation, interviews	Nanjing, China	Urban	1296 households
Mattar et al., 2018	Questionnaire, interview	Lebanon	Urban and Rural	1264 households
Metcalfe et al., 2012	Survey, interviews	London, England	Urban	1,627 respondents; 27 households
Mosler et al., 2008	Interview-based questionnaire	Santiago, Cuba	Urban	935 respondents
Nomura et al., 2011	Randomized controlled trial	Oldham, Greater Manchester, England	Urban	318 streets
Refsgaard and Magnussen, 2009	Interviews, questionnaires, focus groups, multi-criteria mapping	Norway	Urban	
Shearer et al., 2017	Randomized controlled trial	England	Urban and Rural	64,284 households
Sussman and Gifford, 2013	Observational study, interviews	Canada	Urban	540 participants
Taylor and Todd, 1997	Survey, Diary records	Kingston, Ontario, Canada	Urban	2,389 respondents; 1,489 participants
Werf et al., 2019	Survey	London, Ontario, Canada	Urban	1,263 households
Wu et al., 2019	Survey data analysis	San Francisco, California, United States	Urban	3979 respondents
Zhang et al., 2018	Survey	Shenzhen, China	Urban	418 households
Tucker et al., 2003	Survey	Scotland and England	Rural	491 respondents
Loan et al., 2019	Interviews, survey	Hoi An, Vietnam	Rural	202 respondents
Fanelli, 2019	Survey	Italy		1058 respondents
Kawai & Huong, 2017	Physocal composition analysis	Hanoi, Vietnam	Urban	558 households
Ghani et al., 2013	Survey, interviews	Serdang, Selanor, Malaysia	Urban	296 respondents
Millute-Plepiene & Plepys, 2015	Data analysis, survey	Sweden		117 participants
Grandhi & Sing, 2016	Survey	Singapore	Urban	158 respondents

Table 4. Distribution of social factors among selected papers.

Publication	Infrastructure Type	Cultural and Socio-Economic Differences	Knowledge, Attitude, Interest	Social Approval	Convenience
Andersson and Stage, 2018	Curbside collection, home composting	x		x	
Bernstad, 2014	Curbside collection		x	x	x
Comber and Thieme, 2012	Home composting			x	
Edgerton et al., 2009	Home composting	x	x		x
Evans, 2011		x		x	
Fonseca, 2013	Home composting	x			
Geislar, 2017	Curbside collection			x	x
Kim et al., 2020					
Li et al., 2017	Drop-off service			x	
Mattar et al., 2018		x	x		x
Metcalfe et al., 2012	Curbside collection				x
Mosler et al., 2008	Curbside collection, home composting		x	x	x
Nomura et al., 2011	Curbside collection			x	
Refsgaard and Magnussen, 2009	Curbside collection	x	x	x	x
Shearer et al., 2017	Curbside collection			x	
Sussman and Gifford, 2013			x	x	x
Taylor and Todd, 1997	Home composting		x		x
Werf et al., 2019	Home composting	x		x	x
Wu et al., 2019	Curbside collection	x			x
Zhang et al., 2018		x	x		
Tucker et. al, 2003	Home composting	x	x		
Loan et al., 2019	Home composting		x		
Fanelli, 2019		x	x		
Kawai & Huong, 2017	Curbside collection		x		
Ghani et al., 2013			x		x
Milute-Plepiene & Plepys, 2015			x		x
Grandhi & Sing, 2016		x	x		x

Figure 2. Percent of papers in review that addressed each social factor.

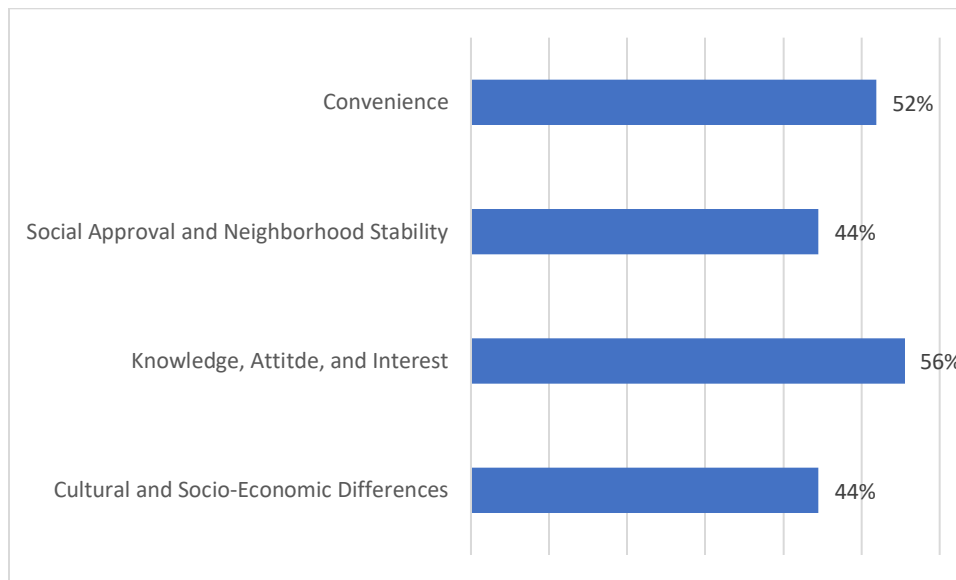


Figure 3. The distribution of selected papers per geographical region

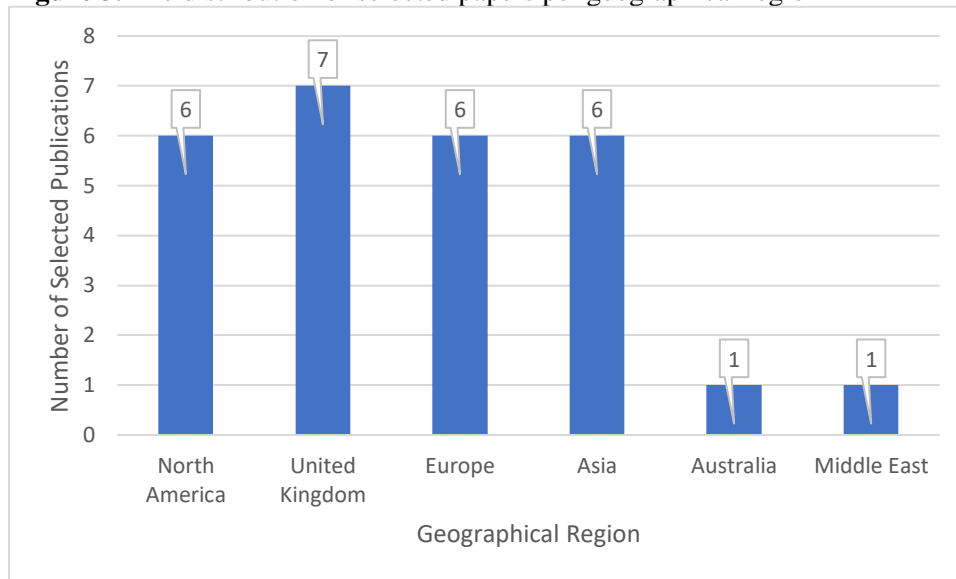


Figure 4. Distribution of selected papers per infrastructure type studied. These categories are mutually exclusive; each paper is only counted once. Not all papers specifically studied food waste disposal services already in place, thus this only includes the percentages within those papers that did in fact do so.

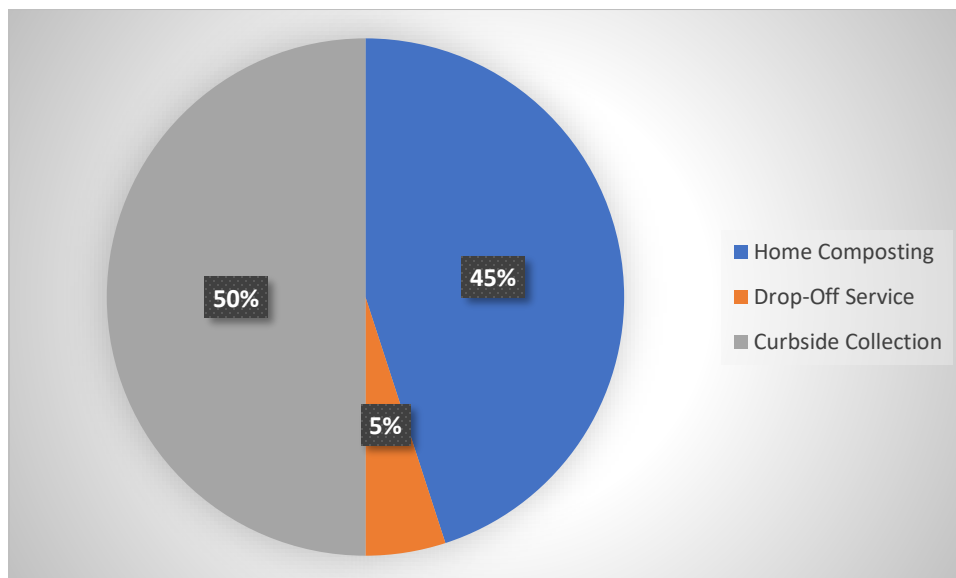


Table 5. Key determinants encouraging separate food waste disposal.

Which factors determine composting behavior?	Which solutions could best be applied to encourage composting behavior?
<ol style="list-style-type: none"> 1. Cultural and socio-economic differences <ol style="list-style-type: none"> a. Education b. Household size c. Income d. Employment status e. Perceived costs 2. Knowledge, attitude, and interest <ol style="list-style-type: none"> a. General food waste issue b. Consequences of food wasting behavior c. “How-to” of separation d. Services available e. Morals and values f. Perception of issue 3. Social approval <ol style="list-style-type: none"> a. Social normativity b. Common behavior/practice c. Social responsibility d. Solidarity e. Collective norm f. Community Trust 4. Convenience <ol style="list-style-type: none"> a. Easy to perform b. Operation hours c. Location d. Material provision e. Availability of time f. Accessibility g. Habit 	<ol style="list-style-type: none"> 1. Community specific interventions <ol style="list-style-type: none"> a. Message framing b. Language barriers c. Cultural background d. Individual needs 2. Feedback provision <ol style="list-style-type: none"> a. Trust in services b. Transparency of success c. Community sharing 3. Effective information distribution <ol style="list-style-type: none"> a. Knowledge sharing b. Visual prompting c. Use of technology and social media d. Instill normalization e. Modeling behavior 4. Infrastructure and material provision <ol style="list-style-type: none"> a. Availability of services and facilities b. Design consideration c. Cleanliness d. Weight-based tariffs e. Policy regulation