# Systematic literature review of best practice in food waste reduction programs

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Structured Abstract

Purpose (mandatory)

Food waste is a systemic problem, with waste occurring at all stages in the supply chain and consumption process. There is a need to unpack which strategies, approaches, and tools can be applied to reduce the amount of food wasted. Understanding the extent of social marketing principles used offers insights into the additional means that can be applied to increase voluntary behaviour change.

Design/methodology/approach (mandatory)

Following PRISMA guidelines, a systematic quantitative literature review was undertaken focussed on outcome evaluation studies conducted since 2000. Six databases were examined, and cross rating was used to identify previous programs tackling food waste behaviour at a household level. A total of 23 programs were analysed against eight social marketing components.

Findings (mandatory)

Overall, only two out of 23 food waste programs self-identified as social marketing programs. A lack of application of social marketing elements was observed across all studies indicating a tendency to implement non-voluntary change approaches. The most commonly targeted behaviours were source-separation. Personal interaction involved the distribution of information in person (typically through door knocking). Personal interaction strategies were identified as the most effective program techniques. Program effectiveness was greater when the social marketing components of behaviour change, theory, and marketing mix were used indicating the potential for voluntary approaches to be applied more in the future.

Originality/value (mandatory)

The current study was the first systematic literature review to examine the extent of social marketing application in food waste programs reported in peer reviewed academic literature using eight components of social marketing. The study revealed behavioural change was more likely when more social marketing components were used. Future research is recommended to consider the application of full range of social marketing elements to extend beyond involuntary approaches, which can be subjected to criticism from community.

Keywords

Food waste, social marketing, benchmark criteria, program
Introduction

The Food and Agriculture Organization of the United Nations (FAO) (2015) estimates one third of edible food, equivalent to 1.3 billion tonnes, is lost or wasted annually. Increased greenhouse gas emission (GHG) from food waste is posited to lead to an increase in the risk of climate change (Pielke et al., 2007, Schmidhuber and Tubiello, 2007). Estimates suggest that 8% of global warming is caused by food waste dumped into landfill (FAO, 2015). The global generation of food waste poses significant harm to the environment, communities and society; wasting both monetary and physical resources (Gustavsson et al., 2011). Food production and disposal processes involve considerable use of resources including water, energy, and capital. Economic losses generated from food waste are estimated to cost our communities over $900 billion globally (FAO, 2015).

Both the food supply chain and households contribute to the food waste problem (Miafodzyeva and Brandt, 2013). While the need for shared responsibility is acknowledged, individual households must bear some responsibility for organic food waste. Research indicates that private households are significant food waste contributors (Bio Intelligence Service, 2011, Conrad et al., 2018). Food waste costs Australian households an estimated AU$3,800 in wasted food every year (RaboDirect Financial Health Barometer, 2017). This phenomenon is not only limited to the Australia but is also found in other high-income countries with estimates suggesting 47 million tonnes of food waste arise from households (FUSIONS, 2016). UK reports suggest 7.1 million tonnes of food is wasted in the UK every year and of this amount 70 percent are edible foods worth an estimated £15 billion (WRAP, 2019). This indicates households need to be engaged to reduce the amount of food wasted (Dietz et al., 2009).

Previous food waste programs delivered at a household level feature partnerships and/or funding from Governments, Commercial and/or Not-for-profit organisations (Dai et al., 2015, Dai et al., 2016, Waste and Resources Action Programme, 2007, Waste and Resources Action Programme, 2010). The collaborative movement toward zero food waste has more recently emerged recognising both economic and environmental costs to society. However, Governments and NGOs require cost- and time-effective programs
(Cox et al., 2010, Tonglet et al., 2004). For example, the Queensland Government (2010) states that programs require feasible strategies which can draw on success within a short time frame and limited budget.

Overall, understanding more about program efficacy and program strategies that can be applied to effectively engage households in food waste reduction is an important undertaking. Thus, this study aims to unpack which strategies, approaches, and tools deliver food waste reduction efficiencies.

A wide range of behaviour change tools exist (e.g. education, behavioural science and policy), most of which are involuntary leading to community criticism. Application of social marketing in its fullest extent involves the delivery of alternatives that people value and are willing to pay for. Application of social marketing, a voluntary approach to behaviour change, lacking in the food waste context (Barr et al., 2011, Takahashi, 2009, Truong, 2014), suggesting further research focus is warranted. Social marketing has been shown to be effective in health-focused studies such as healthy eating (Carins and Rundle-Thiele, 2014), problem alcohol use (Kubacki et al., 2015b) and many more (Almestahiri et al., 2017, Almosa et al., 2017, Fujihira et al., 2015). However, environmental problems such as food waste have received less attention in social marketing when compared to health behaviours (Barr et al., 2011). Truong (2014) who conducted a systematic review identifying 867 social marketing studies identified that health behaviours were the dominant focus in social marketing research (55.7%). Emphasis on the health-related issue was once again identified in the most recent review of social marketing studies (Truong and Dang, 2017).

Environmental protection (3.7%) has received comparably less research attention from social marketers (Truong, 2014). Takahashi (2009) stated that the number of environmental social marketing studies are small and called for wide adoption of social marketing to support environmental protection. We do note this call has received some attention with a recent special issue on wildlife conservation (Veríssimo, 2019). Furthermore, the extent that social marketing principles have been applied to reduce food
waste is not known, which is limiting given that the likelihood of behavioural change increases as a greater number of social marketing principles are used (see Carins and Rundle-Thiele, 2014, Xia et al., 2016). Thus, the current study aims to assess the extent to which social marketing components have been applied in food waste reduction programs aimed at households that have been conducted since 2000.

Recent systematic review of household food waste practices found that information campaigns were one of the most widespread tools used for food waste prevention and reduction in Europe (Priefer et al., 2016, Schanes et al., 2018). However, current reviews have not been undertaken to examine the research approach and program strategies that have been empirically tested to examine effectiveness worldwide. Examining the extent of application of social marketing principles within empirical food waste reduction programs not only assists to discover the most frequently utilized strategies it also indicates how reductions in food waste behaviour may be achieved, ideally voluntarily. Expanding on earlier studies this study seeks to identify the extent of use of factors known to increase rates of behavioural change. The aims of this paper are twofold; 1) ascertain the extent that social marketing components are applied and 2) identify effective program strategies that can be applied to reduce household food waste.

Major components of social marketing

In 2002, Andreasen introduced six social marketing benchmark criteria which outlined the defining characteristics of social marketing, contrasting social marketing from other behavioural science approaches. Two criteria, namely consumer orientation/insight and theory were added by the UK National Social Marketing Centre (NSMC) in 2010. The criterion of consumer orientation was added to reflect modern conceptions of relationship marketing (Grönroos, 1994, Gummesson, 1987) and contributions from the service marketing field proposing that perceived service value is central to satisfying customers' needs, wants and desires (Lusch and Vargo, 2006). This was to ensure social marketers execute consumer-oriented research and practice, thus providing empirical data to generate insights to inform strategic program planning. Literature reviews note that focus groups and survey methods were dominant methods employed to gain insights and pre-test program strategies (Almestahiri et al., 2017, Kubacki et al., 2015b); limiting
insights obtained to self-reported data forms overlooking ethnographic and other observational approaches which would assist to overcome many unconscious biases (Kubacki and Rundle-Thiele, 2016).

To date, it is unknown to what extent social marketing has been applied within food waste programs. Thus, this paper assesses the extent components are applied within food waste programs aimed at households drawing on definitions for the eight major components of social marketing (see Table 1) as outlined by the NSMC. This paper identifies the extent that core social marketing principles, namely behaviour change, a consumer-orientation approach, insight, marketing mix, segmentation, exchange, competition, and theory have been utilised in food waste programs targeting households. This study aims to provide evidence for the extent to which social marketing principles are reported for programs aiming to reduce household food waste.

Methods

A systematic search and literature review following PRISMA guidelines (Moher et al., 2015), and other social marketing reviews (Carins and Rundle-Thiele, 2014, Kubacki et al., 2015a, Pickering et al., 2015) was undertaken to identify previous programs aimed at reducing household food waste. A systematic approach to literature reviews is considered to be bias free; as rigorous scientific protocols are followed and authors are not ‘picking and choosing’ which studies to review for their purposes (Petticrew and Roberts, 2008). Published studies were identified through searches of Emerald and ScienceDirect, and all Databases of EBSCO, Ovid, ProQuest, and Web of Science for the period of 2000 to February 2019 (see Table 2). The search included peer reviewed journals only. The main search terms were ‘Environment* OR food OR organic’ AND ‘wast*’ AND ‘household*’ AND ‘intervention* OR Randomi?ed Controlled Trial OR evaluation OR trial OR campaign* OR program* OR stud*’. These terms were used in search fields of abstract, publication title, and subjects. As databases have different styles in searching, Ovid and Web of Science included topic fields and keywords.
Exclusion criteria and screening

Any unqualified records including conference papers and book chapters, and non-English papers were excluded from the data set (see Figure 1). As this paper only targeted empirical studies that implemented food waste reduction programs at a household level, any non-journal articles, formative and review studies (i.e. meta-analysis, conceptual studies), studies focused on other environmental issues (i.e. air pollution and other types of waste including water, solid, electric, plastic, hazardous, medical), studies beyond the scope of the review (e.g., food insecurity, nutrition, pharmaceutical, healthcare, lab experiment, soil composition), and studies without a behavioural outcome measure (e.g., those which measured only awareness, attitudes) were excluded. (National Social Marketing Centre, 2019)

Downloaded records were imported into Endnote for screening. Duplicated records were removed from the data set. The titles and abstracts of 3,294 unique records were screened to verify study suitability. By following the exclusion criteria, five non-English and 280 non-journal articles (e.g. book chapters) were deleted. Title and abstract search with the exclusion criteria further eliminated 2,493 unqualified records. A total of 516 qualified records including experimental and outcome studies to examine the effectiveness of food waste reduction programs were identified. Papers were imported into Covidence (Babineau, 2014) allowing two reviewers to cross-check and code papers simultaneously.

Two independent reviewers screened the titles and abstract of each record to identify food waste reduction programs delivered at the household level. Conflicting decisions were resolved by discussion. The pool of papers were reduced to 129 records and these proceeded to full text screening. Through searching of reference lists of four review papers, a further 18 articles were imported for full text screening.

Data analysis

Eliminating studies that used simulation models, reported descriptive characterisations of solid waste and properties of soil/compost, the final number of papers meeting study criteria were 25 articles describing 23 discrete programs. These studies were analysed to
identify the eight major social marketing components reported by the NSMC (2019). Two raters conducted a quality assessment of each study according to the Risk Of Bias In Non-randomized Studies (ROBINS) – of Interventions (Sterne et al., 2019) assessment. ROBINS enable researchers to assign the risk of bias (i.e. Low, Moderate, Serious, Critical, and No information).

Results
Our systematic literature review and data extraction enabled quantification of the application of eight social marketing components in food waste reduction programs. In addition, our analysis identified the most commonly practiced program strategies/tools and targeted behaviours reported in the international literature.

Overview
All studies reported programs targeted at food waste behaviour. Studies aimed to reduce all types of food waste. Results indicate that studies did not focus on a specific type of food waste (i.e. bread or fruit and vegetables). All studies differed in the behaviour targeted, program strategies, sample size, and settings. Most studies were conducted in Europe (n = 11) including Sweden, The Netherlands, Italy and Germany. Six studies were conducted in Asia (e.g. China, Republic of Korea, and Vietnam) and five studies were conducted in the UK. One US studied was located in this review. Studies featured sample sizes of n = 12 to 33,000 households. In 19 studies the program outcomes were achieved through community involvement.

Examination against eight social marketing components
Of the 23 interventions examined, 21 were aimed at extending environmental knowledge (see Table 3). Only two interventions claimed to apply social marketing (Devaney and Davies, 2017, Linder et al., 2018). Full application of eight major social marketing components was not achieved in any of food waste interventions. All studies reported behavioural objectives and 20 studies found positive behaviour change (i.e. decrease in food wastage, increase in food waste reduction behaviour). Two studies claimed no
behaviour change (Jagau and Vyrastekova, 2017, Lim et al., 2017). One study reported an increase in food waste (Morone et al., 2018).

Only one program was developed based on consumer-orientated research (Devaney and Davies, 2017). A further two studies conducted research to gain insight prior to intervention development (Dai et al., 2015, Romani et al., 2018). Eight studies reported that theory informed program design. All studies produced programs that used at least one marketing mix component (e.g. communications). Ten studies reported using two or more marketing mix elements (e.g. Product and Price – sale of compost bins). Two studies evidenced delivery of exchange (Bench et al., 2005, Harder and Woodard, 2009). No studies reported evidence of undertaking segmentation or assessing competition (e.g. other food waste programs) prior to program build. An average of 2.69 social marketing components were applied across the studies (see Table 3).

Behaviour change
Social marketing aims to change behaviour and as such the success of any program is assessed by measuring whether the desired behaviour change has occurred (Andreasen, 2002, French and Blair-Stevens, 2006).

**Targeted behaviour**

The most commonly targeted behaviour was source-separation (n = 12) as the majority the studies focused on increasing the reusability of consumed food through recycling. To encourage less consumption, mixed behaviours were often targeted (n = 5). For example, Lim et al. (2017) utilised social recipes as an intervention strategy targeted at three different food waste-related behaviours; planning, purchasing, and leftover-reuse. Some studies aimed to increase disposal behaviour (Kawai and Huong, 2017, Lee and Jung, 2017, Linder et al., 2018) and composting (Bench et al., 2005, Harder and Woodard, 2009). Two studies focussed on food sharing behaviour (Jagau and Vyrastekova, 2017, Morone et al., 2018) fostering community communication within programs.
**Program strategy**

To effect behaviour change, four broad program strategies were identified across the various studies: 1. education, 2. personal interaction, 3. installation of systems, and 4. technology. An information-educational approach (n = 16) including the provision of leaflets and posters was the most frequently identified strategy. Four studies installed food waste collection systems in targeted households (Bench et al., 2005, Bernstad et al., 2012, Bernstad, 2014, Harder and Woodard, 2009) offering paper bags or mobile bins that could sit under the kitchen sink. Four studies introduced kerbside or council waste stations (Dai et al., 2016, Kawai and Huong, 2017, Lee and Jung, 2017, Li et al., 2017). Few studies (n = 2) used technology as a food waste reduction strategy to overcome barriers to food waste reduction. For example, Lim et al. (2017) utilised a social networking platform to help participants to share their ‘Social Recipes’.

A combination of more than one program strategy was found in six studies. Personal interactions including door-knocking were often paired with information-education tools (Bernstad et al., 2013, Dai et al., 2016, Dai et al., 2015). For example, Dai et al. (2015) hired paired university and local volunteers (wearing branded tabards) to door-knock community households and they delivered A2 size posters, colour leaflets, and hand sized stickers that included a message noting the ease of recycling. One study combined imposition of a tariff with a community waste bin strategy (Lee and Jung, 2017).

**Program effectiveness**

Outcome measures varied from psychological constructs (i.e. Attitudes, perception) to self-reported food wastage/weight of food wastage generated (kg) per households/community. The majority of the programs measured behaviour change by weighing the volume of food waste produced (n = 16). One third of studies used self-reported food waste behaviour (n = 7) as their behavioural outcome measure.

In total, 21 interventions reported some positive behavioural effects for one or more identified outcome variables (Table 3). Positive effectiveness were achieved in programs that targeted source-separation behaviour using multiple strategies including
information-based door-knocking and the provision of waste bins (Dai et al., 2016, Devaney and Davies, 2017). Bernstad et al. (2013) reported that households who received oral information demonstrated higher source-separation ratios and lower rates of incorrectly sorted materials when compared to households who received written information. Neither oral nor written information via door-knocking were effective, casting some doubt on this strategy. In contrast, Dai et al. (2015) found that the information-based door-knocking program did not encourage source-separation behaviour while the personal interaction approach did promote source-separation with purity rates of 95 per cent achieved.

The studies targeting disposal and composting behaviours via waste system installation (Bench et al., 2005, Kawai and Huong, 2017, Lee and Jung, 2017, Linder et al., 2018) resulted in positive outcomes. Thus, the importance of selecting a strategy that matches with the target behaviour was clear.

Although this review further attempted to verify the effect size for each study, under-reporting of effect sizes limited statistical assessment of the effectiveness of programs identified in this review. Within six studies that reported the effect size, the majority of studies which reported the effect size \( (n = 4) \) reported use of a combination of: Behaviour change, theory, and marketing mix. Furthermore, available evidence identified in this review indicates that greater effect sizes are achieved when the combination of marketing mix \( (\text{e.g. more than promotion}) \) and theory use is reported. Specifically, Shearer et al. (2017) reports use of three social marketing elements \( (\text{i.e. behaviour change, theory, marketing mix}) \) and greatest effect size \( (\text{Cohen's} \ d = 0.73) \) when compared to other studies \( (\text{Bernstad et al., 2013, Romani et al., 2018}) \) which did not report the use of theory or marketing mix \( (\text{Cohen's} \ d < 0.3). \)

**Theory**

The benchmark criterion of theory suggests that the use of theory in the examination, implementation and evaluation of social programs increases the probability of effectiveness (Craig et al., 2015, Darnton, 2008). Theories provide explanations for why

**Consumer orientation**

Adoption of consumer-orientation ensures that program design responds to the needs and wants of the target audience (Trischler et al., 2017), which is in contrast to many other disciplines (e.g. education on waste reduction) that are predominantly expert-driven. Consumer orientation is different to audience research which focuses on explaining and/or predicting consumer characteristics. A true consumer orientation occurs when programs are developed with the target audience (for example see Rundle-Thiele et al., 2019). Evidence of consumer engagement in program design was only observed in one study which self-identified as a social marketing program. Devaney and Davies (2017) stated that the program ‘Homelab’ was developed with consumers. However, limited detail was reported.

**Insight**

Two studies reported gaining of insight prior to program development (Dai et al., 2015, Romani et al., 2018). In this review, insight was defined as any formative study that
enabled the identification and understanding of consumers’ demographic, geographic, psychological, and/or behavioural means of preventing food waste. Knowledge gained from formative research may provide a new perspective to inform program development. For example, Romani et al. (2018) found a lack of planning was a key barrier in domestic food preparation behaviour. Romani et al. (2018) provided an excel sheet to assist weekly menu planning and reported decreases in self-reported food wastage. Thus, highlighting the benefits of gaining insight prior to program development.

Marketing mix elements
Grounded from a traditional commercial marketing perspective, the marketing mix consists of product, price, place, and promotion. All studies employed at least one of the 4 Ps to deliver programs. There were only five studies implementing three or more marketing mix elements (Bench et al., 2005, Dai et al., 2016, Devaney and Davies, 2017, Geislar, 2017, Harder and Woodard, 2009).

In social marketing a product refers to physical and tangible goods/services that social marketers provide or sell. Eleven programs provided products or services including community waste stations (Dai et al., 2016, Kawai and Huong, 2017, Lee and Jung, 2017), mobile waste bins (Bernstad et al., 2012, Geislar, 2017, Li et al., 2017), and compost bins or boxes (Bench et al., 2005, Devaney and Davies, 2017, Harder and Woodard, 2009).

Monetary pricing was observed in four studies (Bench et al., 2005, Harder and Woodard, 2009, Morone et al., 2018). For example, Bench et al. (2005) and Harder and Woodard (2009) sold ‘Green Cone Digester’s’ to their target audience through supermarkets. The Green Cone Digester was priced at AUD$230.

Distribution of products/services via various platforms to increase desired behaviour (Kotler and Zaltman, 1971) is the place element of the marketing mix. Presence of placement was observed in nine studies. Four studies mentioned platforms that allowed placement of their program product (Bench et al., 2005, Dai et al., 2016, Harder and Woodard, 2009, Young et al., 2017). For example, Young et al. (2017) mentioned two places: retailer shops and online websites.
Nineteen studies executed a promotional effort to encourage consumers to act (Lee and Kotler, 2011). The most commonly used persuasive communication efforts were informational program brochures (Bernstad, 2014, Bernstad et al., 2013, Dai et al., 2015, Devaney and Davies, 2017, Geislar, 2017, Huang et al., 2018, Jagau and Vyrastekova, 2017, Kawai and Huong, 2017, Lim et al., 2017, Linder et al., 2018, Morone et al., 2018, Nomura et al., 2011, Rousta et al., 2015, Schmidt, 2016, Shearer et al., 2017, Young et al., 2017) followed by monetary rewards including gift vouchers (Romani et al., 2018) and tokens that could be exchanged for goods (Dai et al., 2016). Bench et al. (2005) promoted sales by offering a free kitchen caddy to assist the use of the program product (i.e. Green Cone Digester).

**Segmentation**

Audience segmentation refers to a process of categorising the target population into groups based on their shared characteristics which are expected to influence program adoption (Bryant et al., 2001). This review defined the presence of segmentation as a direct mention of application of a selection process that involved consideration of group similarities and group differences. Thus, the existence of segmentation methods (e.g. two-step cluster analysis) was important to examine the presence of segmentation (for examples of segmentation see Dietrich et al., 2015, Schuster et al., 2015). As a result, there were no studies that reported strict use of the segmentation process. However, nine studies reported a targeting process of identifying the most relevant and appropriate group of individuals or households to uptake the program based on their age, region and generated food wastage (Bernstad et al., 2013, Dai et al., 2016, Dai et al., 2015, Huang et al., 2018, Kawai and Huong, 2017, Lee and Jung, 2017, Li et al., 2017, Linder et al., 2018, Shearer et al., 2017).

**Exchange**

The concept of exchange is defined by many social marketers as the delivery of a program, product or service that people value and will willingly buy or actively seek out. Exchange requires that benefits must outweigh the costs of undertaking the desired
behaviour (Andreasen, 2002, National Social Marketing Centre, 2019). In its most direct form exchange involves money changing hands. Almestahiri et al. (2017) defined exchange as the provision of tangible products and services. This review accounted for the presence of exchange when direct exchange was evident. Only two of 23 programs offered exchange: sales of ‘Green Cone digesters’ offered tangible and direct inducements to give up food waste behaviour (Bench et al., 2005, Harder and Woodard, 2009). Both studies reported a reduction in food wastage indicating the potential for delivery of exchange to ensure valued alternatives are supplied that can reduce household food waste.

Competition

Competition in social marketing refers to consideration of other programs and/or other behaviours that compete with the desired behaviour (Grier and Bryant, 2005). In this review, strategies were coded as accounting for competition when consideration of other food waste reduction programs and/or competing behaviours was reported. An understanding of direct competitors can provide information preventing failure and enhancing opportunities for improvement. Since competitors (i.e. other food waste reduction programs) share a similar program aim such as reduction of food waste, identification of competitors can assist program outcomes (Hastings, 2003). In this review, no direct mention of consideration of competitive programs fostering similar behaviour was reported in any study.

Summary. Application of the major components of social marketing was found to be lacking in food waste programs, which might limit program effectiveness given that behavioural change is more likely when more of the social marketing principles are used (Carins and Rundle-Thiele, 2014, Xia et al., 2016). A strong presence of behavioural objectives was observed in studies, however, limited use of marketing mix, consumer-orientation, exchange, segmentation and competition indicates a clear absence of social marketing to effect behaviour change. Importantly, greater program effectiveness (e.g. effect size) was observed in the study that reported use of three social marketing benchmark criteria: Behaviour change, theory, and marketing mix. This provides further
evidence that application of core social marketing components can enhance rates of behavioural change.

Discussion

This study aimed to identify effective program strategies and approaches to guide food waste reduction. Further, this paper examined the extent that all eight social marketing components were applied within programs targeting households to reduce food waste extending beyond previous review efforts which typically centre on Andreasen’s (2002) six components (Almosa et al., 2017, Almestahiri et al., 2017). This review followed PRISMA guidelines to overcome the limitation of previous narrative reviews (Pearson and Perera, 2018). Although recent reviews have identified the most common practices in food waste, an understanding of the extent that social marketing components have been applied on empirically tested food waste programs was not previously available (Schaines et al., 2018). This paper contributes to our understanding of the extent that social marketing components have been applied using eight social marketing benchmark criteria.

Our review found a lack of full application of social marketing components in food waste programs reported in academic literature to date. None of the identified food waste programs used all eight components of social marketing. Only 2 out of 23 studies self-identified as social marketing studies, which indicates that few voluntary approaches have been applied within food waste reduction to date. Prior studies suggest that use of more of the social marketing components increases rates of behavioural change (e.g. Carins and Rundle-Thiele, 2014, Xia et al., 2016) and application of voluntary approaches offers a means to reduce community criticisms that are frequently aimed at non-voluntary approaches. A clear omission of segmentation was found in the review. Few programs used exchange and competition, both of which are core features. Limited development of differentiated offerings that consumer’s voluntarily exchange for were evident, which impact’s program sustainability (Almestahiri et al., 2017). Importantly, while previous research has identified the importance of consumer-orientation (Daae et
al., 2016, Trischler et al., 2017) involvement of people targeted for change in program design was absent in this review.

Evidence of the importance of including the target audience in program design exists (David et al., 2019, Rundle-Thiele et al., 2019). Audience research can enhance the understanding of people targeted for change narrowing focus to key factors that guide program design (Almestahiri et al., 2017, Carins and Rundle-Thiele, 2014). Formative research must extend beyond researcher or expert driven approaches ensuring target audience preferences are taken into account as far as possible in program development. According to Witell et al. (2011), co-design practices entail active user involvement, thus allowing researchers to collect novel insights into user needs and wants. A recent study utilised this co-design process discovering incongruency between expert and community expectations for food waste programs [Name withheld for a review] in regards to target behaviour, program strategy and types of food that formed program focus.

In terms of target behaviour and program strategy, source separation was targeted most often and a strong presence of information-education focus was noted. Information initiatives adopted education tools and focussed on addressing and supplying knowledge to overcome deficiencies (Schanes et al., 2018). However, an emphasis on education is problematic if assumptions are made that people will reduce food waste solely on the basis of being fully informed about the environmental benefits of doing so. Education focussed interventions assume that motivation is strong, and it is merely a lack of comprehensible information that prevents the behaviour from being adopted (Tapp and Rundle-Thiele, 2016). In contrast, social marketing ‘offers’ value inviting people to engage with a program and assumes that existing levels of motivation and knowledge are insufficient to generate changes in behaviour without an external boost (Almestahiri et al., 2017).

Implications for future food waste practice

Non-voluntary approaches have dominated food waste prevention efforts targeting households and this can lead to community criticism. This review identifies examples
that can be applied to assist households to voluntarily reduce their household food waste. Consider, Bench et al. (2005) and Harder and Woodard (2009) who sold ‘Green Cone Digester’s’ for a price of AUD $230 to householders through supermarkets. Programs that can deliver a product (Green Cone Digester) at a price (AUD $230) that householders are willing to pay for demonstrate how value offerings can be built and in turn how food waste programs can be implemented in communities to deliver lasting change. By delivering a valued product or service offering programs can extend beyond funding timeframes, which are typically short, ensuring that lasting food waste reductions can occur.

This review identifies examples of application of social marketing core principles across a variety of household food waste reduction programs and can be used as a guiding framework for practitioners seeking to build voluntary programs. Additional examples of application of core social marketing principles are available in reviews conducted in other contexts to further expand on case study examples identified in the present review (for examples see Almestahiri et al., 2017, Almosa et al., 2017, Fujihira et al., 2015; Kubacki et al., 2015b). Reductions in food waste deliver a host of environmental benefits given reduction in energy, water and other finite resources in addition to costs savings for individuals. This paper indicates the potential for social marketing to be applied as a voluntary behavioural science approach that can be applied within the food-water-energy nexus.

Further implications arise from this study. Results in this review indicate that program outcomes can be achieved when program strategies are aligned with the behaviour targeted. Theory can be applied to guide the process of matching program strategies to the most appropriate behaviour to target (Shearer et al., 2017). Thus, future research should use innovative methods of data collection to deliver a nuanced account of how food waste should be reduced. Secondly, success was observed in studies that actively involved community during the delivery of the program (see David et al., 2019 and Linder et al., 2018). Consideration of consumer views as a core component of the program shown its potential to improve program delivery and in turn program outcomes.
Finally, this paper delivered further evidence that behavioural change is more likely when more social marketing components are used. Lastly but most importantly, application of social marketing components can lead to positive program outcomes (Carins and Rundle-Thiele, 2014, Xia et al., 2016). Based on statistical assessment of program effectiveness, social marketing components of behaviour change, theory, and marketing mix were found to be particularly valuable in increasing effect size. Thus, in order to leverage food waste program effectiveness, our review suggests the application of social marketing principles to deliver lasting change.

Limitations and Future Studies
Regardless of the contributions, this review has a few inevitable limitations. The food waste program studies reported in industry and government documents are excluded from this review which focussed on peer reviewed, academic studies. The inclusion of grey literature might be considered in future systematic literature reviews to capture additional initiatives. The number of social marketing-based food waste program studies was small (n = 2), which offers an opportunity for additional food waste research to be conducted in social marketing. Since there are simply not enough valid studies on food waste reduction programs to warrant a systematic review of the literature at this moment. Therefore, comparison between BC to address application of which BC leads to greater outcome was limited to those studies reported effect size. An opportunity exists to establish a deeper evidence base. Luca and Suggs (2013) claimed that there are not enough replicated studies in social marketing to assure its reliability. Further, the ROBINS-I quality assessment tool identified that in most interventions, the risk of bias was 'Unclear/Critical' or 'Moderate' (see second column of Table 3). To better understand program strategies that can be implemented by public service organisations to reduce food waste, high-quality research is needed, with particular focus on validity in intervention and evaluation research design and reliability of outcome measures utilised to ensure avoidance of bias. Previous researchers have argued that social marketers need to focus attention away from the individual and they need to move upstream in order to achieve multidimensional change (Hoek and Jones, 2011). Therefore, a research
opportunity exists to consider whether restaurants (i.e. midstream) or policy (i.e. upstream) efforts are (a) successful, (b) which behaviour and program strategies were successful, and (c) to what extent social marketing has been applied.

Conclusions

The current study was the first systematic literature review to examine the extent of social marketing application in food waste programs reported in peer reviewed academic literature using eight components of social marketing. Evidence identified in this review provides further support for the role that social marketing principles have on behavioural change. Clear omission of segmentation and the importance of consumer-orientation in food waste programs were highlighted and wider application of these principles in food waste reduction programs targeting households is expected to deliver higher rates of behavioural change. Of all social marketing components, behaviour change, theory, and marketing mix were identified as being particularly valuable in increasing the effectiveness of food waste programs.


Response to reviewer comments: JSOCM-05-2019-0074 “Systematic literature review of best practice in food waste reduction programs”

Dear reviewers,

We wish to extend our thanks to the reviewers for their positive remarks about our paper and for the time they took to give us further suggestions on how we might improve the paper. We have revised our submission, addressing all of the comments as indicated below. The corresponding sections in our paper have been highlighted in yellow. We feel the revisions have strengthened the paper further. We look forward to receiving your final decision.

Kind regards,
Authors
<table>
<thead>
<tr>
<th>COMMENTS</th>
<th>RESPONSE</th>
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</thead>
<tbody>
<tr>
<td>Reviewer: 1</td>
<td></td>
</tr>
<tr>
<td>Page 1, Line 3 add ' to after tools; line 8 principles used; line 46 Personal interaction led information... maybe rephrase to assist clarity of understanding</td>
<td>The sentences were revised as follows:</td>
</tr>
<tr>
<td></td>
<td>Food waste is a systemic problem, with waste occurring at all stages in the supply chain and consumption process. There is a need to unpack which strategies, approaches, and tools can be applied to reduce the amount of food wasted. Understanding the extent of social marketing principle’s used offers insights into the additional means that can be applied to increase voluntary behaviour change.</td>
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<tr>
<td></td>
<td>We have modified the manuscript as recommended. The personal interaction sentence has been rephrased as follows:</td>
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<td></td>
<td>Personal interaction involved the distribution of information in person (typically through door knocking). Personal interaction strategies were identified as the most effective program techniques.</td>
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<tr>
<td>page 3, Line 32 as global audience for article, maybe add amount wasted for other countries</td>
<td>Good point. We have expanded further as recommended. The paper now states:</td>
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<td>This phenomenon is not only limited to the Australia but is also found in other high-income countries with estimates suggesting 47 million tonnes of food waste arise from households (FUSIONS, 2016). UK reports suggest 7.1 million tonnes of food is wasted in the UK every year and of this amount 70 percent are edible foods worth an estimated £15 billion (WRAP, 2019).</td>
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<td>Reviewer: 2</td>
<td></td>
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<tr>
<td>The study objective is best reflected on pg. 4 (line 58) and the top</td>
<td>Thank you for comments. Our revision has considered your views. We</td>
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</table>
of pg. 5 (lines 4 and 5). The objective is also stated clearly in the abstract as it reflects its twofold nature (pg. 1; line 20 – 24). However, I found the introduction quite muddled as it fails to maintain a focus on the key purpose of the study. It needs to be clear from the outset that the study is focusing on reviewing food waste reduction programs rather (sic then) food waste reduction practices.

Therefore, the paragraph on pg. 4 (lines 8 – 19) is confusing as it suggests that one contribution of the paper is the global scope of the review compared to Priefer et al 2016; Schanes et al; 2018, which tended to focus on European studies. As these papers had a different purpose (i.e. food waste practices) you should not be comparing your study against them other than to highlight that your study has a different purpose.

Similarly, on pg. 4 (lines 22 – 26) in an attempt to highlight the value of this review, you note that the consensus among scholars is that further research on social marketing campaigns targeting food waste reduction is warranted. This suggests to me that further empiricism/ data collection is required. The criticism I have here is that you are highlighting the lack of research on this topic and therefore undermining the necessity for a systematic review of the literature at this moment.

The review is very descriptive. The social marketing criteria is used as a template to guide the discussion. This is not providing the critical reflection required to address the core purpose of the paper – to identify best practice in food waste reduction programs.

We value your comments. In order to contribute in enhancing the reporting of behaviour change in future studies, our review attempted to go beyond reported program effectiveness (i.e. positive, negative, and no change measures), thus, assessed effect sizes of each studies. However,

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We value your comments. In order to contribute in enhancing the reporting of behaviour change in future studies, our review attempted to go beyond reported program effectiveness (i.e. positive, negative, and no change measures), thus, assessed effect sizes of each studies. However,

In regard to food waste reduction program strategies, a systematic review of household food waste practices found that information campaigns were one of the most widespread tools used for food waste prevention and reduction in Europe (Priefer et al., 2016, Schanes et al., 2018). However, current reviews have not been undertaken to examine the research approach and program strategies that have been empirically tested to examine effectiveness worldwide. Examining the extent of application of BC within empirical food waste reduction programs not only assists to discover the most frequently utilized strategies it also indicates how reductions in food waste behaviour may be achieved. Expanding on earlier studies this study seeks to identify the extent of use of factors known to increase rates of behavioural change. The aims of this paper are twofold; 1) ascertain the extent that social marketing components are applied and 2) identify most effective program strategy successfully reduced food waste at a household level.
In my view, the section ‘program effectiveness’ is the most valuable (pg. 10 line 22). You summarise some interesting outcomes and link these to certain practices, for example pg.10, lines 43 & 44. While I note that you were unable to verify effect size for each study, you nonetheless needed a system of critiquing programs with reference to (a) outcomes and (b) social marketing criteria because this is the stated purpose and value of the study.

Indeed, in summarising you note on pg. 14, line 55/56 that “…social marketing was lacking in in food waste programs, which might limit program effectiveness”. I would have expected a more definitive conclusion as this is the value of the paper i.e. does the inclusion of SM components in food waste reduction programs improve the effectiveness of these programs and if so which components are particularly valuable.

As we stated in pg. 11 (line 58) and you mentioned in the comment, there are simply not enough valid studies to run comparison analysis between BC to further examine which BC’s leads to better outcomes and this is an important endeavour for future research. Only 6 studies reported effect sizes to assess statistical assessment of the program effectiveness. For these reasons, we have drawn early conclusions that ‘the use of behaviour change, theory, and marketing mix leads to a greater impact’. However, further research is needed and we do outline an agenda for future research.

We have deleted the word ‘Greater’ in pg. 10 (line 35-36) to avoid the impression of our review comparing BC.

To make more definitive conclusion, we added below sentence in the Limitations and Future Studies:

There are simply not enough valid studies on food waste reduction programs to warrant a systematic review of the literature at this moment. Therefore, comparison between BC to address application of which BC leads to greater outcome was limited to those studies reported effect size.

For example, in pg. 14, line 27 you note that only two out of 23 programs incorporated ‘exchange’ into their programs. You do not comment if these two programs were more effective than the other 21 in promoting food waste reduction.

Both studies reported a reduction in food wastage indicating the potential for delivery of exchange to ensure valued alternatives are supplied that can reduce household food waste.

Therefore, with the exception of page 11, lines 8 – 27, there are not enough useful insights resulting from this study other than the observation that programs tend not to use social marketing. This is rather predictable based on studies in other domains such as health. In my opinion, there are simply not enough valid studies on social marketing is one of many approaches applied globally to effect behavioural change. This review demonstrates a large body of work is underway and extending application of principles known to deliver behavioural change is an important undertaking. Delivering clear examples to showcase application of benchmarks is a worthy research
food waste reduction programs to a warrant a systematic review of the literature at this moment.

| <b>1. Originality: </b> This paper provides a review of empirical studies that have applied food waste programs and evaluates these programs based on their outcomes and use of social marketing components. Unfortunately, in my view, there are few interesting insights resulting from the study. | The value in our work is noted by other reviewers. For example, Reviewer 3 states: “I enjoyed reading this and would like to commend on the originality and scope of the study which is evident through the very large amount of work presented across distinct areas of scholarship. I think that a particular strength of the research was the author's potential contribution to the examination of Social marketing as a behavioural science approach that can be applied across environmental communication research within the food-water-energy nexus.”

Understanding the extent that core social marketing principles are applied is a very important undertaking offering a clear base to guide future research and practice by delivering concrete examples to follow in future.

| <b>4. Results: </b> Are results presented clearly and analysed appropriately? Do the conclusions adequately tie together the other elements of the paper?: The only conclusion supported by evidence is that food waste reduction programs do not fully apply social marketing components. The majority of the discussion is a generic overview of how incorporating social marketing criteria can improve behaviour change interventions. This paper provides no findings on the effectiveness of different SM criteria in food waste reduction programs. | Thank you for these critical comments. As you note a key finding is that social marketing is rarely applied and therefore food waste reduction in households would benefit from wider adoption of social marketing, which is a voluntary approach to behaviour change.

A further contribution of our paper is demonstration of studies that do apply social marketing principles. This can serve as a guide to increase uptake of key social marketing tools and techniques. We now highlight this in the implications section.

Finally, a contribution of our study is evidence drawing from reported effect sizes on which BC components may lead to greater impact. This is detailed in the paper as follows:

_Evidence identified in this review provides further support for the role that social marketing principles have on behavioural change. Clear_
omission of segmentation and the importance of consumer-orientation in food waste programs were highlighted and wider application of these principles in food waste reduction programs targeting households is expected to deliver higher rates of behavioural change. Of all social marketing components, behaviour change, theory, and marketing mix were identified as being particularly valuable in increasing the effectiveness of food waste programs.

5. Implications for research, practice and/or society: The proposed study implications are based on generic social marketing theory (page 16, lines 52 -59; page 17, lines 4-21). They could have been written without doing this systematic review as they are not derived from evidence on food waste reduction programs.

Thank you for this comment. We agree and our revised paper now offers precise implications that can be used to guide practitioners. The paper now states:

Non-voluntary approaches have dominated food waste prevention efforts targeting households and this can lead to community criticism. This review identifies examples that can be applied to assist households to voluntarily reduce their household food waste. Consider, Bench et al. (2005) and Harder and Woodard (2009) who sold ‘Green Cone Digesters’ for a price of AUD $230 to householders through supermarkets. Programs that can deliver a product (Green Cone Digester) at a price (AUD $230) that householders are willing to pay for demonstrate how value offerings can be built and in turn how food waste programs can be implemented in communities to deliver lasting change. By delivering a valued product or service offering programs can extend beyond funding timeframes, which are typically short, ensuring that lasting food waste reductions can occur.

This review identifies examples of application of social marketing core principles across a variety of household food waste reduction programs and can be used as a guiding framework for practitioners.
This review identifies examples of application of social marketing core principles across a variety of household food waste reduction programs and can be used as a guiding framework for practitioners seeking to build voluntary programs. Additional examples of application of core social marketing principles are available in reviews conducted in other contexts to further expand on case study examples identified in the present review (for examples see Almestahiri et al., 2017, Almosa et al., 2017, Fujihira et al., 2015; Kubacki et al., 2015b). Reductions in food waste deliver a host of environmental benefits given reduction in energy, water and other finite resources in addition to costs savings for individuals. This paper indicates the potential for social marketing to be applied as a voluntary behavioural science approach that can be applied within the food-water-energy nexus.

Reviewer: 3

This paper addresses an important topic and identification of a theory-practice gap sets it up to make a useful contribution to the literature. I enjoyed reading this and would like to commend on the originality and scope of the study which is evident through the very large amount of work presented across distinct areas of scholarship. I think that a particular strength of the research was the author's potential contribution to the examination of Social marketing as a behavioural science approach that can be applied across environmental communication research within the food-water-energy nexus.

Thank you very much for your comment. We agree and our paper now states:

This review identifies examples of application of social marketing core principles across a variety of household food waste reduction programs and can be used as a guiding framework for practitioners seeking to build voluntary programs. Additional examples of application of core social marketing principles are available in reviews conducted in other contexts to further expand on case study examples identified in the present review (for examples see Almestahiri et al., 2017, Almosa et al., 2017, Fujihira et al., 2015; Kubacki et al., 2015b). Reductions in food waste deliver a host of environmental benefits given reduction in energy, water and other finite resources in addition to costs savings for individuals. This paper indicates the potential for social marketing to be applied as a voluntary behavioural science approach that can be applied within the food-water-energy nexus.
1. Originality: Yes. The author clearly introduced the background and the significance of the study being the first systematic literature review to examine the extent of social marketing application in food waste programs reported in peer-reviewed academic literature using eight components of social marketing. The paper is well engaged with the literature and the gap is well argued. This study aims to bring the application of social marketing principles and food waste reduction scholarship together. The scope of the study is novel, and the results make an original contribution to the overarching discipline of environmental communication through the lens of food waste communication research. It would be even better if the author provided an elaborated discussion of guiding theories.

Thank you for this comment. The paper outlines which theories have previously been reported in the papers include in this review. The paper now states:


2. Relationship to Literature: I think that a particular strength of the research was the author's potential contribution to the examination of the extent that social marketing components are applied in food waste reduction processes – which is a niche but a growing area. I would like to make the suggestion that the researcher considers a more context-specific conclusion that will

The paper notes that only two out of 23 studies identified as social marketing and we expect this factor alone explains the low utilisation of key social marketing principles. Our revision outlines the importance of adopting social marketing – a voluntary approach to behaviour change when applied to its fullest extent. The paper now states:
give us better insights into the cause of the lack of application of social marketing elements in food waste reduction programs. That said, overall, the author made strong arguments which are strengthened by making an explicit connection with the literature.

A wide range of behaviour change tools exist (e.g. education, behavioural science and policy), most of which are involuntary leading to community criticism. Application of social marketing in its fullest extent involves the delivery of alternatives that people value and are willing to pay for. Application of social marketing, a voluntary approach to behaviour change, lacking in the food waste context (Barr et al., 2011, Takahashi, 2009, Truong, 2014), suggesting further research focus is warranted.

Minor point – highlighting the implications of the conclusions in the abstract, would add more weight to this paper.

Thank you for this suggestion. We have outlined the implications as recommended. The abstract now reads:

Behavioural change was more likely when more social marketing components were used. Future research is recommended to consider the application of full range of social marketing elements.
Table 1. Eight Major Components of Social Marketing

<p>| | |</p>
<table>
<thead>
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<tbody>
<tr>
<td>1</td>
<td>Behaviour change</td>
</tr>
<tr>
<td>2</td>
<td>Consumer-orientation approach</td>
</tr>
<tr>
<td>3</td>
<td>Insights</td>
</tr>
<tr>
<td>4</td>
<td>Marketing Mix</td>
</tr>
<tr>
<td>5</td>
<td>Segmentation</td>
</tr>
<tr>
<td>6</td>
<td>Exchange</td>
</tr>
<tr>
<td>7</td>
<td>Competition</td>
</tr>
<tr>
<td>8</td>
<td>Theory</td>
</tr>
</tbody>
</table>

Note. *4P refers to Produce, Price, Place, and Promotion
### Table 1 Databases and records retrieved in initial research

<table>
<thead>
<tr>
<th>Database</th>
<th>Number of records retrieved</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emerald</td>
<td>0</td>
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<tr>
<td>ScienceDirect</td>
<td>0</td>
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<tr>
<td>EBSCO All Databases</td>
<td>740</td>
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<tr>
<td>Ovid All Databases</td>
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<tr>
<td>ProQuest All Databases</td>
<td>823</td>
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<tr>
<td>Web of Science All Databases</td>
<td>2792</td>
</tr>
<tr>
<td>Total</td>
<td>5476</td>
</tr>
</tbody>
</table>

*** Since 2000
Figure 1. Flowchart of the literature search process (PRISMA)
### Table 1: Assessing programs (n = 23) against social marketing components

<table>
<thead>
<tr>
<th>Study</th>
<th>Field of Study/ROBIN S-I</th>
<th>Target Behaviour</th>
<th>Program strategy (Community involvement)</th>
<th>Number of SMBC</th>
<th>Behaviour change (effect size)</th>
<th>Consumer-oriented approach</th>
<th>Insight</th>
<th>Segmentation</th>
<th>Exchange</th>
<th>Competitio n</th>
<th>Theory</th>
<th>Marketing Mix (Number of 4Ps)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Devaney and Davies (2017)</td>
<td>Behaviour change/Critical</td>
<td>Planning &amp; Source-separation &amp; Composting</td>
<td>Information &amp; Personal interaction (door-knocking) (X)</td>
<td>4</td>
<td>✓ (+) (N/A)</td>
<td>✓</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>✓</td>
<td>✓ (2)</td>
</tr>
<tr>
<td>Romani et al. (2018)</td>
<td>Environment/ Unclear</td>
<td>Planning</td>
<td>Information (X)</td>
<td>4</td>
<td>✓ (+) (0.302)</td>
<td>X</td>
<td>✓</td>
<td>X</td>
<td>X</td>
<td>X</td>
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</tr>
<tr>
<td>Linder et al. (2018)</td>
<td>Behaviour change/Low</td>
<td>Disposing</td>
<td>Information (√)</td>
<td>3</td>
<td>✓ (+) (N/A)</td>
<td>X</td>
<td>X</td>
<td>X</td>
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<td>X</td>
<td>✓</td>
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</tr>
<tr>
<td>Shearer et al. (2017)</td>
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<td>Source-separation</td>
<td>Information (√)</td>
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<td>Schmidt (2016)</td>
<td>Environment/ Moderate</td>
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</tr>
<tr>
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<td>Environment/ Unclear</td>
<td>Planning &amp; Purchasing &amp; Cooking/eating</td>
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<td>✓ (+) (0.014)</td>
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<td>X</td>
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<tr>
<td>Study</td>
<td>Field of Study/ROBIN S-I</td>
<td>Target Behaviour</td>
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<tr>
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<td>Source-separation</td>
<td>Information &amp; Personal interaction (door-knocking) (√)</td>
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<td>Waste Bin (X)</td>
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<td>Waste Bin &amp; Personal interaction (door-knocking) (√)</td>
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</tr>
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<td>Rousta et al. (2015)</td>
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<td>Source-separation</td>
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<td>Waste Bin &amp; Information (√)</td>
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<td>Field of Study/ROBIN S-I</td>
<td>Target Behaviour (Community involvement)</td>
<td>Program strategy</td>
<td>Number of SMBC</td>
<td>Behaviour change (effect size)</td>
<td>Consumer-oriented approach</td>
<td>Insight</td>
<td>Segmentation</td>
<td>Exchange</td>
<td>Competitio</td>
<td>Theory</td>
<td>Marketing Mix (Number of 4Ps)</td>
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<td>Food-sharing</td>
<td>Information (√)</td>
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<td>Information &amp; Technology (√)</td>
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Note. √ = meet criteria, X = do not meet criteria, + = Positive behavioural outcomes reported, - = Negative behavioural outcomes reported. * = No behavioural outcomes reported.