

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

Food waste  
reduction  
programs

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## Abstract

**Purpose** – 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 behavioral change.

**Design/methodology/approach** – Following preferred reporting items for systematic reviews and meta-analyses guidelines, a systematic quantitative literature review was undertaken focused on outcome evaluation studies conducted since 2000. Six databases were examined, and cross rating was used to identify previous programs tackling food waste behavior at a household level. A total of 23 programs were analyzed against 8 social marketing components.

**Findings** – Overall, only 2 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 behaviors 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 behavioral change, theory and marketing mix were used, indicating the potential for voluntary approaches to be applied more in the future.

**Originality/value** – To the best of the authors' knowledge, 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 behavioral 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** Social marketing, Environmental sustainability, Benchmark criteria, Food waste, Programme

**Paper type** Literature review



## Introduction

The Food and Agriculture Organization of the United Nations (FAO, 2015) estimates one-third of edible food, equivalent to 1.3 billion tons, is lost or wasted annually. Increased

greenhouse gas emission 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 per cent of global warming is caused by food waste dumped into landfills (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 US\$900bn 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 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 tons of food waste arise from households (FUSIONS, 2016). UK reports suggest 7.1 million tons of food is wasted in the UK every year and of this amount 70 per cent are edible foods worth an estimate of £15bn (Waste and Resources Action Programme, 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 organizations (Dai *et al.*, 2015, 2016; Waste and Resources Action Programme, 2007, 2010). The collaborative movement toward zero food waste has more recently emerged recognizing both economic and environmental costs to society. However, governments and non-government organizations 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 behavioral change tools exist (e.g. education, behavioral 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 behavioral change, lacking in the food waste context (Barr *et al.*, 2011; Takahashi, 2009; Truong, 2014), suggests 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 behaviors (Barr *et al.*, 2011). Truong (2014) conducted a systematic review identifying 867 social marketing studies and identified that health behaviors were the dominant focus in social marketing research (55.7 per cent). 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 per cent) has received comparably less research attention from social marketers (Truong, 2014). Takahashi (2009) stated that the number of environmental social marketing studies is 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 (Verissimo, 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 behavioral change increases as a greater number of social marketing principles are used (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 assist in discovering the most frequently used strategies but also indicates how reductions in food waste behavior 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 behavioral change. The aims of this paper are twofold:

- (1) to ascertain the extent that social marketing components are applied; and
- (2) to 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 behavioral 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 used 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 which are applied within food waste programs aimed at households drawing on definitions for the eight major components of social marketing (Table I) as outlined by the NSMC. This paper identifies the extent that core social marketing principles, namely behavioral change, consumer-orientation approach, insight, marketing mix, segmentation, exchange, competition and theory have been used 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.

**Table I.**  
Eight major  
components of social  
marketing

1. Behavioral change	The program is focused on influencing specific desired behavior, not psychological constructs (i.e. attitudes, beliefs and knowledge). The presence of behavior outcome measure (subjective/objective) and its effect size is required to assess behavioral change
2. Consumer-orientation approach	Undertake bottom-up approach by fully engaging consumers in the development of the program and adapting consumer-identified ideas as a core of the program
3. Insights	Identify and verify actionable insights of the target consumer, pre-test the program materials and ideas with the target consumer and monitor program effectiveness
4. Marketing mix	Apply all marketing mix elements (i.e. 4Ps*). This includes a provision of tangible goods/services, set price for the offered product and use multiple placement and communications channels to promote the product
5. Segmentation	Selection of the target consumer should involve the process of segmentation that classifies a group of people by their characteristics
6. Exchange	A bundle of attributes that not only involve a cost but also provide benefits that consumers will willingly (voluntarily) purchase or partake in
7. Competition	Consider other programs offering similar benefiting offers to the target consumer. Learn from successful and failed programs
8. Theory	Use behavioral theories as a framework to understand the behavior and evaluate programs

**Note:** \*4Ps refers to produce, price, place and promotion\

**Methods**

A systematic search and literature review following preferred reporting items for systematic reviews and meta-analyses (PRISMA) guidelines (Moher *et al.*, 2015) and other social marketing reviews (Carins and Rundle-Thiele, 2014; Kubacki *et al.*, 2015a; Pickering *et al.*, 2015) were 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-February 2019 (Table II). The search included peer reviewed journals only. The main search terms were “Environment\* OR food OR organic” AND “wast\*” AND “household\*” AND “intervention\* OR Randomized 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

**Table II.**  
Databases and  
records retrieved in  
initial research

Database	No. of records retrieved
Emerald	0
ScienceDirect	0
EBSCO all databases	740
Ovid all databases	1,121
ProQuest all databases	823
Web of Science all databases	2,792
Total	5,476

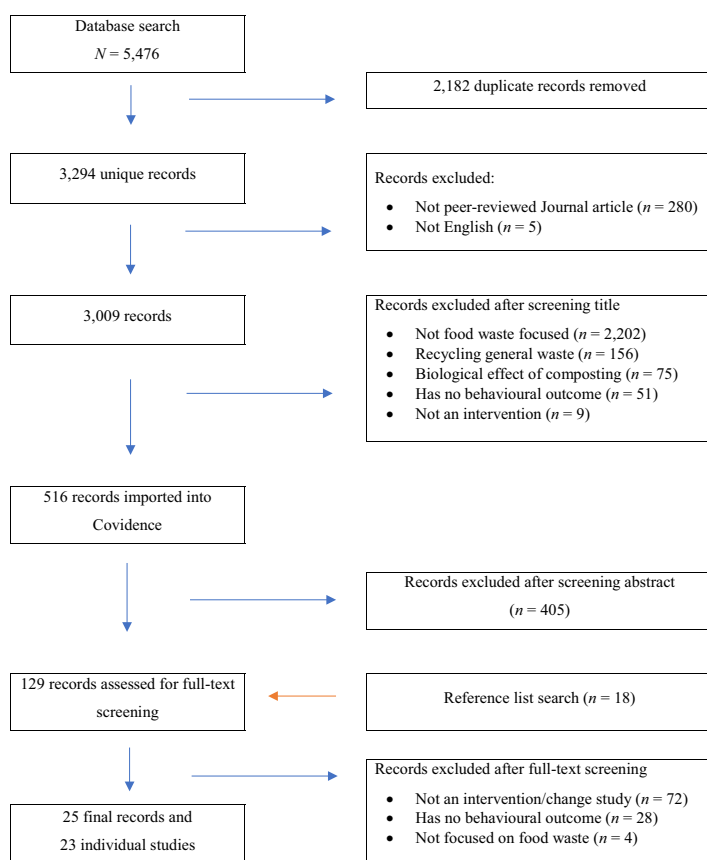
**Note:** \*\*\*Since 2000

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 (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 and conceptual studies), studies focused on other environmental issues (i.e. air pollution and other types of waste including water, solid, electric, plastic, hazardous and medical), studies beyond the scope of the review (e.g. food insecurity, nutrition, pharmaceutical, healthcare, lab experiment and soil composition) and studies without a behavioral outcome measure (e.g. those which measured only awareness and attitudes) were excluded (National Social Marketing Centre, 2019).

Downloaded records were imported into Endnote for screening. Duplicate 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-



**Figure 1.**  
Flowchart of the  
literature search  
process (PRISMA)

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 was 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 and reported descriptive characterizations of solid waste and properties of soil/compost, the final number of papers meeting the study criteria was 25 articles, describing 23 discrete programs. These studies were analyzed to identify the eight major social marketing components reported by the National Social Marketing Centre (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 behaviors reported in the international literature.

### Overview

All studies reported programs targeted at food waste behavior. 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 behavior 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 study 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 (Table III). 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 behavioral objectives and 20 studies found positive behavioral change (i.e. decrease in food wastage, increase in food waste reduction behavior). Two studies claimed no behavioral change (Jagau and Vyrastekova, 2017; Lim *et al.*, 2017). One study reported an increase in food waste (Morone *et al.*, 2018).

Study	Field of study/ ROBINS-I	Target behavior	Program strategy (Community involvement)	No. of SMBC	Behavioral change (effect size)	Consumer- oriented approach	Insight	Segmentation	Exchange	Competition	Theory	Marketing mix (No. of 4Ps)
Devaney and Davies (2017)	Behavioral change/ critical	Planning and source- separation and composting	Information and personal interaction (door-knocking) (X)	4	✓ (+) (N/A)	✓	X	X	X	X	✓	✓ (2)
Romani <i>et al.</i> (2018)	Environment/ unclear	Planning	Information (X)	4	✓ (+) (0.302)	X	✓	X	X	X	✓	✓ (1)
Linder <i>et al.</i> (2018)	Behavioral change/ low	Disposing	Information (✓)	3	✓ (+) (N/A)	X	X	X	X	X	✓	✓ (1)
Shearer <i>et al.</i> (2017)	Environment/low	Source-separation	Information (✓)	3	✓ (+) (0.733)	X	X	X	X	X	✓	✓ (1)
Schmidt (2016)	Environment/ moderate	Planning and purchasing	Information (X)	3	✓ (+) (0.361)	X	X	X	X	X	✓	✓ (1)
Geislar (2017)	Environment/low	Source-separation	Information (✓)	3	✓ (+) (0.22)	X	X	X	X	X	✓	✓ (2)
Young <i>et al.</i> (2017)	Environment/ unclear	Planning and purchasing and cooking/eating	Information (✓)	3	✓ (+) (0.014)	X	X	X	X	X	✓	✓ (2)
Nomura <i>et al.</i> (2011)	Environment/low	Source-separation	Information (✓)	3	✓ (+) (N/A)	X	X	X	X	X	✓	✓ (1)
Dai <i>et al.</i> (2015)	Environment/critical	Source-separation	Information and personal interaction (door-knocking) (✓)	3	✓ (+) (N/A)	X	✓	X	X	X	X	✓ (1)
Harder and Woodard (2009)	Environment/ unclear	Composting	Waste bin (X)	3	✓ (+) (N/A)	X	X	X	✓	X	X	✓ (3)
Bench <i>et al.</i> (2005)	Environment/critical	Composting	Waste bin (✓)	3	✓ (+) (N/A)	X	X	X	✓	X	X	✓ (4)
Kawai and Huang (2017)	Environment/low	Disposing	Waste bin (✓)	3	✓ (+) (N/A)	X	X	✓	X	X	X	✓ (2)
Lee and Jung (2017)	Environment/low	Disposing	Waste bin (✓)	3	✓ (+) (N/A)	X	X	✓	X	X	X	✓ (1)
Jagau and Vrastekova (2017)	Environment/ unclear	Food-sharing	Information (✓)	3	✓ (*) (N/A)	X	X	X	X	X	✓	✓ (1)
Bernstad <i>et al.</i> (2013)	Environment/ moderate	Source-separation	Information and personal interaction (door-knocking) (✓)	2	✓ (+) (0.207)	X	X	X	X	X	X	✓ (2)
Huang <i>et al.</i> (2018)	Environment/ moderate	Source-separation	Information (✓)	2	✓ (+) (N/A)	X	X	X	X	X	X	✓ (1)

(continued)

Table III.

Study	Field of study/ ROBINS-I	Target behavior	Program strategy (Community involvement)	No. of SMBC	Behavioral change (effect size)	Consumer- oriented approach	Insight	Segmentation	Exchange	Competition	Theory	Marketing mix (No. of 4Ps)
Dai <i>et al.</i> (2016)	Environment/low	Source-separation	Waste bin and personal interaction (door-knocking) (✓)	2	✓ (+) (N/A)	X	X	X	X	X	X	✓ (3)
Li <i>et al.</i> (2017)	Environment/ unclear	Source-separation	Waste bin (✓)	2	✓ (+) (N/A)	X	X	X	X	X	X	✓ (1)
Raustia <i>et al.</i> (2015)	Environment/low	Source-separation	Information (✓)	2	✓ (+) (N/A)	X	X	X	X	X	X	✓ (1)
Bernstad (2014)	Environment/ unclear	Source-separation	Waste bin and information (✓)	2	✓ (+) (N/A)	X	X	X	X	X	X	✓ (2)
Bernstad <i>et al.</i> (2012)	Environment/ unclear	Source-separation	Waste bin (✓)	2	✓ (+) (N/A)	X	X	X	X	X	X	✓ (1)
Marone <i>et al.</i> (2018)	Environment/low	Food-sharing	Information (✓)	2	✓ (–) (N/A)	X	X	X	X	X	X	✓ (2)
Lim <i>et al.</i> (2017)	Environment/ critical	Planning and purchasing and leftover-reuse	Information and technology (✓)	2	✓ (*) (N/A)	X	X	X	X	X	X	✓ (1)

Notes: ✓ = meet criteria; X = do not meet criteria; + = positive behavioral outcomes reported; – = negative behavioral outcomes reported; \* = no behavioral outcomes reported



Only one program was developed based on consumer-orientated research (Devaney and Davies, 2017). 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 study 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 was applied across the studies (Table III).

### Behavioral change

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

#### *Targeted behavior*

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

#### *Program strategy*

To effect behavioral change, four broad program strategies were identified across various studies: education, personal interaction, installation of systems and 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) used 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, 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, color 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 and perception) to self-reported food wastage/weight of food wastage generated (kg) per households/community. The majority of the programs measured behavioral change by weighing the volume of food waste produced ( $n = 16$ ). One-third of studies used self-reported food waste behavior ( $n = 7$ ) as their behavioral outcome measure.

In total, 21 interventions reported some positive behavioral effects for one or more identified outcome variables (Table III). Positive effectiveness were achieved in programs that targeted source-separation behavior 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 behavior while the personal interaction approach did promote source-separation with purity rates of 95 per cent achieved.

The studies targeting disposal and composting behaviors 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 behavior 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: behavioral 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 (e.g. more than promotion) and theory use is reported. Specifically, Shearer *et al.* (2017) reports use of three social marketing elements (i.e. behavioral change, theory and marketing mix) and greatest effect size (Cohen's  $d = 0.73$ ) when compared to other studies (Bernstad *et al.*, 2013; Romani *et al.*, 2018) which did not report the use of theory or marketing mix (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 phenomenon occur (Michie, 2005). Accordingly, theory is used transparently to *inform* and *guide* the development of an intervention (National Social Marketing Centre, 2019). In this review, nine studies relied on a theoretical framework in program design (Devaney and Davies, 2017; Geislar, 2017; Jagau and Vyrastekova, 2017; Linder *et al.*, 2018; Nomura *et al.*, 2011; Romani *et al.*, 2018; Shearer *et al.*, 2017; Schmidt, 2016; Young *et al.*, 2017). The majority of programs used norm-related theories including social practice theory (Reckwitz, 2002 cited by Devaney and Davies, 2017), social influence theory (Goldsmith and Goldsmith, 2011 cited by Young *et al.*, 2017), social norm marketing (McKenzie-Mohr, 2000 cited by Geislar, 2017), the integrative influence model of pro-environmental behavior (Matthies, 2005 cited by Schmidt, 2016) and theory of intergroup behavior and social identity theory (Nomura *et al.*, 2011). Three studies reported the use of nudge (Thaler and Sunstein, 2008) in program design

(Jagau and Vyrastekova, 2017; Linder *et al.*, 2018; Shearer *et al.*, 2017). Romani *et al.* (2018) used the theory of planned behavior (Ajzen, 1991) to inform their intervention design.

### 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 (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 behavioral 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 behavior. 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 used at least one of the four 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 AU\$230.

Distribution of products/services via various platforms to increase desired behavior (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 products (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.

A total of 19 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 categorizing 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, 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 behavior (Andreassen, 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 2 out of 23 programs offered exchange: sales of “Green Cone Digesters” offered tangible and direct inducements to give up food waste behavior (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 behaviors that compete with the desired behavior (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 behaviors was reported. An understanding of direct competitors can provide information preventing failure and enhancing opportunities for improvement. Because 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 behavior 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 behavioral 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 behavioral 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 behavioral change. Importantly, greater program effectiveness (e.g. effect size) was observed in the study that reported use of three social marketing benchmark criteria: behavioral change, theory and marketing mix. This provides further evidence that application of core social marketing component can enhance rates of behavioral 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 center on Andreassen'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 (Schanes *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 behavioral change (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 (Dae *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 used this co-design process discovering incongruity between expert and community expectations for food waste programs (name withheld for a review) in regard to target behavior, program strategy and types of food that formed program focus.

In terms of target behavior 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 focused 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 focused interventions assume that motivation is strong, and it is merely a lack of comprehensible information that prevents the behavior 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 behavior 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 AU\$230 to householders through supermarkets. Programs that can deliver a product (Green Cone Digester) at a price (AU\$230) that householders are willing to pay for demonstrating 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 (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 behavioral 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 behavior targeted. Theory can be applied to guide the process of matching program strategies to the most appropriate behavior 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. Second, success was observed in studies that actively involved community during the delivery of the program (David *et al.*, 2019; Linder *et al.*, 2018). Consideration of consumer views as a core component of the program shows its potential to improve program delivery and in turn program outcomes. Finally, this paper delivered further evidence that behavioral 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 behavioral change, theory and marketing mix were found to be particularly valuable in increasing effect size.



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Thus, 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 focused 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. As 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 which 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 III). To better understand program strategies that can be implemented by public service organizations 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 used 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 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 successful, which behavior and program strategies were successful and to what extent social marketing has been applied.

### Conclusions

To the best of author’s knowledge, 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 behavioral 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 behavioral change. Of all social marketing components, behavioral change, theory and marketing mix were identified as being particularly valuable in increasing the effectiveness of food waste programs.

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