



Social Media:

The Real Impact on Food
Waste Reduction Beyond
the Swipe or the Click

SUMMARY REPORT

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DISCLAIMER

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Executive Summary

This Summary Report presents key insights from a 2020-2021 research project addressing the challenge of evaluating the multifaceted impact of social media communication and/or campaigns as interventions for changing domestic food waste behaviour. It was funded by the Fight Food Waste Cooperative Research Centre (CRC) and NSW Environment Protection Authority.

The **Objectives** of this project were: (1) to identify viable approaches, models, and pathways to assess the multifaceted impact of social media communication (campaigns) on domestic food waste reduction behaviour; (2) to provide a best practices guide for future planning, design, implementation, and evaluation of social media communication (campaigns) tailored to the domestic food waste area; and (3) to deliver evidence-based recommendations for executives and decision-makers to invest in social media communication (campaigns) as part of an intervention mix to reduce domestic food waste.

Data collection involved **Phase 1** three **Focus Group Discussions (FGDs)** with 12 international, multi-disciplinary experts on social media campaigns and food waste management; and **Phase 2 Systematic Literature Review (SLR)**, which examined an international data set of 3709 articles, with seven articles determined to meet all eligibility criteria and analysed in this report in detail.

Key findings synthesised from the two phases of studies are highlighted below:

FINDING 1

Substantial research into social media impact on food waste behaviour is lacking. There is insufficient empirical evidence to determine a direct causal link between social media intervention and food waste behaviour change.

Most evaluation research has not focused on social media alone; rather, it has approached behavioural impact through measuring various key constructs ranging from awareness, motivation, norms, knowledge (literacy), self-efficacy, perceived behaviour control, and behavioural intention, all contributing but not equal to actual behaviour change or food waste reduction.

FINDING 2

Measuring social media interventions in food waste behaviour requires **identifying specific action points in a behavioural chain** and **each action point requires a tailored intervention strategy and evaluation method.**

Domestic food waste may happen at every single action point of the behavioural chain, ranging from planning, buying, cooking, storing, and recycling. Each action point and habitual behaviour requires a purposeful intervention from a tailored social media campaign. The campaign's behavioural impact should be measured in specific action contexts.

FINDING 3

Current social media interventions and evaluation of their effectiveness have **predominantly focused on the downstream, consumer/household level.** However, **fighting food waste entails an ecosystem approach involving multi-stakeholder participation** from across the full spectrum of the demand-supply chain.

Downstream consumers/households are often exposed to more opportunities to waste than save food, partially due to the mid-stream or upstream stakeholders' counter-practices (e.g., retailers promoting 'buy in bulk', government encouraging food production). It is essential to integrate all downstream, mid-stream, and upstream stakeholders to build a food saving 'infrastructure' to enable food waste reduction at individual and household levels.

FINDING 4

As part of an intervention mix, **social media are found to be effective for raising awareness, developing social norms, enhancing food waste literacy, and increasing 'perceived' behaviour control over food waste.**

Social media are often juxtaposed with other influence tools and techniques. When social media are integrated with novel persuasive technologies (e.g., BinCam), gamification strategies, and easy-to-use applications (e.g., Chefbot), their intervention effectiveness may increase. However, the key challenge lies in how to maintain user momentum for engaging long-term, sustained behaviour change.

FINDING 5

There is no one-size-fit-all model. **Effective and measurable social marketing campaigns feature social or multi-media intervention design** that plays to the strength of each distinct platform and incorporates purposefully designed artefacts to **synergistically induce behaviour changes** toward food waste reduction.

Instead of relying on social media alone, many social marketing campaigns have developed wide-ranging intervention artefacts from information packs (print media), game apps, learning websites, email alerts, fridge magnets, recipe cards, grocery shopping notepads, digital kitchen scales, and plastic buckets with lids for waste composting/collection. These are all useful nudge tools for reducing food waste.



In line with the preceding objectives, this report **recommends** the following actions:

REGARDING THE EVALUATION OF SOCIAL MEDIA EFFECTIVENESS:

- **Action 1:** Develop a **long-term oriented** evaluation approach to track sustained behaviour changes over time and combine quantitative and qualitative methods to ascertain to what extent, and in which ways food waste reduction behaviour occurs.
- **Action 2:** Leverage the advantages of each distinct digital technology and **ethically grounded citizen science methods** (e.g., calling participants to donate data to a shared platform) to collect behavioural evidence and to audit actual food waste.
- **Action 3:** Harness **cross-disciplinary perspectives** (e.g., psychology, sociology, communication, and Internet research) and integrate theoretically dynamic frameworks for food waste evaluation research, to develop a comprehensive understanding of behaviour change in broader and collective contexts.

REGARDING SOCIAL MEDIA INTERVENTIONS DESIGN:

- **Action 1:** Prioritise an **affordance-first** (rather than popularity *per se*) and **platform-specific approach** to social media intervention design that addresses the needs of target audiences, specifies behavioural outcomes, and encourages meaningful and participatory engagement.
- **Action 2:** Integrate **(downstream) co-design with consumers and (upstream) co-production with influencers** (e.g., retailers, policymakers) methods to inform social or multi-media intervention design, wherein multiple stakeholders play an active role in facilitating food waste reduction initiatives.
- **Action 3:** Incorporate **gamification apps** to social media-based intervention campaigns to foster audience habitual and conscious behaviour engagement, as well as to incentivise their waste reduction efforts and progress.

REGARDING INVESTMENT IN SOCIAL MEDIA COMMUNICATIONS:

- **Action 1:** Increase **investment in developing sustained social media campaigns** aimed at changing target food waste behaviour longitudinally and persistently through fusing with other purpose-designed intervention methods (e.g., persuasive technologies, nudge tools).
- **Action 2:** Grant **funding for longitudinal and cross-sectional evaluation research** involving scientific researchers, industry partners, and citizen participants to regularly measure the effectiveness of social media campaigns and secure evidence-informed improvement of intervention design.
- **Action 3:** Provide **resources support for exploring gamification technologies or apps** through hiring a professional game developer in collaboration with (social media) communication practitioners, potential users, and the evaluation research team.



Introduction

Research rationale

Food waste is at the top of the waste hierarchy, which has contributed up to 30% of greenhouse gas emissions and presented significant global challenges (Sharp, Giorgi, & Wilson, 2010). In Australia, the food waste bill is estimated at \$36.6 billion annually, making it the world's fourth highest food waster per capita (FIAL, 2021). In an attempt to address this global issue, social media campaigns have been launched as education and intervention tools to change people's awareness, attitudes, and behaviours towards food waste reduction. Exemplary campaigns include the Australian "Fight food waste: It's easy as", NSW Government "Love food hate waste", United Nations "Think.Eat. Save. Reduce your footprint", and US "Food recovery challenge".

Despite the growing popularity of social media campaigns, the evaluation of social media campaigns' effectiveness in changing or reducing food waste behaviours is under-examined (Leavy et al., 2011). It is a common challenge for both researchers and practitioners to systematically measure the real-world impact and value of social media-based communications beyond the swipe or click. The complexity of evaluation arises from several contributing factors, including the novelty and variety of social media platforms, the multifaceted and dynamic nature of behavioural change processes, and the lack of personnel and resources for research (Niederdeppe et al., 2008).

To break through the evaluation 'bottleneck', the Digital Media Research Centre team at Queensland University of Technology (QUT), in partnership with Fight Food Waste CRC and NSW Environment Protection Authority, conducted this project to explore the viable approaches, key models, and solution plans to measure the multi-layered and multi-dimensional influence of social media campaigns in altering Australians' food waste behaviours. To this end, this project employs a **dual-phased research design**:

1. **Expert focus group discussions (FGDs)** to gather global insights and transferrable knowledge about assessing social media campaigns' impact on broader food waste behaviours.
2. **Systematic literature review (SLR)** of the most recent, evidence-based research evaluating the effect of social media campaigns on incremental food waste behaviour change.

PHASE 1 STUDY PURPOSES

The Phase 1 Study involved three FGDs with invited international scholars and researchers with expert knowledge of social media practices, evaluation experience, food waste management, and sustainability development. The study aimed to:

- Learn about understandings and practices of applying social media campaigns and/or communication in the food waste area and other intervention contexts within and outside of Australia;
- Identify best possible approaches, models, and pathways to evaluate the multifaceted impacts of social media campaigns on altering food waste behaviours;
- Provide implications and guidelines for subsequent literature review of the most recent research on the topic.

PHASE 2 STUDY PURPOSES

Informed by the Phase 1 study results, the Phase 2 Systematic Literature Review (SLR) served to:

- Comprehensively search peer-reviewed, scientific studies within the intersecting fields of social media communication (campaigns), food waste, and behavioural impact;
- Identify, synthesise, and appraise key insights and best practice examples from the reviewed literature, and deliver evidence-based recommendations on effective intervention designs and social media strategies that can be applied to the domestic food waste context;
- Compile a codebook (Excel spreadsheet) that outlines the reviewed studies and their key findings, and which also serves as a resource toolkit and portfolio of (inter)national learnings.

Methods

PHASE 1 EXPERT FOCUS GROUP DISCUSSIONS (FGDS)

Given the underdeveloped scholarship of this emerging topic, the FGDs method is suitable to not only gather cutting-edge expertise and experience from international experts with cross-disciplinary knowledge through a moderated interaction, but to also enable open conversations and debates within the group that can lead to the generation of new ideas and/or shared understandings of the topic (Nyumba et al., 2018).

Participants

We conducted three FGDs between October and December 2020, each group with four participants, one moderator, and one research assistant. To ensure the capture of a wide range of perspectives on food waste campaigns, we recruited participants from broad and diverse backgrounds. FGD1 comprised experts with social media experience across different influence programs (e.g., clean energy, electricity saving, health promotion) to change behaviours. FGD2 included international scholars dedicated to food waste communication and sustainability development within UK, US, Europe, and Australia. The third FGD consisted of researchers in the fields of media psychology, persuasion, and food policy (see Table 1 for an overview of the three FGDs).

Table 1. An overview of the three focus group discussions

Group number	FGD expertise area	Participants	Date & Duration
FGD 1	Social media communication across diverse intervention contexts	N = 4 (QUT researchers)	4 Nov 2020 1 hour 36 mins via Zoom
FGD 2	Engaging social media in Food waste reduction	N = 4 (International scholars from UK, US, and Australia)	26 Nov 2020 1 hour 28 mins via Zoom
FGD 3	Media psychology, persuasion, and food policy	N = 4 (US scholars)	28 Oct 2020 1 hour 6 mins via Zoom

Implementation

A FGD protocol was developed to guide the conversation and debate (see Appendix 1). The topic guide was semi-structured to cover the focal questions:

- What constitutes behavioural influence from the exposure to social media campaigns?
- What role has research shown that social media campaigns can play in behaviour change outcomes such as that tied to reducing food waste?
- What existing evaluation models, tools, or measurements of social media impact can be applied or adapted to food waste research?

Each FGD was conducted via Zoom and moderated by an experienced researcher. The three FGDs lasted between 1 hour 6 minutes to 1 hour and 36 minutes. All participants gave their consent to be recorded, some of whom agreed to release their image within the screenshot of the FGD. This project was approved by QUT Human Research Ethics Committee (Approval Number: 2000000780).

Data analysis

FGDs often yield both qualitative and observational data, the analysis of which can be complicated. We followed steps to conduct iterative, inductive analysis to enable for findings to emerge from the empirical data naturally (see Figure 1). The software Nvivo 9.0 was used as an instrument for data storage, management, and navigation, whereas the researchers played an agentic role in developing and refining the codes.

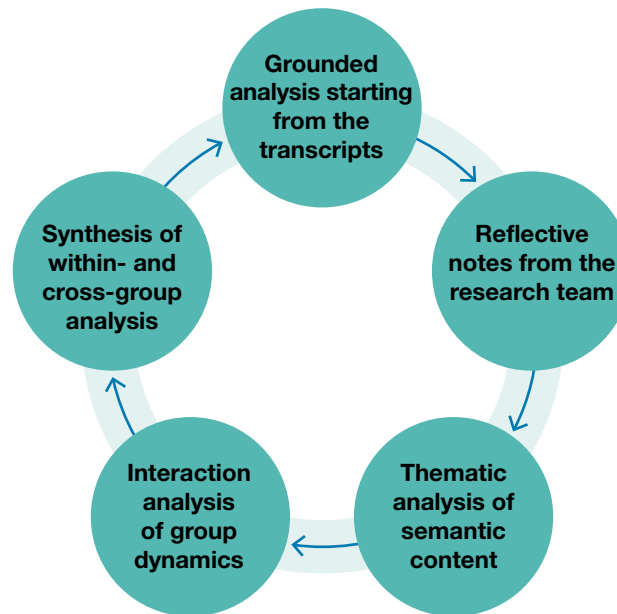


Figure 1. An iterative and inductive process of FGDs data analysis

We started with a grounded analysis of 73-page-long transcripts of the three FGDs recordings, each transcribed verbatim. Grounded analysis refers to not being constrained by a *priori*, but instead attends to self-emerging, conceptual categories from the data *per se* (Charmaz, 2006). Reading through the transcripts, each researcher wrote reflective notes about the major indicators or key directions of analysing the FGDs that they had moderated and/or attended. The reflective notes served as a foundation to develop initial codes in the form of a descriptive phrase/keyword/statement, which were used to categorise the raw ideas and comments from each group participant.

We then proceeded to a two-level analysis: (1) thematic analysis of semantic content, to identify interrelated thematic patterns from the semantic content, for example, what are the significant themes and subthemes emerging from the meanings of FGDs? How to make sense of the data? (2) interaction analysis of group dynamics, to examine the interactions between group members, for example, what are the consensuses, disagreements, or contradictions within the group, any alliance formed among the group members, as well as what topics evoked disagreements? After this two-level analysis of individual FGDs, we combined, refined, and synthesised the key themes/subthemes both within each group and across different groups.

PHASE 2 SYSTEMATIC LITERATURE REVIEW (SLR)

Informed by the results of FGDs, we followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (Moher et al., 2009) to conduct the SLR in a methodologically rigorous and reproducible manner. A systematic approach to literature review helps to capture the comprehensive, relevant, and well-defined body of scholarship pertaining to a particular research topic, thus producing a relatively holistic understanding of the emerging patterns, trends, and dynamics in the evolving research field (e.g., social media communication of food waste) (Petticrew & Roberts, 2006). The SLR was conducted between February to July 2021.

Procedures

Following the PRISMA guideline, a SLR protocol was developed to guide all stages of the review, which established the inclusion and exclusion criteria of studies considered for this study, as well as the procedures for data collection, extraction, analysis, and management (see a summary in Appendix 2).

Search strategies

With assistance from two librarians, we identified six scientific databases to conduct electronic searches for literature: Proquest, Ebscohost, Emerald Insight, Scopus, Web of Science, and ScienceDirect. These databases cover a broad range of journals and the most recent globally indexed articles, and thus are frequently used in many other systematic review articles. We then devised keyword search strategies and developed three unique search strings to (1) enable a broad capture of data (search #1); (2) to retrieve relevant literature specific to food waste and social media (search #2); and (3) to focus on data that covered the topic of food waste together with a social/digital media campaign and that included a behaviour change outcome (search #3). Searches were composed to retrieve full literature texts published between 2010 to 2021. The search strings were:

Search #1 (peer reviewed journal articles only)

(campaign* OR marketing OR intervention*) AND (“social media” OR “social network*” OR Twitter OR Facebook OR Instagram OR “social marketing” OR transmedia OR “digital media” OR “digital platform*”) AND (behavi* NEAR/15 chang*) AND (food* NEAR/20 wast*)

Search #2 (peer reviewed journal articles only)

(“food waste” AND “social media”) AND noft(“social media” OR “social network*” OR Twitter OR Facebook OR Instagram OR “social marketing”) AND noft(“digital platform*” OR “digital media”)

Search #3 (peer reviewed journal articles only)

“food waste” AND noft(“social media” OR “social network*” OR “digital media” OR “digital campaign*” OR “public communic*”) AND noft(“behaviour* change*” OR “behavior* change*” AND intervention* AND influence OR affect)

Exclusion/screening criteria

We used Endnote software to record database searches, collect, and organise extracted references, and categorise data throughout the literature screening process. Groups and subgroups were created for each database and each search string performed. We then proceeded to screening. We only targeted peer-reviewed **empirical studies** that addressed a **social/digital media and/or transmedia campaign** focused on **food waste reduction** at a **domestic consumer/household level** in **English-speaking** and **developed countries** and which evaluated a **behavioural change intervention**. Therefore, any non-peer-reviewed research, scoping reviews, and review studies (i.e. meta-analysis, conceptual studies, systematic reviews), studies focused on other environmental or sustainability issues (i.e. energy conservation, sharing economy, and other types of waste including plastic and commercial waste), studies without a behavioural outcome measure (e.g. those which measured only attitudes

and awareness), and studies that focused on only traditional forms of communication (e.g. print and broadcast) instead of digital/social media interventions were excluded.

The search and screening result

The database searches yielded 3709 potentially relevant records, which were filed into the “All References” folder of Endnote. Of those articles, 1676 were eliminated as duplicate references. The remaining 2033 unique records were manually screened in two phases against the inclusion/exclusion criteria to determine potential relevance (see Figure 2). The following diagram illustrates the identification, screening, and inclusion process.

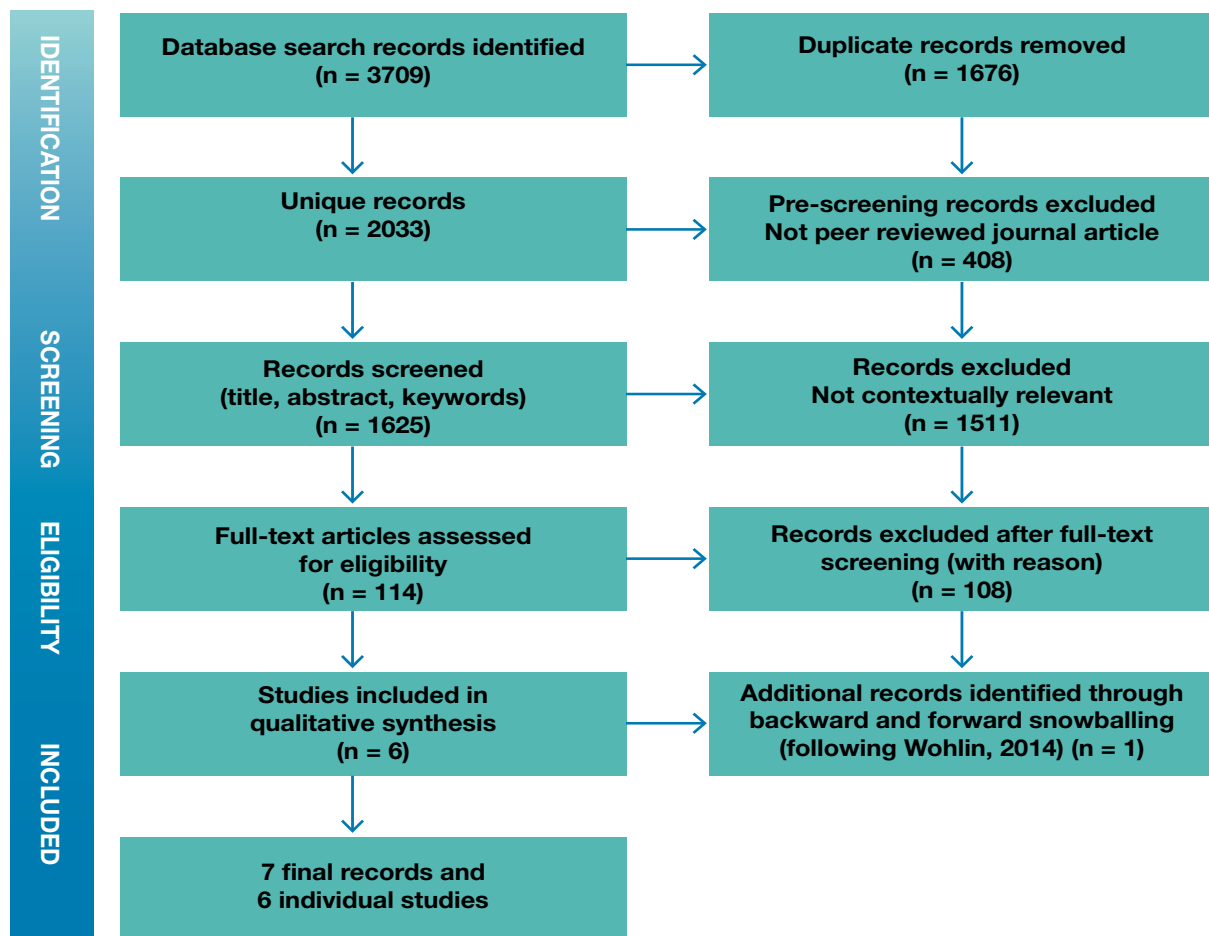


Figure 2. Flowchart of the literature search and screening process (PRISMA)

To ensure a comprehensive capture, we also conducted a manual **backward and forward snowballing search** (Wohlin, 2014) (see Figure 1, in Appendix 2) to identify any additional studies worth considering for inclusion. According to Wohlin (2014), backward snowballing involves using the reference list of each study to identify potential new studies to include. This step was followed by the forward snowballing method, which involved examining and evaluating studies citing the paper being examined in Google Scholar. Through both backward and forward snowballing techniques, an examination of all candidate papers’ abstracts was conducted, along with a further review of their full texts where necessary to determine their relevance for inclusion or exclusion. Following this process, one additional study was identified for inclusion and therefore, seven articles in total met all eligibility criteria and thus were included for in-depth analysis.

A summary of the eligible studies

Table 2 presents an overview of the seven qualified studies. Due to the methodological variability in study populations, differences in intervention design, and contextual heterogeneity it was not possible to analyse the correlations quantitatively and statistically between various independent variables (e.g., social media interventions) and dependent variables (e.g., behaviour outcomes). Therefore, a meta-analysis was not warranted.

Table 2. An overview of the eligible studies for an in-depth analysis

Code	Authors (Year)	Title	Context	Campaign
Study 1	Young, William Russell, Sally V. Robinson, Cheryl A. Barkemeyer, Ralf (2017)	Can social media be a tool for reducing consumers' food waste? A behaviour change experiment by a UK retailer	UK	Love Food Hate Waste
Study 2	Comber, Rob Thieme, Anja (2013)	Designing beyond habit: Opening space for improved recycling and food waste behaviours through processes of persuasion, social influence, and aversive affect	UK	BinCam System
Study 3	Soma, Tammara Li, Belinda Maclaren, Virginia (2021)	An evaluation of a consumer food waste awareness campaign using the motivation opportunity ability framework	Canada	Save the Food
Study 4	Soma, Tammara Li, Belinda Maclaren, Virginia (2020)	Food waste reduction: A test of three consumer awareness interventions	Canada	Food: Too Good to Waste
Study 5	Kim, Jeawon Rundle-Thiele, Sharyn Knox, Kathy (2020)	Outcome evaluation of an empirical study: Food waste social marketing pilot	Australia	Waste Not Want Not (WNNWN)
Study 6	Wharton, Christopher Vizcaino, Maricarmen Berardy, Andrew (2021)	Waste watchers: A food waste reduction intervention among households in Arizona	USA	Waste Watchers
Study 7	van der Werf, Paul Seabrook, Jamie A. Gilliland, Jason A. (2021)	"Reduce Food Waste, Save Money": Testing a novel intervention to reduce household food waste	Canada	Reduce Food Waste, Save Money

Coding of the eligible studies

The final step of SLR involved the evaluation of each of the above seven studies by two researchers. We entered notes into an Excel spreadsheet for 20 coding categories: 1) Author(s), 2) Year, 3) Title, 4) Journal, 5) Country of Study, 6) Study Objective(s), 7) RQ(s), 8) Theoretical Lens, 9) Sample Size, 10) Method(s) of data collection, 11) Platform(s) and/or digital technology (e.g. apps), 12) Intervention, 13) Target Behaviour, 14) Methods of Data Analysis, 15) Outcome/Findings, 16) Study Limitations, 17) Best Practices, 18) Referred Campaigns, 19) Recommendations & Practical Models, 20) Future Research. The intercoder reliability of the research results was assured.



Key Findings

Part I.

Food waste behaviour change in the social media context: Expert views

In response to the overarching research question “in what ways can social media campaigns influence people’s food waste behaviour and how can campaigns be best evaluated?”, the results of the Phase 1 Study did not offer an easy answer but assembled valuable insights from international experts.

KEY FINDING 1

To meaningfully measure the effectiveness of social media campaigns, the priority is to identify and target specific action point(s) in a behavioural chain that is key to reducing food waste over a sustained period.

Across the three FGDs, participants admitted that little social media research has been done to evaluate actual behaviour change in the food waste context. One compelling reason for the lack of research is that behaviour change is often a complex, accumulative, and multifaceted process with multiple variables and factors (e.g., awareness, attitude, knowledge) shaping it. Thus, the priority is to map out the full spectrum of behavioural change by **identifying concrete action (micro-behaviour)** that is targeted to occur at whatever time point. For example, FGD1 called those action points ‘behavioural components’, which resonated with FGD2’s ‘elements of habituation’, and ‘multi-focal behavioural change’ as echoed by FGD3.

In the household food waste scenario, the typical behavioural chain can be broken down into such action points as planning, buying, cooking, storing, reusing, and recycling. Each action point can be intervened by social media campaigns to alter people’s norms and attitudes toward food waste reduction, and to increase awareness and intention of behaviours. For example, social media campaigns can mobilise actions like buying less in the first place – shopping with a list – cooking meals daily – turning fridges to below 5 degrees centigrade – reducing fridge waste – cooking leftovers with creativity. Campaigners and researchers need to know exactly **what behavioural parameter is to be targeted and evaluated at specific time points** and understand **the optimal social media intervention required to realise specified behavioural changes**. This understanding must be situated within a broader context of social and behavioural processes. According to the experts, the following Figure 3. provides an implication for ‘upstream’ behaviour recognition and intervention by social media campaigns as part of an intervention mix.

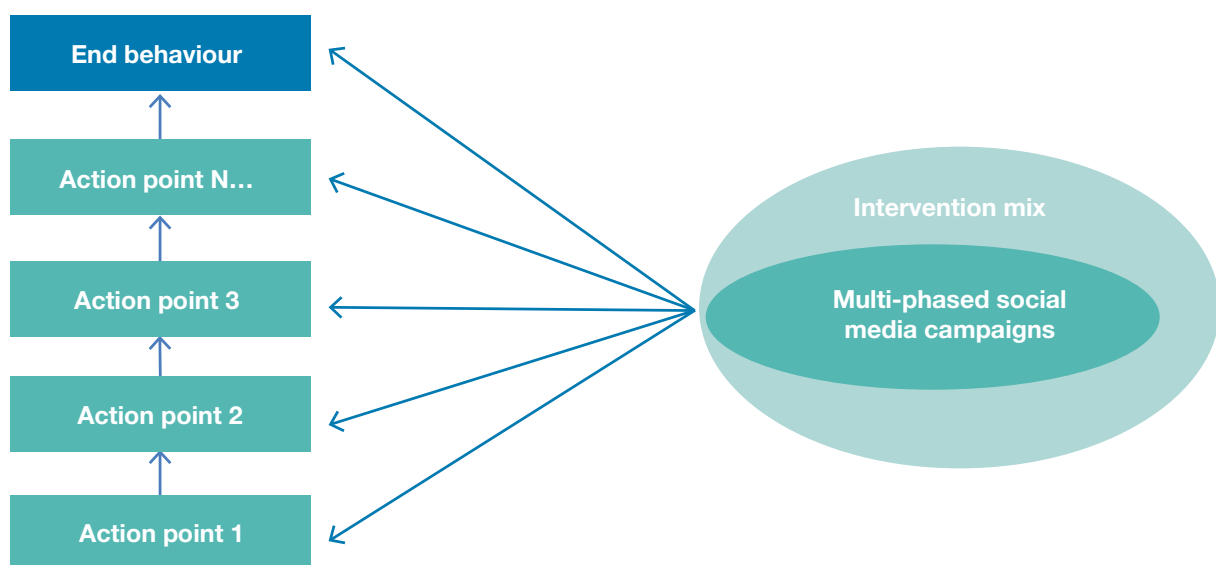


Figure 3. Upstream behavioural chain and social media interventions

In addition, FGD experts highlighted the need to distinguish between different types of food waste-related behaviour in the social media context as each requires context-specific evaluation:

- **Social media ‘conversion’ behaviour:** behaviour *on* social media that is convertible to the actual food waste reduction (e.g., sign up a program, download an app) → measurable by social media ‘vanity’ metrics/traffic
- **‘Actual’ food waste reduction behaviour:** behaviour occurring in the real world (e.g., buying less, shopping locally, cooking leftovers) → measurable by personal/household behaviour data
- **‘Staged’ behaviour for social media:** behaviour performed to gain social media attention and status (e.g., cooking show for reaping likes or clicktivism but not necessarily saving food)
- **Once-off vs. Sustainable behaviour** (small habits) → measurable by benchmarks

KEY FINDING 2

A multi-stakeholder, eco-system approach is essential to build the food waste reduction 'infrastructure' to enable and support behaviour change at an individual level.

A consensus emerged across all FGDs that food waste is a systemic issue, where producers/manufacturers, suppliers, retailers, consumers, environmentalists, activists, community groups, and policymakers should all play an active role in facilitating food waste reduction throughout the supply-demand chain. Individuals are surrounded by this eco-system which shapes their lived experience and behaviour. **If social media campaigns have only focused on individuals (e.g., consumers), it is possible to “create divide and reactance and we upset people”** (FGD2). This view was shared in the other two FGDs, which mentioned that “it is really the systemic change that we should be chasing” (FGD3) and “building an ‘infrastructure’ to enable individuals’ food saving is critical” (FGD1).

Since there might be ‘conflict of interests’ or ‘paradox of values’ among stakeholders, for example, buying more (in supermarkets) vs. wasting less (in consumption), and double food production vs. halve food waste, it is advisable to create an **‘ecosystem of shared value’** that benefits all parties. It is feasible to start from consumers and mobilise multi-stakeholder involvement (bottom-up approach) to establish a consortium that has a national voice around food waste (see Figure 4).

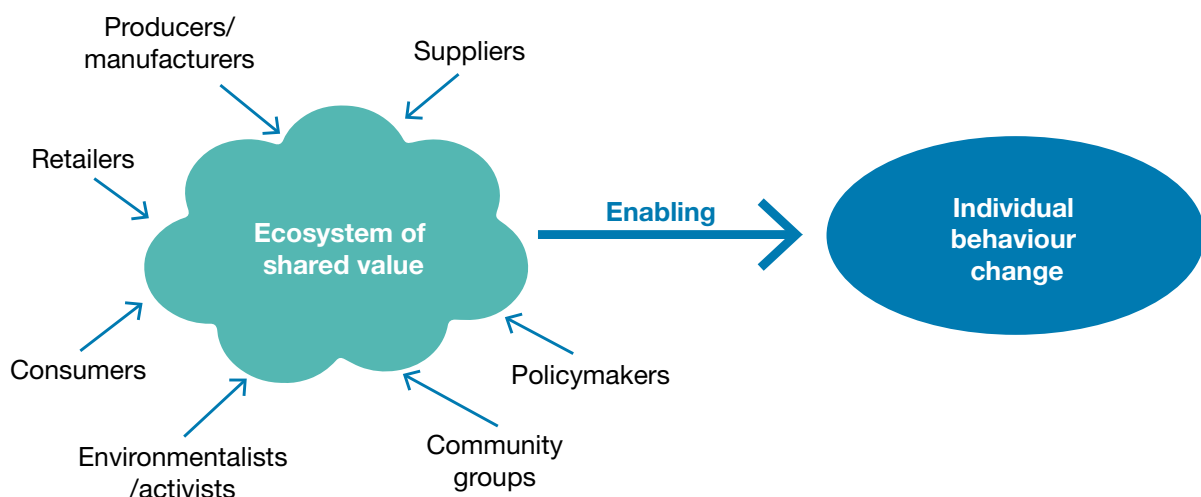


Figure 4. Creating a multi-stakeholder ‘ecosystem of shared value’

Specifically, the experts shared some examples of how multiple stakeholders are contributing to the food waste reduction ecosystem in other countries:

- **Farmers (producers):** In UK, recycle coffee grounds to farms and educate people how to pick up and storage food for a longer shelf life.
- **Supermarkets (retailers):** In UK, some supermarkets put stickers on the highest wasted food (e.g., potatoes) and give consumers tips what to do with it.
- **Governments (policymakers):** In Austria and Switzerland, governments enact top-down policies (e.g., imposing fines) to sanction food waste behaviours at a national level. In UK, the government implements bin waste audits.
- **Community groups:** In Australia, Brisbane Zero Waste is a long-term campaign that aims to not only change people’s minds, but to also create policy change and political will to make things happen (driving campaigns for a political outcome).

KEY FINDING 3

Social media are often incorporated as part of an 'intervention mix', along with other influence sources (e.g., peer pressure, opinion leaders, social disapproval, policy incentives), to conjointly change food waste behaviours.

As cautioned by all experts, there seems to be a trend or blind optimism to overstate the effectiveness of social media in changing people's minds, attitudes, and behaviours toward social issues. In fact, research shows that social media is only '**one piece of the jigsaw puzzle**' that should fit with other intervention tools to make an overall impactful program. To put it another way, the impact of social media is somewhat limited or indirect to behavioural change, and thus should be incorporated as part of an 'intervention mix' that occurs as part of broader social and multi-platform informational processes. The FGDs experts summarised that social media seem to demonstrate the effects in the following aspects:

- **Awareness raising:** Social media campaigns are instrumental to awareness building, and sometimes can deliver a supporting and favourable structure that helps compel users to take action, but more often that action happens offline, which may be difficult to track or detect.
- **Social norming:** Numerous social media campaigns are developed for social norming – to promote a new culture, value, or norm that can be leveraged to garner support for a change in behaviour across diverse populations. In this regard, it is important to understand that the existing social norm within a particularly targeted social media community may not hold the same as the broader population. For example, in previous successful quit-smoking campaigns, campaigners used influencers from the within-group (e.g., LBGTQIA+ community), to shift the social norm within that subgroup. In the food waste scenario, a social norm such as 'everyone else is saving food' can also be created through sustained social media campaigns.
- **Social listening through conversation and sentiment analysis:** Social media metrics are useful for tapping into where minds and hearts are, people's attention, awareness, concern, and potential attitude/sentiment toward a social issue (e.g., why people do not engage in non-waste behaviours). The conversations online about particular activities/behaviours promoted by social media campaigns do not clearly indicate whether people's opinions, feelings, and thoughts will lead to behavioural change. In this aspect, the QUT Digital Observatory might offer a great resource for conversation and sentiment analysis research.
- **Short-term change:** Social media campaigns are effective in enacting short-term changes (e.g., awareness raising, impression increasing, one-off action taking), but for long-term sustainable change, social media need to be part of a broader arsenal of campaign tools. For example, safety driving campaigns often go beyond social media to use the signs/billboards on highways to influence people's speeding behaviour by reinforcing messages at the moment of the perceived behaviour.

In addition, all FGDs experts emphasised the importance of platform specificity/affordances to design and deliver social media campaigns. Different platforms vary in how they operate, how communication works on them, and how people behave on those platforms. For example, **Twitter** is a public forum suitable to promote dialogue around food waste issues; **Facebook** is effective for sharing messages within social networks or local communities. **YouTube** is useful for visual appeals and informational awareness, e.g., teaching how to cook with leftovers. However, some social media platforms may drive behavioural extremes in counterproductive ways. For example, the aestheticised performative culture of **Instagram** might raise expectations of how food should look like, or even enable a culture of 'foodporn' that can lead to more food waste.

KEY FINDING 4

Mainstream value-orientation and emotional appeals work better than scientific education in social media messaging to persuade and influence food waste behaviour.

Unlike other political issues with strongly polarised views (e.g., climate change, abortion), food waste is seen as a mundane, everyday phenomenon that few people may even recognise as an issue. Some experts noted that food is a very '**emotional**' thing for people, family, culture, communities, and for taste and so on. Social media campaigns aimed at fighting food waste are best driven by values (e.g., saving money, time efficiency) that appeal to people's **pragmatic needs** – often through emotion – instead of through moralising and preaching about the scientific rationale. In particular, the persuasion literature shows that behaviour change arises more from positive emotional influences (e.g., fun, humour, inspiration) than negative cognitive impacts (e.g., pressure, anxiety, social stigma). This means, social media messaging does not always need to be directly about food waste education, but “more about what is valuable to the individual and/or household, which can be altered by social media campaigns” (FGD1).

Making **value positioning** explicit in social media campaigns relies on the **framing of key messages** in relation to the '**identity**' of the target audience. For example, mothers are deemed as decision-makers in household shopping and thus to a large extent influence food waste production or reduction. Being a mother (*identity*) has traditionally been associated with caregiving or caretaking *values* to provide a family with enough nutritious, fresh, and healthy food, which might inadvertently cause food waste. However, if social media campaigns *reframe/reposition* the value of being a 'good mum' as buying what the family needs, such an emotional appeal may help to prevent food waste as every mum wants to be 'good' by this definition. “It's really about reframing of the messages to lower possible latent needs that people aren't themselves aware of why they're buying” (FGD3).

KEY FINDING 5

Effective, measurable social media campaigns often embed the following pragmatics in planning and implementation: Rather than using a broad approach, they are specifically tuned to differentiate for which audiences (identity), which platforms (tool), which cues (messaging), and aiming for which behavioural change (outcome).

FGDs experts recommended the essential pragmatics/components of effective social media campaigns – how to design a social media campaign with measurable impact. As indicated earlier, **the primary task is to specify, contextualise, and define the behavioural outcome** that is being asked for – to achieve the end goal behaviour. Being clear and realistic about what can be achieved through social media campaigns is crucial to attaining evidence-based, behavioural influence to convince executives and decision-makers of the need for ongoing investment in social media interventions. “It involves a bit of forward thinking about what the desired outcome is, what can realistically be done at each time point, and what can be realistically measured, and working back from there” (FGD1).

Other pragmatic considerations of social media campaign planning include:

- **Audience segmentation:** Most current food waste campaigns have targeted the broad population as the audience. However, food waste in the households differs according to household type e.g., a large family, core family, vs. a single resident. Promoting food waste behaviour change among adults and children is also disparate. Social media campaigns need to be designed specifically for and tailored to niche audiences.
- **Influencer engagement:** It is a key social media strategy to use influencers to reach the hard-to-reach audiences. Social media campaigners should be strategic to understand whose voice(s) in the 'intervention mix' are heard by different groups of people and then act on the voice or advice of that influencer. As praised by an expert from FGD1, using a 'drag queen' (influencer) in tobacco cessation campaigns has effectively targeted LGBTQIA+ communities. Likewise, in the 'Share the Dignity' campaign, **micro-influencers** (e.g., lay-person in local communities) have successfully influenced the Queensland Government to install vending machines in schools to enable girls and women to access tampons more conveniently. The implication for food waste campaigns is to identify the target audience and then mobilise appropriate influencers with popular authority,

credibility, and authenticity (e.g., cooking personalities and farmers as **micro-celebrities**) to boost the impact of social media campaigns.

- **Partnering social media with practical, easy-to-use apps/tools:** Since social media are best used for awareness raising, it would be beneficial to partner social media platforms with hands-on, easy-to-follow apps to convert social media engagement metrics (e.g., views, likes, shares) to observable, lived behaviours. For example, **@KrogerChefbot** is such a combination of Twitter and an app designed to reduce food waste by helping people to cook with what they already have at home. The three easy steps have greatly facilitated food waste reduction (see Image 1 for the three-step illustration). It is fun and a participatory way to encourage people to share pictures on Twitter about food-making processes according to the recommended recipes.



Image 1. Chefbot
(Sourced from the pinned tweet of [Kroger Chefbot](#))

Part II.

Social media interventions in food waste behaviour: Literature insights

Since Part I has focused on presenting international panels' views, ideas, and suggestions, this section summarises evidence-based findings from the Phase 2 systematic literature review (SLR) study, to ascertain what the state of social media research on food waste behaviour is and what research has determined the role social media plays in food waste reduction. Based on the seven qualified empirical studies identified from the SLR, we synthesised the scientific knowledge about the viable models, approaches, and pathways to measure social media impact, as well as the potential benefits and limitations of social media communication and/or campaigns to effect food waste-related behavioural outcomes.

A synthesis of included studies

Despite the heterogeneous research design across the seven included studies, we found some general patterns in how those studies approached the evaluation of social media impact on food waste reduction. The following table synthesises the included studies' general features, including their dominant and/or varied theoretical frameworks, evaluation methods, target behaviour outcomes, target audience(s), and intervention tools.

Table 3. A synthesis of the included studies' general features

Theoretical frameworks	Evaluation methods	Target behaviour	Target audience(s)	Intervention tools
<ul style="list-style-type: none"> Mainly used Theory of Planned Behaviour (TPB); or Motivation-opportunity-ability (MOA) framework; or Social influence theory 	<ul style="list-style-type: none"> Self-reported survey (dominant) Automated visual (image) analysis; or Actual food waste audit 	<ul style="list-style-type: none"> Mostly behaviour chain through pathways (e.g., awareness, intention, perceived behaviour control); or Few targets a specific behaviour (e.g., reusing leftover) 	<ul style="list-style-type: none"> Single-family household, female, mid-aged or above, employed (middle-income), and residents Few used students as experiment or survey participants 	<ul style="list-style-type: none"> Mostly use an intervention mix (e.g., info pack, social media, digital apps) Few used social media alone (e.g., Facebook, BinCam)

As shown in Table 3, the three popular **theoretical frameworks** used in most literature to evaluate behaviour changes are: (1) **Theory of Planned Behaviour (TPB)**, a psychological theory to understand behavioural process through examining key constructs like *motivation* (behavioural intent) to perform a behaviour and the *ability* (behavioural control) to exert self-control to achieve the expected outcome; (2) **Motivation, Opportunity, and Ability (MOA) framework**, which extends TPB from simply assessing behavioural intentions or motivations, to consider broader contextual factors such as *barriers*, *opportunities*, and *abilities*; and (3) **Social Influence Theory**, a sociological theory to examine the role of *social networked communication* (e.g., Facebook), as a potential duplicate of *face-to-face social influence*, and its capacity to facilitate anti-food waste discourse and thus behaviour.

The **evaluation methods** involved in the reviewed studies are representative, if not exhaustive, to measure food waste behaviour change or food waste reduction resulting from various interventions:

- A. Self-reported survey (along with focus group or interview feedback).** Three studies (i.e., Study 1, 3, 5) relied solely on a survey method to benchmark perceived behaviour changes or self-efficacy in reducing food waste pre- and post-interventions, or at different time points (e.g., one month before intervention, two weeks after intervention, five months after intervention). Typically examined behaviour changes include **perceived changes** in food waste attitude and behaviour, the use rates of food waste information guidelines, and **perceived self-efficacy** in reusing leftovers and controlling other food waste behaviours. Self-reported surveys suffer from personal biases.
- B. Actual food waste audit.** Based on a pre-intervention survey to collect self-reported data on food waste disposal, three studies (i.e., Study 4, 6, 7) integrated actual household waste measurement/ audits to detect the changes during and post-interventions. The **waste audit sampling** was often collected weekly by the research team via household food waste disposed in garbage and organic bins set out at the curbside, or reported by participants who were trained in waste collection/ reporting. Household food waste was sorted into primary categories of edible, inedible, and non-food waste, or more specifically, six food waste categories (bread and baked goods, meat and fish, dairy, fruit and vegetables, dried food, and other foods). Each category of food waste was then weighed with weight data reported for total household waste. Actual waste audits provide reliable evidence to ascertain the actual intervention effectiveness.
- C. Automated (visual) data collection.** One study (i.e., Study 2) employed **automated (visual feedback) data collection** to measure household food waste. This involves an innovatively designed, *persuasive technology* called **'BinCam'** App, which uses built-in technology to automatically capture images with a smartphone installed on the underside of the bin's lid (see Image 2). The smartphone wirelessly uploaded images to the BinCam app on Facebook where they were immediately visible to all BinCam participants. As images were captured and uploaded, they were processed by Amazon's Mechanical Turk crowd-sourcing services and tagged accordingly by workers (acting as data processors). However, such a visual analysis via images provided only an estimation of waste measurement.



Image 2. 'BinCam'
(Sourced from Comber & Thieme (2013), p. 1201)

Across the seven included studies, the **target behaviour outcomes** predominantly revolve around the **pathways to the behaviour change chain** such as *awareness raising, information and knowledge acquisition, food saving and storage literacy, intention of or attitude toward behaviour change, and shared value/norm of food saving*. Those pathways alone may not guarantee an actual behaviour change but are deemed as essential to behavioural processes. Only two studies targeted a specific behaviour change such as reusing leftovers (i.e., Study 5) or changing behaviour(s) ranging from food planning (to increase literacy), purchase (to encourage money saving), storage, preparation, and recycle (to manage food waste) (i.e., Study 7).

Despite the varying sample size from 22 to 2018, the demographics of **target audiences** (participants) covered by most studies mainly featured **single-family dwellings**, with few studies targeting multi-family dwellings, or shared accommodation, and others excluding households in apartments or multi-unit dwellings. There is some **gender bias** in study populations, with four studies recruiting a high portion of female participants. A slight **age bias** is also present across the studies with more than half of participants in two studies aged 50 and above, and one study included participants aged between 18 to 35 years only. From a **cultural and geographical perspective**, all included studies are drawn from Western, developed, and English-speaking countries with four studies conducted in North America (i.e., USA, Canada), two in UK, and one in Australia. Most of the participants are residents, with few studies using students as the participants of experiments or surveys.

The **intervention tools/materials/artefacts** used in the reviewed studies are wide-ranging from information pack (print media), digital technologies (apps), social media platforms, gamification, pervasive technologies, purpose-built websites, emails, fridge magnets, recipe cards, face-to-face interaction, and conventional text-based and pamphlet materials. Most studies used an **intervention mix** to shape food waste behaviour, with only two studies focusing on social media platforms like **Facebook**. The studies that mobilised the Facebook intervention assume that social media engagement forms part of everyday communication activities. Thus, integrating Facebook as a core campaign strategy is believed to increase campaign engagement, develop opportunities for informative feedback, and social (networked) influence is supposed to induce behavioural changes.

Based on the above synthesis of included studies, we highlight the key findings below in relation to:

1. Viable approaches, models, and pathways to measure social media impact on food waste behaviour (Evaluation);
2. Best practice examples of intervention design and social media campaign pragmatics (Practice); and
3. Evidence-based social media effects and constraints on food waste behaviour (Impact).



KEY FINDING 1 (EVALUATION)

Existing approaches to measuring food waste behaviour in the literature are divergent, depending on the variety of influence outcomes, target audience(s), and digital/social media involvement. There is no one-size-fit-all model, but some evaluation methods are replicable and adaptable with due cautions.

By using surveys and experiments, most of the reviewed studies have involved a pre- and post-intervention design to benchmark and track any differences in perceived or actual behaviour change toward food waste reduction (dependent variables) through influencing different target groups with purposeful interventions (*independent variables*) such as:

- Information group (who receive food waste education information packages)
- Gamification group (who engage with a gamification app for online activities)
- Community engagement group (who attend community-based workshops); and
- Control group (who receive no intervention)

The intervention effectiveness in terms of behaviour outcomes is often measured by means of self-reported data with inherent biases, or automated image analysis with an estimated amount of food waste, or actual food waste audit, as explained earlier. Among these evaluation methods, only **weight-based auditing provides reliable and accurate evidence of intervention effectiveness**, but few studies have employed it because of the associated challenges such as limited access to enable food waste collection, difficulty in separating waste between participants in multi-residential dwellings, difficulty in sorting food waste from general waste, and the time and cost involved in waste collection and measurement methods (e.g., number of audits, interval frequency, and study durations). Nevertheless, there are some **smart ways to audit actual food waste** as identified in the literature:

- 1. Train participants in food waste collection and reporting.** For example, provide participants with toolkits like plastic 3.8 litre buckets with lids, a digital kitchen scale, printed instructions, and the option of a printed or online log to measure and report waste (see Image 3. for the ‘Waste Watchers’ Program as detailed in Study 6).

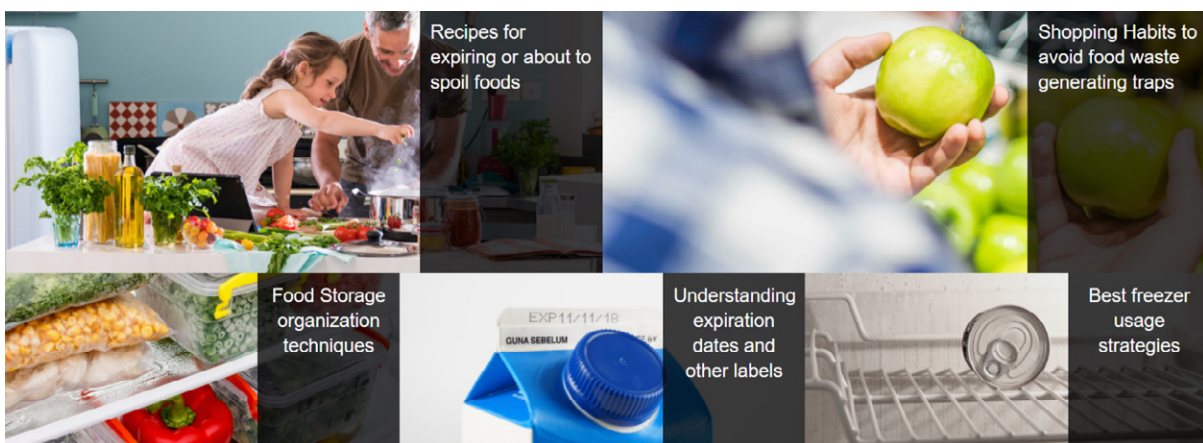


Image 3. ‘Waste Watchers’ program
(Sourced from [Arizona State University Global Institute of Sustainability and Innovation](#))

- 2. Use a bespoke waste sampling method.** For example, collect garbage and sort for food waste into avoidable, and unavoidable food waste categories, or specific food subtypes (see Image 4 below). Collect and sort of household food waste from curbside garbage samples at pre- and post-intervention time points. Then seek weight data on a weekly basis for household garbage samples (kg/week) and food waste categories (kg/week) (see the ‘Reduce food waste, Save money’ Program detailed in Study 7).

LEGEND:

- Bread and Baked Goods:
- Meat and Fish:
- Dairy:
- Dried Food (e.g. cereal, dry pasta):
- Fruits and Vegetables:
- Other:

Please make sure the total is 100%

Generate Pie-Chart

Breakdown of estimated food waste at your household

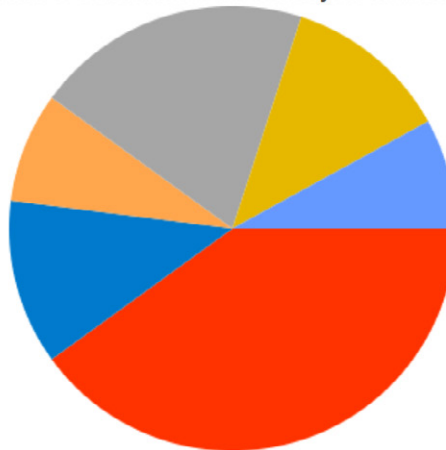


Image 4. Household food waste composition
(Sourced from [‘Reduce Food Waste, Save Money’](#))

One of the widely used **theoretical models** to evaluate food waste behaviour change is **Theory of Planned Behaviour (TPB)** developed by Icek Ajzen (1985), which seeks to examine behaviour outcomes through various constructs in the behaviour chain (see Figure 5). As a psychological theory, TPB explains and predicts an individual’s intention to engage in a specified behaviour. TPB comprises three key constructs: *attitude*, *subjective norms*, and *perceived behavioural control*. TPB maintains that the three conceptually independent variables together shape a person’s *intentions to perform a behaviour* (e.g., reduce food waste), which may lead to *actual behaviour change*. As part of social cognition theories TPB assumes that a person’s behavioural intentions of food waste can be determined by other factors such as personal norms, good provider identity, and household planning habits.

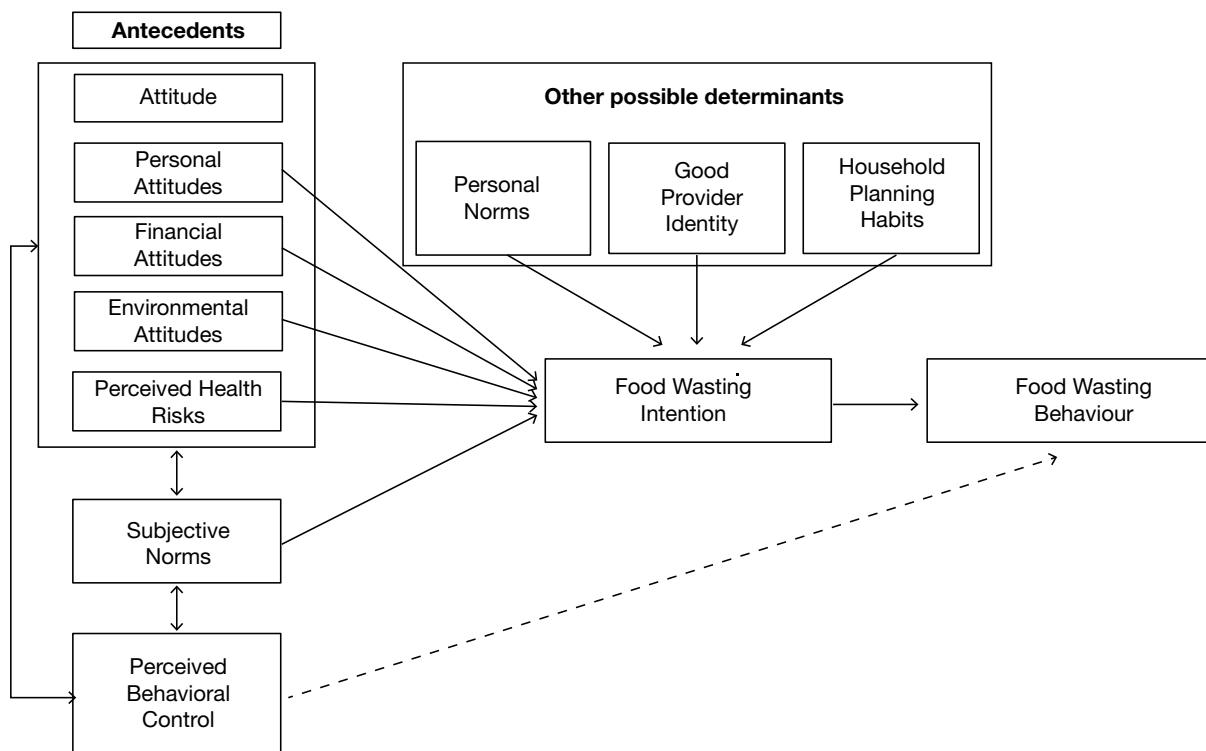


Figure 5. An illustration of Theory of Planned Behaviour
(Sourced from van der Werf et al. (2021), p. 155)

This model was adopted in Studies 2, 3, 6 and 7. For example, Study 7 applied TPB to test whether increasing people's perceived behavioural control through *improved food literacy* would facilitate behaviour change (van der Werf et al., 2021). Study 6 used TPB to measure constructs including *intentions, norms, attitudes, and perceived behavioural control* as specifically related to household food waste (Wharton et al., 2021). Study 2 incorporated TPB with *Social Influence Theory* (face-to-face social influence intervention) and *Aversive Affect* (unpleasant stimuli that induces behaviour change via negative reinforcement or positive punishment) (Comber & Thieme, 2013). Study 3 adopted an expanded version of the **Motivation, Opportunity, and Ability (MOA) framework** (see Figure 6) from TPB, to test a model aimed at assessing the efficacy of consumer food waste *awareness* campaigns in altering consumer motivation, opportunity, and ability as well as to identify the *drivers* and *barriers* that affect a consumer's capacity to reduce food waste (Soma et al., 2021).

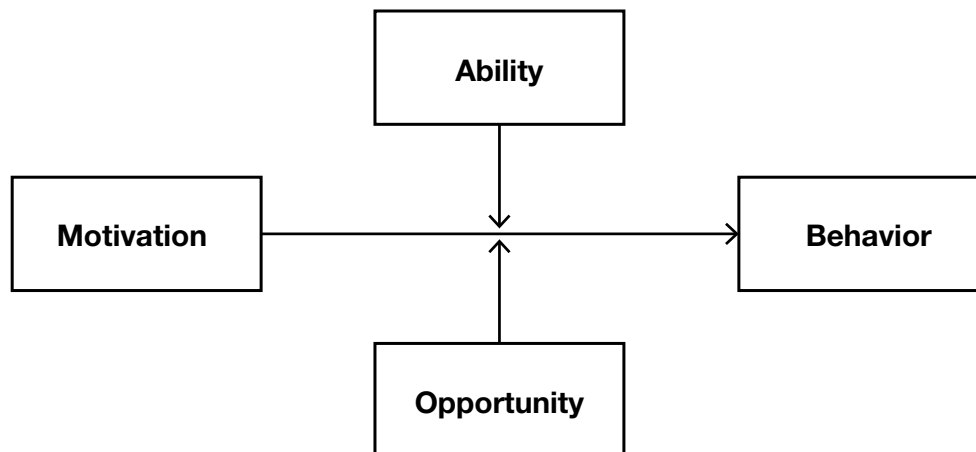


Figure 6. The Motivation, Opportunity, Ability (MOA) framework
(Sourced from: Hughes (2007), p. 2)

While theoretical models like **TPB and MOA assume intention and motivation as key drivers of behaviour**, these theories do not articulate exactly how intention and motivation drive behaviour, thus limiting their practical applications. While TPB offers a valuable ‘predictive’ model based on measures of *behavioural intention*, it is insufficient as an applied theory to measure *actual behavioural changes*. Moreover, **TPB and MOA are insufficient for understanding broader and non-conscious factors** such as contexts (e.g., economy, society, environment), injunctive norms, emotions, and habits that drive actual and long-term behaviours. As such, actual behaviour change is more likely to transpire through interventions that apply more dynamic models and where greater collaboration across disciplinary frameworks and perspectives are implemented. Overall, the various evaluation models presented here offer valuable implications, but they all have inherent limitations, and thus a contextualised and tailored approach is needed to detect and determine if an actual reduction in food waste occurs in response to receiving a perceptual, attitudinal, and/or behavioural intervention.

KEY FINDING 2 (PRACTICE)

Social media are mostly included as part of an ‘intervention mix’ to induce food waste behaviour change. Despite the variety of intervention designs, the literature has offered international exemplars of innovative practices in reducing food waste that are adaptable to the Australian context.

All reviewed studies involved a **multi-media and cross-intervention design** to conjointly shape food waste behaviour, yet only two studies (i.e., Study 1 and 2) involved a social media platform (Facebook) as part of the intervention mix. Study 1 delivered an intervention mix via a *magazine* in print and online, an *e-newsletter*, and the retail store’s (Asda) *Facebook* page (Young et al., 2017). Study 2 integrates a two-part persuasive technology design called ‘BinCam’ consisting of an *augmented bin* and a custom *BinCam application on Facebook* (Comber & Thieme, 2013). The identified innovative practices of intervention design and social media (campaign) pragmatics are elaborated below.

Intervention Design Exemplar 1: Juxtaposing different intervention techniques

In two Canadian studies (i.e., Study 3 and 4) aimed at raising awareness and motivating food waste reduction, researchers designed three treatment groups, each with a different intervention (mix), and one control group without receiving any interventions at all, during a 12-week campaign period:

- An **information-based intervention** that used more **passive approaches** (Information Treatment Group). Participants received a *booklet* with information on why food waste is a problem (motivation), tips to reduce food waste at home (ability), and a visible fridge magnet (as a visual prompt or nudge) with storage tips (opportunity). Participants also received *e-newsletters* (or by *mail* for those without internet access) four times (once every three weeks) throughout the course of the campaign, to receive *tips for food storage, meal planning, shopping, understanding best-before dates, and recipes for using leftovers or slightly spoiled food (knowledge/literacy development tools)*.
- An **information-based intervention augmented by community workshops** (Community Treat Group). In parallel to receive information materials, participants also received an invitation to attend *four one-hour community workshops* (opportunity/capacity building), with *presentations on food waste reduction, group discussions, group activities, watching videos together, and quizzes with small prizes*. The first workshop focused on meal planning and reusing leftovers, the second focused on proper food storage, the third on understanding best-before dates, and the final workshop was a review and wrap-up on the importance of preventing and reducing food waste in general.
- An **information-based intervention augmented by an online game** (Gamification Treatment Group). Based on the information materials, participants were invited to play an *online quiz game with points and rewards*. The gamification intervention consisted of a *simple online educational trivia-based game with facts and strategies to help participants learn to reduce food waste*. Specifically, there were *five trivia questions each week* about food waste as a problem (motivation) and how to reduce food waste at home (ability). Participants earned 10 points per week (12-week game) for correct answers and were rewarded with a CAD\$20 grocery *gift card* if they accumulated 120 points or a CAD\$10 grocery gift card if they accumulated 60 points at the end of the 12 weeks (motivation).
- **Control group**: No intervention was received.

Intervention Design Exemplar 2: Partnering with retailers (a mid-stream intervention)

While most retailers (e.g., supermarkets) tend to promote food consumption (rather than food saving or waste reduction), UK scholars (Study 1) collaborated with Asda (a popular supermarket chain) and leveraged its communication resources to design various interventions to shape consumers' food waste behaviour:

- **Retailer's (Asda) magazine** (print and online): Asda magazine served as an intervention through publishing an expert featured article that provided category-specific tips on storage, recipe inspiration, and methods to reuse leftovers to reduce five highly wasted household food: a) fruit and vegetables; b) meat and fish; c) bread and baked goods; d) dairy items; and e) cooked rice and pasta.
- **Retailer's (Asda) e-newsletter**: The Asda e-newsletter was circulated in conjunction with a social media campaign (on Facebook). The e-newsletter featured: (i) like the social media campaign, discussing using leftovers to reduce food waste, and using a web link to connect customers to the social media campaign and encouraging them to share ideas of reducing food waste; and (ii) highlighting correct storage techniques to keep food fresh and prevent waste, and provided a link for purchasing food storage items.
- **Retailer's (Asda) Facebook page**. This intervention was used to *facilitate discussions about the food waste issue* among customers on Asda's Facebook (see Image 5.). Utilising Asda's social media group, this intervention consisted of posting a 'leftovers' campaign on Facebook which asked Asda customers to submit their favourite recipes that involved using leftover food and directed users to a website providing 'Love Food, Hate Waste' tips from the Waste Action Resource Plan (WRAP) on reducing food waste at home.

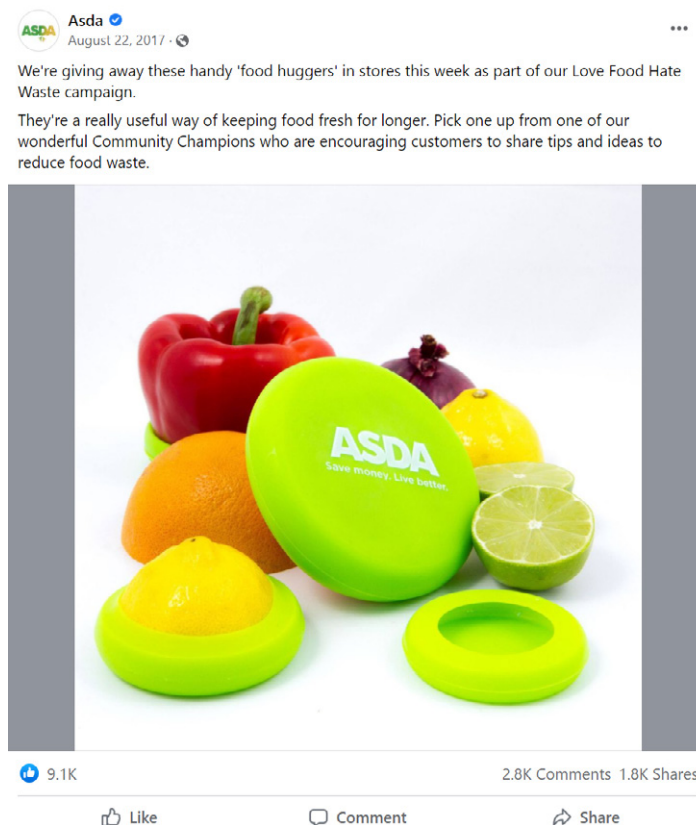


Image 5. An example of Asda's high-engaging Facebook intervention (Sourced from: [Asda's Facebook page](#))

Intervention Design Exemplar 3: Combining persuasive technology with social media

With the aim to change an individual's *habitual behaviour* (e.g., wasting food) to *conscious performance* (e.g., recycling), a UK study (Study 2) by Comber and Thieme (2013) implemented a five-week **BinCam intervention** as a **two-part system consisting of an augmented bin and a custom BinCam application (app) on Facebook**. BinCam was designed as a persuasive technology to persuade, influence, or even coerce both unconscious and conscious behaviour of waste management. To increase participant engagement, the *BinCam app* produced both 'BinPictures' and 'BinLeague' features (see Image 6.) to enable social informational and normative influences.

- **BinPictures** automatically captured discarded waste items and published those images via the app which was believed to act as an *aversive social force* and thus require individuals to adjust their behaviour to avoid public disapproval.
- **BinLeague** visualised the crowdsourced scores for two elements of waste disposal: (1) *recycling* achievements presented as 'leaves on a tree'; and (2) *prevented* food waste (money saved) displayed as 'gold bars.' Apart from visual feedback on each household's waste performances, BinLeague created competition between the BinCam households, and made *normative social influences* salient, as comparing one's efforts with the progress of others facilitated a social informational influence.

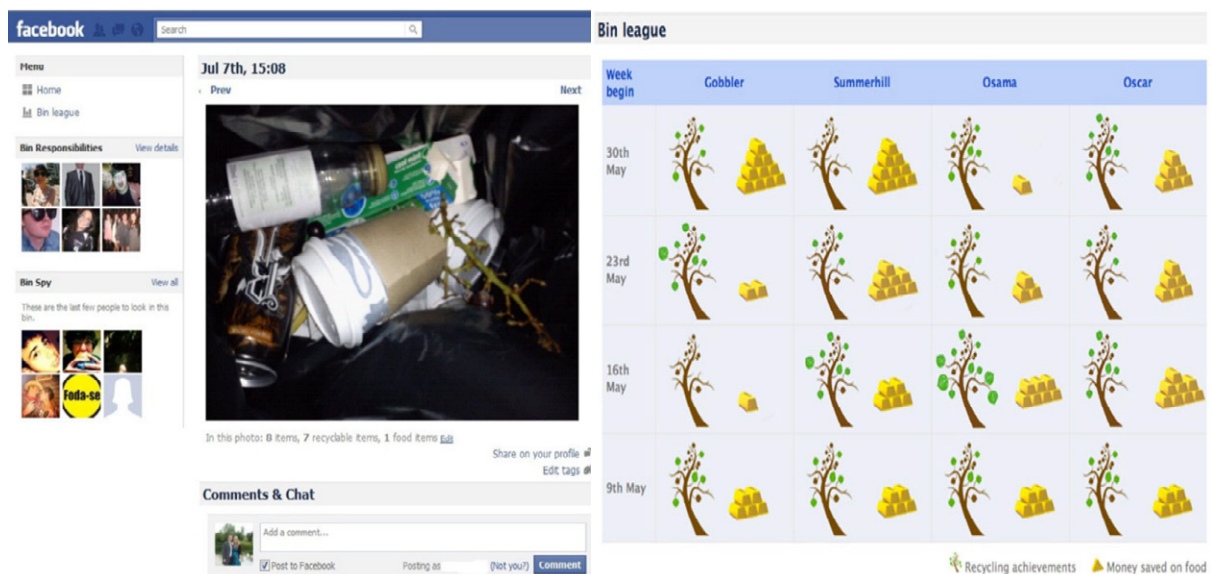


Image 6. An illustration of BinPictures (left) and BinLeague (right)
(Sourced from: Comber & Thieme, 2013, p. 1202-1203)

Intervention Design Exemplar 4: Co-designed social marketing programs

This refers to an Australian program called 'Waste Not Want Not' (WNWN), running daily with Redland City Council residents for a period of two weeks' **face-to-face, consumer-insight driven social marketing intervention** (Study 5). The highlight is the **co-design thinking to elicit input from household residents** living in the local government area to inform preferred intervention design. This co-design process was combined with a prior systematic literature review to *identify target behaviour, tools for intervention delivery, and conceptual design* for the social marketing program WNWN.

An **information intervention (treatment group) comprising two interactive activities** that were delivered in a partnered shopping centre: 1) daily food demonstrations and 2) culminating in a cook-off event featuring two local chefs. This was *augmented with community engagement* with volunteers who offered food to participants to taste, a free set of 16 recipe cards, and discussions with participants about what food could be prepared using the available food in the program display fridges. Prior to intervention execution, three *local professional chefs created new recipes* consisting of food items that were commonly available in household fridges and therefore were most likely to be wasted.

Partnering with nine local retailers to offer a discount for participants who showed their recipe cards. The Treatment Group received an *information package* of materials that consisted of chopping boards, shopping bags, and shopping list note pads. A *multi-media approach*, ranging from national television, local radio, shopping centre billboards, and local newspapers was implemented prior to and throughout the program execution to maximise the program visibility. Participants in the Treatment Group had access to all intervention materials and the interactive shopping centre display between the pre- and post-survey period. The Control Group did not receive any interventions and were not exposed to the interactive shopping centre display.

Intervention Design Exemplar 5: Purpose-built learning website

In Study 6 by Wharton et al. (2021) a five-week **education-based intervention** called “**Waste Watchers**”, a purpose-built learning website, was designed in collaboration with a nutrition faculty at a major southwestern university in America. Participants were asked to interact with the **(learning) website** which provided key information and tools to prevent food waste at home and was presented in a variety of formats including *downloadable content* (such as recipes and grocery shopping tools), a series of *podcasts, infographics, videos, and text-based information*.

- The website contained **five-themed modules** about food waste prevention (*recipes, shopping habits, food storage, expiration dates, freezer usage*) and a section of frequently asked questions to assist participants in their household food waste collection. Participants were instructed to access one module per week and were *provided weekly reminders* to visit the site and the corresponding week’s content. All content was organised, edited, and uploaded to a website built for the study, available at: <https://sustainability.asu.edu/waste-watchers/>.
- All information interventions were framed using **three persuasive appeals**: impacts on health (e.g., throwing away fruits and vegetables represents a lost opportunity to eat healthfully), impacts on home finances (e.g., throwing away food causes a waste of money), and environment (e.g., throwing away food means a waste of precious resources and a greater household impact on the environment).
- The research team provided participants with **a waste measurement toolkit and trained participants on standardised waste collection and measurement procedures**. This approach could provide **a systematic method to measure actual waste (pre- and post-intervention)** and enhance the reliability of findings. Though, as a time and cost intensive method, the scalability of this method for a large and longitudinal study requires systematic and institutional resources investment.

Intervention Design Exemplar 6: Multi-media and multi-artefact intervention

In a Canadian Study (Study 7), a two-week *multi-media intervention* called “Reduce Food Waste, Save Money” was mobilised to encourage participants to reduce the amount of money wasted on food waste and to **strengthen perceived behavioural control**, by **enhancing food literacy**.

- Participating households were provided with **food literacy messaging** on: food planning, efficient purchasing, storing, and preparing food, and using leftovers, to ultimately reduce the amount of food that becomes waste.
- The **interventional artefact package** comprised a commercially available four litre *container*–designed to extend produce life, as an ‘envelope’–along with a ‘Reduce Food Waste, Save Money’ *postcard* affixed on the top of the container, as well as a *fridge magnet* version of the postcard, and food waste reduction tools including an *explanatory letter, freezer stickers, and a grocery list pad* inside the container. All messaging included directions on how to access a *purpose-built website* www.foodwaste.ca.
- Participating households received five **email messages/alerts**, which encouraged visits to the website, reiterated food waste reduction tips, and reinforced the message that reducing food waste could save money.

KEY FINDING 3 (IMPACT)

There is a lack of substantial evidence to determine the direct causal link between social media interventions and effectual and sustainable food waste behaviour change. The evidence from the literature shows that social media are effective in certain aspects but fall short in others to enable for positive behavioural outcomes.

Based on the SLR, there seems no sufficient available evidence to establish that social media alone can lead to reduced food waste behaviour, or that social media make a significant difference in the intervention mix to actualise food waste reduction behaviour. Particularly as found in Study 1 (Young et al., 2017) social media intervention did not outperform the information intervention or control groups, mainly because social media (e.g., Facebook) cannot replicate enough of the interaction shown by face-to-face social influences to change reported behaviour more than the information stimulus (e.g., information packages). Thus, it is not sound to assert or overstate the effect of social media in enabling food waste reduction behaviour. However, there is tangible evidence demonstrating the **potentials and benefits of social media** in the following aspects:

Raising awareness and disrupting habitual behaviour

One of the most proven social media effects across food waste (or general public intervention) campaigns is awareness raising and disrupting habitual behaviour patterns. For example, Study 2 (Comber & Thieme, 2013) observed three primary changes resulting from BinCam (app+Facebook) interventions, namely *awareness raising of local behaviour*, *reevaluation of social influence*, and *re-evaluation of behavioural control*. Unintentionally in the design of BinCam, the **click sound of the camera upon image capture** was most readily recognised by participants **as a challenge to their habitual performance of waste disposal**. In the BinCam system, the appropriation of Facebook affords a way to **leverage social influence** and **impart change in the network**. The BinLeague suggested that **group norms** facilitated a local influence not to let the household down in the competition of reducing food waste. When individuals perceived their behaviour and that of their household as below this norm, they experienced feelings of guilt and resolved to perform better. This implies that **system-led feedback can lead to behavioural change**.

More impact on 'motivation' and 'ability' than 'opportunity' to change behaviour

In light of the Motivation, Opportunity, and Ability (MOA) framework as introduced earlier, Study 3 (Soma et al., 2021) found that social media interventions were more effective in increasing '**motivation**' by increasing awareness based on environmental, economic, or moral appeals, and improving '**abilities**' by providing information and knowledge on how to better manage food, than in creating '**opportunities**' for participants not to waste food. The **main reason** is that 'opportunity' typically arises from structural, material, and potentially systemic changes occurring further upstream (e.g., changing access to retail infrastructure, or a complete change in food marketing practices) from the household (downstream) level. Interventions like **awareness campaigns do not necessarily address the long-term and systemic opportunities to reduce food waste**. Nevertheless, some artefacts like '*nudging tools*' (e.g., fridge magnets as a reminder of proper food storage) might help to fill the gap in the opportunity aspect.

Impact on behaviour constructs (not outcomes) to reduce (avoidable) food waste

Study 7 by van der Werf et al. (2021) found significant correlations between various media-based interventions (independent variables) and the amount of total food waste, avoidable food waste and unavoidable food waste (dependent variables). They found the intervention effect mainly occurred through key constructs like **motivator** (e.g., reducing wasted money to reduce food waste), **perceived behavioural control** (i.e., not overbuying), and the good provider **identity** and **personal norms**, all of which were found to be significantly linked to reducing **avoidable food waste**. Especially researchers suggested that **identity** (e.g., full-time mums, professionals) may be a useful determinant and possible intervention point to shape household food waste behaviour, although it is questionable whether those behavioural changes are sustainable or not.

Only highly engaged gamification facilitates low generation of food waste

Study 4 by Soma et al. (2020) compared the *actual* and *self-reported* food waste between three intervention groups (Information, Community Engagement, and Gamification) and one Control Group (no interventions). Results show that waste audit analysis revealed no significant differences in pre- and post- intervention food waste reduction in the Control, Information, and Community Groups. **Only the Gamification Group had a marginally significant result in terms of less edible food waste after the campaign.** And **only highly engaged gamification (e.g., playing games every week) incurred a significantly lower amount of food waste generation** compared to those who played less frequently or not at all.

However, the self-reported data found that the Information and the Gamification Groups had higher awareness of food waste than the Control Group after the campaign, as well as lower self-perceived food wastage. While self-reported data on food waste behaviour changes may overestimate actual changes, researchers argued that results still illustrate the success of the **Information and Game campaigns in facilitating pro-environmental behaviour mainly through awareness lifting.** An additional interesting result was that there seems to be **more 'opportunities' to waste than to reduce waste.** The opportunities to waste can arise from what might seemingly be an environmentally sustainable and benign approach to waste management, e.g., the use of organic waste green bins as an opportunity for people to feel less guilty about wasting food because it goes into a composting process, which is deemed as a positive environmental action.

Social marketing campaigns increase self-efficacy to change behaviour

Study 5 by Kim et al. (2020) demonstrated that a **participant (consumer) insight-driven social marketing program** encouraged household food waste reduction behaviour through **increasing participant's self-efficacy** to cook and subsequently decrease the amount of food waste. They found that social marketing offered an effective approach to reduce food waste behaviour where the campaign design followed key benchmark criteria such as consumer orientation, insight, competition, marketing mix, and behaviour change. Especially their pilot study 'Waste Not Want Not' program embedded those elements in the campaign planning and implementation, thus offering potential and capacity to reduce household food waste.

Well-designed educational materials to influence behaviour change

Study 6 by Wharton et al. (2021) found that an educational intervention, delivered virtually through multiple forms of media and captured centrally on a website, was effective in reducing food waste by 27.85% among participating households. They found that **content of educational materials** had affected individuals' food waste behaviour, including *clear themes about awareness-building, use of information and strategies, and connecting relevant values or issues*, such as home finances and environmental impact, *to the problem of household food waste.* They also found that **the most effective forms of information were delivered via podcasts and videos**, well above and beyond other deliverables such as infographics, text, and downloadable tools. Both the podcast and the videos included, for example, real people demonstrating recipes (in the videos) or describing the application of strategies in the home to reduce food waste (in the podcasts). The **relatability of education interventions** is key to assist participants in food waste reduction.



Summary and Conclusion

There appears a good synergy between the results from Phase 1 and Phase 2 studies, both revealing that social media practices in the food waste area are evolving, and accordingly that research into evaluating the impact of social media campaigns on food waste behaviour is nascent. Specifically, there are five key findings synthesised from the two studies:

FINDING 1

Substantial research into social media impact on food waste behaviour is lacking. There lacks empirical evidence to determine a direct causal link between social media intervention and food waste behaviour change. As identified by both FGDs experts and SLR, most evaluation research has not focused on social media alone, but rather measured an intervention mix that may (or may not) contain a social media component. And the majority attempted to evaluate behavioural impact through various pathways and key constructs ranging from awareness, motivation, norms, knowledge (literacy), self-efficacy, perceived behaviour control, and behavioural intention, all contributing but not equal to actual behaviour change or food waste reduction. Therefore, it is difficult to establish if there is a causal impact of social media communication on food waste behaviour. Moreover, an important reflection is that behaviour change can be/is shaped by multiple interventions as well as broader and non-conscious factors such as contexts, emotions, and habits.

FINDING 2

Measuring social media interventions in food waste behaviour requires **identifying specific action points in a behavioural chain** and **each action point requires a tailored intervention strategy and evaluation method**. As FGDs experts pointed out, domestic food waste may happen at any and all action point(s) of the behavioural chain, ranging from food planning, buying, cooking, storing, and recycling. Each action point and habitual behaviour requires a purposeful intervention that involves a tailored social media campaign and a contextualised evaluation method. This proposition seems to be verified by the SLR results. For example, the most tested action points in existing research are meal planning, shopping with a list, and cooking with leftovers after participants have received a particular intervention. Therefore, a systematic examination of social media campaigns' behavioural impact needs to identify the target action points in a behaviour chain and measure them in nuanced contexts.

FINDING 3

Current social media interventions and evaluation of their effectiveness have **predominantly focused on the downstream, consumer/household level**. However, **fighting food waste entails an ecosystem approach involving multi-stakeholder participation** from across the full spectrum of the demand-supply chain. As found in both Phase 1 and 2 studies, downstream consumers/households are often exposed to more opportunities to waste than save food, partially because of the mid-stream or upstream stakeholders' counter-practices (e.g., retailers promoting 'buy in bulk', government encouraging food production). The novel policymaking interventions that introduced organic bins may inadvertently lead to people feeling less guilty about food waste because they think the waste will go to a composting process. Therefore, fighting food waste is a systemic challenge. It is essential to create shared value between all downstream, mid-stream, and upstream stakeholders to build a food saving 'infrastructure' to enable food waste reduction at individual and/or household levels.

FINDING 4

As part of an intervention mix, **social media are found effective for raising awareness, developing social norms, enhancing food waste literacy, and increasing 'perceived' behaviour control over food waste**. Both Phase 1 and Phase 2 studies concur that there is absence of conclusive findings to support the more significant impact of social media campaigns as compared to traditional information education. The impact of social media campaigns cannot be overestimated. Nevertheless, when social media are integrated with novel persuasive technologies (e.g., BinCam system), gamification strategies, and easy-to-use applications (e.g., Chefbot), their intervention effectiveness may be enhanced. However, the key challenge lies in how to maintain user/participant momentum in engaging long-term, sustained behaviour changes.

FINDING 5

There is no one-size-fit-all model. **Effective and measurable social marketing campaigns feature social or multi-media intervention design** that plays to the strength of each distinct platform and incorporates purposefully designed artefacts to **synergistically induce behaviour changes** toward food waste reduction. In correspondence with FGDs experts' recommendations, the SLR results also highlight that successful social marketing campaigns often partner with retailers' (e.g., supermarkets) social media platforms, embed face-to-face interactions with participants in shopping centres, develop and distribute practical intervention artefacts (e.g., information packs, recipe cards, fridge magnet, shopping notepad, digital kitchen scales, plastic buckets with lids for waste collection) as nudge tools for reducing food waste. Beyond social media metrics, it is important to collect both behavioural and actual food waste audit data which, in turn, can be achieved through either well-trained participants or specialists in food waste collection.

Overall, this project is among the first attempts to explore, examine, and evaluate the scholarship and practice-based examples of measuring the multi-dimensional effect of social media in altering food waste behaviour through assembling insights from both international scholars and evidence-based scientific research. While the effectiveness of social media as a behaviour intervention tool should not be overstated, it offers real potential to influence various constructs and components of behavioural change processes. The current evaluation approaches, models, and frameworks of social media effect on food waste reduction are limited or flawed. Yet, they provide implications for both researchers and practitioners to identify suitable solutions to achieve social media impact beyond the swipe or click (social media traffic).

Recommendations

Based on the key findings from Phase 1 and 2 as presented earlier, this project **recommends** the following action points for *assessing and determining the effectiveness of social media campaign/intervention in reducing food waste* (evaluation), as well as future *social media campaign/intervention design* (practice), so that executives can make informed decisions in *investing in social media communications for tangible benefits and impact* (investment).

Recommendations on evaluation of social media impact

Scientific assessment and determination of the effectiveness of social media interventions in shaping food waste behaviour change is a longstanding challenge due to evaluation designs and methods being inconsistent, somewhat flawed, or constrained. Nevertheless, we recommend the following action points to overcome some typical methodological challenges and thus improve the reliability and validity of evaluation results:

ACTION 1

Develop a **long-term oriented** evaluation approach to track sustained behaviour changes over time and combine quantitative and qualitative methods to ascertain to what extent, and in which ways food waste reduction behaviour occurs.

Most evaluation research has thus far examined a relatively short timeframe (often within a year) to compare the behaviour-related outcomes (e.g., awareness raising, knowledge acquisition, perceived behaviour control) pre- and post-interventions. Despite multiple measurements undertaken at different time points around social media campaigns (e.g., one month before the campaign, one month after the campaign launch, one month after the campaign completion), such a short-term oriented evaluation is insufficient for determining whether food waste reduction behaviour is sustainable over time. As such, **longitudinal benchmark studies are required** for future evaluation research to systematically assess and improve the effectiveness of social media-based interventions. Also, given the various biases and limitations embedded in the chosen samples of study participants, for example, mainly targeting single-family households, females, middle-age, and middle-income residents, future studies should involve a larger and more demographically diverse population to validate the feasibility and scalability of social media intervention tools.

Another much-needed improvement for evaluation research is to **measure the actual (not self-reported) food waste amount** per household pre- and post-interventions, by either implementing standard food waste audits led by specialists or providing participants with waste measurement kits/tools (e.g., plastic 3.8 litre buckets with lids, digital kitchen scale) and training them in standardised waste collection, measurement, and note-taking to enhance the reliability of reported data. Further, to determine whether actual behavioural change or food waste reduction occurs because of a particular intervention, researchers should randomly assign participants to Treatment Groups (with interventions) and a Control Group (no interventions) to compare the differences in subsequent food waste behaviours or waste amount. Apart from quantitative methods, it is essential to **integrate observational notes and field-based, qualitative approaches** to fully understand how interventions function and affect participants in real-life settings.

ACTION 2

Leverage the advantages of each distinct digital technology and **ethically grounded citizen science methods** (e.g., calling participants to donate data to a shared platform) to collect behavioural evidence and to audit actual food waste.

While traditional extractive methods of data collection (e.g., surveys, image analysis, waste audits) are valuable and retain their space as part of a multifaceted methodological toolkit, ultimately, they cannot determine the extent to which behaviour change occurs from and results in quantifiable food waste reduction unless consumers/households are proactively engaged in the continuing process of monitoring and measurement. To remedy this drawback, scholars recommend using public or semi-public social media platforms to collect personal data and to protect participant privacy (Comber & Thieme, 2013). On a particular note, the emergent yet **ethically grounded citizen science methods together with computational and qualitative approaches** are useful to enhance the rigor of current data generation from social media-based campaigns. For example, social media analytics could be combined with digital ethnography methods (i.e., netnography – an online research method originating in ethnography and understanding social interaction in a digital environment) to capture and analyse trends in textual and visual communication within social networks.

Specifically, **citizen science methods involve citizens willingly donating their digital data** through the downloading of applications on a smartphone, or, for example, through the extension of a web browser on Firefox and Chrome where people could be asked to follow specific food waste campaign accounts in platforms such as Instagram. This method would ask participants to install a Firefox and/or Chrome add-on web extension, and then follow participants who use the selected social media platforms (via desktop or mobile) to understand how people access, engage with, share information, and generate images about food/food waste, while also capturing data about the broader social media environment and social influence of others and marketing trends. Such a method could also capture what data are displayed in user/participant newsfeeds, collect information about accounts that participants follow, and track the promotion and algorithmic curation of unsustainable food consumption content and retail ads (e.g., ‘buying in bulk’ ads).

Apart from tracking food waste behaviour change, citizen science methods could also assist people developing critical literacy about, and cautious engagement with, viral digital marketing of problematic ‘food porn’-type content. Through involving upstream stakeholders, this approach would offer valuable avenues to document the negative consequences of excessive digital marketing of food consumption and to realise how particular audiences on social media platforms are targeted with specific ads. Moreover, this approach could serve to identify and counteract oppositional ‘buy in bulk’ retail messaging and, to call for greater social media regulations around tightening standards for ethical and sustainable marketing of promotion content.

ACTION 3

Harness **cross-disciplinary perspectives** (e.g., psychology, sociology, communication, and Internet research) and integrate theoretically dynamic frameworks for food waste evaluation research, to develop a comprehensive understanding of behaviour change in broader and collective contexts.

To date, most food waste research has emphasised the individual or interpersonal-level theoretical frameworks (e.g., TPB, MOA) to understand behaviour outcomes. While such a micro-level evaluation is useful, as a phenomenon the food waste issue transpires to the social level because of broader and collective impacts. This indicates that to achieve widespread food waste reduction a greater emphasis should be placed on **dynamic ‘collectivist’ models** that can comprehensively account for the broader social and structural processes that influence behaviour change. It is, therefore, recommended to build on previous research findings and bridge together frameworks from psychological, behavioural, and sociological theories (e.g., social identity, social movement studies) in combination with communication and internet research.

The inclusion of models and rationales from communication and internet studies is necessary because persuasion appeals, media framing, language use, and digital participation require sensitiveness of the socio-cultural, technical, and historical contexts within which people communicate, interact, share, and exchange information. To this purpose, integrating social psychology and sociological theories is an important route for exploring the role of social influence, collective mobilisation, and the socialisation of behavioural learning. This should be integrated with communication and social marketing principles to improve not only the design of interventions, but also to **engage people in creating a sense of shared identity around food waste as recognised as part of a pro-environmental movement** which thus, helps form public opinion and recruit people for collective action to fight food waste.

Recommendations on social media campaign/intervention design

While the effect of social media on changing food waste behaviour should not be overstated and social media are often integrated to an intervention mix, we recommend practitioners consider several aspects to augment the impact of campaign or intervention design:

ACTION 1

Prioritise an **affordance-first** (rather than popularity *per se*) and **platform-specific approach** to social media intervention design that addresses the needs of target audiences, specifies behavioural outcomes, and encourages meaningful and participatory engagement.

When designing a social media-based intervention it matters to select **an appropriate social media platform** for a specific purpose, for the target audience(s), and for the right format of information delivery to track if any actual reduction in food waste has occurred in response to receiving an intervention. Instead of relying on the popularity or dominance of a platform, applying a systematic framework to the selection of a social media platform, or multiple platform design, will help to identify the necessary functionalities of interventions that align with the available 'affordances', that is the technical, social, and aesthetic properties of a given platform. For example, prioritising **visual communication** over dominant textual information can augment the emotional appeals of a platform (e.g., YouTube), to visualise food waste issues in appealing ways.

Another potential pathway to multi-platform intervention design could be to draw on the emergent affordances of social media platforms like **Clubhouse** (<https://www.clubhouse.com/>) an **audio-focused social network where users communicate in chat rooms** (see Image 7). This could be a new avenue to explore whether *communities can be built around topical issues like food waste, generate enough interactions for social influence outcomes, and lead to opportunities for social learning, collective knowledge, and exchanging of ideas* which may stimulate innovative ideas to progressively advance an anti-food waste agenda.

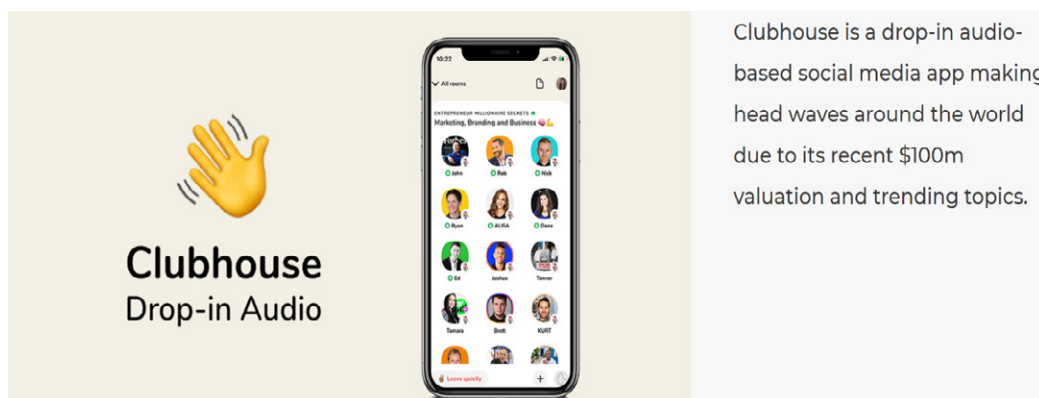


Image 7. Clubhouse
(Sourced from [Internet matters.org](https://www.internetmatters.org/))

In addition to leveraging platform-specific affordances, it is also necessary to **specify target behaviour (intervention outcomes)** and **pair that with intervention strategies** that are appropriate for **broad adoption** and **scalability** beyond a particular geographic location. As found in the literature, target behaviour-related outcomes range from *general awareness raising, information and knowledge acquisition, leftover reuse, fruit and vegetable waste reduction, and food planning and storage*. However, focusing on awareness and education (literacy) alone will not necessarily result in behaviour change. Instead, **multifaceted intervention designs should target the whole behaviour chain** to enable dynamic and sustainable engagement with participants and to prompt their active participation as a core element of the behaviour change process.

In this regard, experts in Phase 1 study highly recommend **TikTok** as one promising social media platform to mobilise young audiences and family units in combatting household food waste. This is mainly built on TikTok's creative participatory design, especially its capacity of inspiring **prosumers** (that is, where people readily participate as both content producers and consumers) to document and share novel, ordinary, and mundane things online and disseminate that to other everyday users on the platform. In this regard, TikTok could offer a potential platform for campaigns to engage broad audiences in the sharing of ideas, practices, or initiatives (e.g., 'cooking show', 'fridge challenge') in entertaining and informative ways.

ACTION 2

Integrate **(downstream) co-design with consumers and (upstream) co-production with influencers** (e.g., retailers, policymakers) methods to inform social or multi-media intervention design, wherein multiple stakeholders play an active role in facilitating food waste reduction initiatives.

Since food waste occurs not only at the consumption level but also within the food supply chain, **effective invention design requires a systematic approach** to integrate insights from downstream consumers/households (bottom-up, co-designing) with inputs from mid-stream (e.g., producers, retailers) and upstream (e.g., policymakers) partners (top-down co-production) to achieve impactful campaign planning. Specifically, **co-design/co-creative thinking** involves garnering ideas from participants to understand their concerns, barriers, motivations, and preferred program characteristics, based on which an audience-oriented campaign is designed to target a specific behaviour change outcome, identify effective modalities of intervention delivery, and develop appealing campaign conceptualisation. Engaging participants in co-design processes helps to **reduce participant attrition** because it enables better understanding of what intervention strategies may work for specific audiences, how they work, and why certain strategies turn out to be ineffective among certain sociodemographic populations.

In parallel to downstream co-designing, it is advisable to adopt **upstream co-production methods** where multiple stakeholders (e.g., researchers, practitioners, policymakers, community groups) actively collaborate throughout all stages of the research process to establish practical solutions to address food waste problems and mobilise necessary resources from system networks. For example, each stakeholder in the co-production process can solicit active buy-in and commitment to influencing decision-making, shaping actions, and increasing interventions on food waste behaviour in all aspects. Such an integrated and multi-stakeholder collaborative approach will aid the development of scientifically rigorous and pragmatically sound interventions to affect the behaviours of target audiences as active citizens, consumers, and community members. Ultimately, targeting solutions to address systemic issues constrained at the upstream level may be required to remove barriers to achieving effective food waste reductions at the downstream level.

ACTION 3

Incorporate **gamification apps** to social media-based intervention campaigns to foster audience habitual and conscious behaviour engagement, as well as to incentivise their waste reduction efforts and progress.

As endorsed by both the expert FGDs (Phase 1) and SLR (Phase 2), **gamification** could potentially be an effective tool to reduce household food waste if used in combination with social media platform interventions. The **main rationale** lies in that gamification can actively involve individuals or families in entertaining ways, whether it being a game, a challenge, a trending topic, or even fandom within a virtual community. As found in the BinCam-featured Study 2, 'BinLeague', as a fun gamification component, has successfully engaged not only individuals but also households/families in competing reducing/recycling food waste and saving money. While gamification seems like a new practice in the food waste area, it has been intelligently used in other intervention contexts such as electricity saving and clean energy (e.g., 'Reduce Your Juice' Campaign).

While incorporating gamification apps to social media interventions, it is vital to explore what messaging and content works best with the gamification strategies to improve and maintain user participation, engagement, and commitment, thus ensuring **intervention sustainability** through non-monetary reward systems (e.g., leader boards, BinLeague). It could be particularly useful to collect behavioural data or food waste audits through various gamification exercises which, in turn, provide benchmarks for observing incremental changes in food waste reduction. For this purpose, we highly recommend **social media campaigners work with game developers** to explore and design games that make participants motivated to play on a daily basis and that are user friendly. As such, the key to gamification design is to maintain user gratification in performing everyday food saving behaviours.

ACTION 4

Follow the **social marketing benchmark indicators** to develop measurable and impactful social media campaigns tailored to the food waste area, especially to incorporate techniques of influence, persuasion, and emotional appeals to intervention design that move beyond a traditional focus on information provision.

Based on a systematic literature review of existing food waste reduction programs, Study 5 by Kim et al. (2020) proposed eight social marketing benchmark criteria to inform and guide the design of social media intervention campaigns:

- Aim to change the target audience's 'behaviour'
- Consumer-oriented thinking
- Conduct 'customer research' to identify actionable 'insights'
- Use 'theories' to understand behaviour change processes
- Apply a full 'marketing mix' (i.e., Product, Price, Place, Promotion)
- Apply 'segmentation' to differentiate the target audiences
- Deliver a compelling 'exchange' (benefits outweigh perceived and actual barriers facing participants)
- Exceed 'competing offerings' that target audiences may encounter when adopting the desired behaviour

To develop persuasive messages and educational content, it is preferable to incorporate more positive emotional appeals in intervention designs rather than to simply deliver instructions that could easily trigger 'information fatigue' among target audiences. Especially, future intervention design should more strongly employ positive reinforcements, incentives, and rewards as opposed to aversive feedback (e.g., social disapproval, stigma) to encourage appropriate food saving behaviour and foster new habits through external motivators/stimuli, such as affirmative comments, social support, and expert or referent power associated with appropriate behaviour performance. Overall, the messaging design should endeavour to reflect the cultural, linguistic, economic, social, and structural contexts that provide implications for tailoring the learning tools, resources, and tips to specialised demographic populations whose behaviours are, in turn, shaped by those contexts.

Recommendations on investment in social media communications

Based on the above recommendations on both evaluation of social media impact and potential effective intervention design, we recommend executives and decision-makers to consider the following aspects of investing in social media communications:

ACTION 1

Increase **investment in developing sustained social media campaigns** aimed at changing target food waste behaviour longitudinally and persistently through integration with other purpose-designed intervention methods (e.g., persuasive technologies, nudge tools). There should be a series of social media campaigns updated each year, with each campaign targeting a specific food waste behaviour and aimed at collectively delivering the key theme of food waste reduction. This predictably requires a budget for a three-year strategic communication plan designed in consultation with both professional agencies and scientific researchers.

ACTION 2

Grant **funding for longitudinal and cross-sectional evaluation research** involving scientific researchers, industry partners, and citizen participants for 1) the regular evaluation and measurement of the effectiveness of social media campaigns and 2) to secure evidence-based improvement of the intervention design. As revealed in this report, measuring social media impact is complex and challenging which thus requires large resources in personnel, software, and management. Especially with longitudinal studies, there would need strong commitment to adjusting the research methods and monitoring the evaluation outcomes to reflect and capture the very dynamic behaviour change process.

ACTION 3

Provide **resources support for exploring gamification technologies or apps** through hiring a professional game developer in collaboration with (social media) communication practitioners, potential users, and the evaluation research team. Drawing on exemplars from other intervention contexts (e.g., electricity saving, clean energy) where gamification has been used as both an intervention design and data collection source, the food waste area can also implement game apps as educational and interventional tools to engage citizens in acquiring food waste literacy and practicing waste reduction behaviour in everyday life.

Future Research

Since existing empirical studies on the impact of social media on food waste behaviour are still in their infancy and evolving, a **future research agenda** could revolve around but not be limited to the following topics to tackle the unresolved challenges in this practice area:

- Develop social media campaigns and strategies to feasibly **scale-up intervention tools and resources** spanning the community, municipality, state, and nation levels;
- Conduct **longitudinal studies with sufficient follow-ups** to understand if/how food waste behaviour changes sustain with the impact of more enduring interventions;
- Explore **diverse intervention strategies** beyond awareness building and literacy education to find out what set of strategies (intervention mix) contributes best to sustained reduction in household food waste;
- Examine the **efficacy of frequent participation in gamification strategies** as nudging tools and where there are no economic incentives for behaviour change.

Specifically, we suggest two research plans as follow-up studies to address the most pressing challenge in this field: how to validate the tie/link between social media intervention and actual food waste reduction via measuring behaviour constructs. Since social media metrics and analytics do not necessarily correspond to offline food waste behaviour, the idea of **'triangulating data sources'** becomes a viable solution to the evaluation puzzle. In this line, we propose future research should aim to build **data partnerships** with target audiences (e.g., individuals, households) and/or key stakeholders (e.g., retailer stores, supermarkets, local councils) to attain both social media metrics and actual behavioural data for correlational analysis to benchmark the effectiveness of social media campaigns or interventions.

There are two options of collecting actual food waste-related behavioural data for triangulation with social media analytics:

- **Project option 1: Convene a national household/consumer panel** to collect both social media and behaviour change data. Enrol people (panellists) into a food waste reduction program. Panellists will grant permission for the collection of their social media data, and researchers/campaigners may seek also additional data from panellists, for example, in the form of shopping dockets uploaded to an online data capture portal or via weekly food waste-related questions delivered to mobile devices as an SMS. Additionally, interviews, focus groups, and/or observational approaches for actual behavioural data tracking could be mobilised to better understand what influences and/or constrains people, and identify which tools/resources would help them to achieve sustainable behaviour change.

Example: CSIRO energise is such a campaign to assemble a national panel of everyday Australians who contribute data to national energy research. The donated data from participants help to better understand how households across the country use, generate and interact with energy. The potential challenge with this evaluation method is how to keep panellists engaged. There might still be a limitation in whether, and to what extent, behaviour change can be tied to social media interventions.

- **Project option 2: Co-opt other stakeholders' (e.g., retailers) data systems** and build social media campaigns into those data systems to examine the campaign's impact on consumers' behaviour data. For example, Woolworths has various store or reward card systems, which provide substantial data about consumers as shoppers and their behavioural patterns. It is worth considering to what extent social media campaigners or researchers can build ethical partnerships with Woolworths to harness the card systems as part of ongoing data collection and explore how to tie a specific social media campaign into changing a particular data set. There could be many other approaches, but this option serves as a starting reference point for data partnership building in line with privacy laws.

In brief, this research topic is relatively new, but the opportunities to tackle domestic food waste are abundant. This exploratory project serves as a point of departure to spark more scholarly and industry interest and investment in leveraging the capacity of social media interventions for food waste reduction.

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Appendix 1:

Focus group discussions protocol

Question Guide/List (Indicative only)

The questions may vary depending on the participants' responses and interaction, which may require different follow-ups or prompts.

1. Grand tour question

Can each of you please introduce yourself like your name, institution, and relevant research expertise in evaluating social media campaigns in the food waste context or relevant area?

2. Focal questions

Each participant will take turns to elaborate on the following questions:

Themes/domains	Sample questions
Evaluation approaches/ models	<ol style="list-style-type: none">1. What constitutes behavioural influence in the context of social media campaigns or communication?2. As per your expertise knowledge, how do you (or the literature) evaluate the influence of social media campaigns/communication, as an education or intervention tool, to change people's food waste behaviours (e.g., key measurements, indicators, evaluation models, case studies, barriers/challenges of evaluation)?3. If the social media influence process is not direct but multi-layered, what could be the possible pathways to evaluate food waste reduction behaviours (chain of behaviours) with the impact of social media campaigns or communication?
(Causal) relationships between social media and behavioural change	<ol style="list-style-type: none">4. What role has current research found about social media campaigns that have played in behavioural changes especially those behaviours tied into food waste reduction?5. What is already known about social media campaigns or communication and their general influences on public at large (e.g., altering people's awareness, attitude, intentions)?

3. Questions for free discussions

In this round, participants are free to discuss the following questions:

Themes/domains	Sample questions
Reflection on social media impact	<p>6. Based on existing research, what has been shown most or least successful by using social media campaigns to promote a social cause (e.g., fight food waste)?</p> <p>7. Are there any key different affordances (contextual factors) in using traditional/mass media versus social media to persuade, educate, and influence public?</p>
Recommendation for this project	<p>8. For organisations with a tight budget of research, what aspects or dimensions of evaluation should be given top priority for social media projects on food waste reduction?</p> <p>9. What areas/streams of literature review would you recommend us to look into?</p> <p>10. BlueSky thinking/creative brainstorm (if time available): What recommendations would you make to assist designing a measurable campaign that leverages power of different platforms, metrics, institutional stakeholders etc. to change food waste behaviours?</p>

4. Open questions

Lastly, are there any points or questions that we haven't discussed yet, but you want to bring up or highlight?

Appendix 2: Systematic literature review protocol

Systematic Literature Review Protocol

Protocol developed by Dr Kelly Lewis, based on the PRISMA statement for systematic reviews and meta-analysis (Moher et al., 2009)

Eligibility Criteria

Review authors	<p>Primary Dr Kelly Lewis (RA): Protocol development, data collection and extraction, screening full-text articles, Coder 1 (all full-text studies coding), analysis, reporting and recommendation</p> <p>Secondary Dr Jenny Hou (LPI): Coder 2 (final full-text studies) intercoder reliability testing, analysis</p>
Date	Include scholarly journal articles published between 2010-2021
Geography	Include studies conducted in/focused on developed and (primary) English-speaking countries only
Target population	Adult, domestic (non-commercial) end users (individuals) and households (single family/collective living) (e.g., ordinary people who buy, prepare, and consume food)
Setting	Social media or digital/transmedia campaign that target the domestic food waste prevention, intervention, or recovery area
Study focus	Specific study design: Evaluate effectiveness and influence of social media campaigns aimed at reducing domestic food waste from multiple aspects, and which take a dynamic approach focused on causal determinants of behaviour and behavioural change processes/outcomes. For example, questions are best answered by examining existing models, case studies/social media campaigns
Publication type	<p>Inclusion criteria:</p> <ul style="list-style-type: none"> • Evidence-based, peer-reviewed, primary research journal articles • Studies mobilising digital and/or social media interventions (food waste related) • Studies mobilising (household) food-waste reduction interventions • Studies mobilising social and/or digital transmedia campaigns with the aim of inducing behaviour change (food waste related) <p>Exclusion criteria:</p> <ul style="list-style-type: none"> • Non-peer-reviewed academic literature • Books, book chapters, trade publications, grey literature (including research/industry reports) • Review studies • Work in-progress • Conference proceedings • Theses/Masters studies • Interventions without empirical evidence • Interventions without a behaviour change outcome • Theoretical articles without an intervention • Studies not related to the phenomenon of food waste
Language	Include studies published in English only

Information sources

- Database-driven search (automation)
- Proquest
 - Ebscohost
 - Emerald Insight
 - Scopus
 - Web of Science
 - ScienceDirect

Backward & Forward Snowballing (manual) Following Wohlin (2014) (see Figure 1), the database-driven search approach is combined with the snowballing approach for conducting systematic literature reviews. The dual-step process is summarised below:

- Backward snowballing: using the reference list to manually identify additional relevant papers/studies for inclusion
- Forward snowballing: manually identifying additional, relevant articles/studies based on those articles citing the paper being examined via Google Scholar

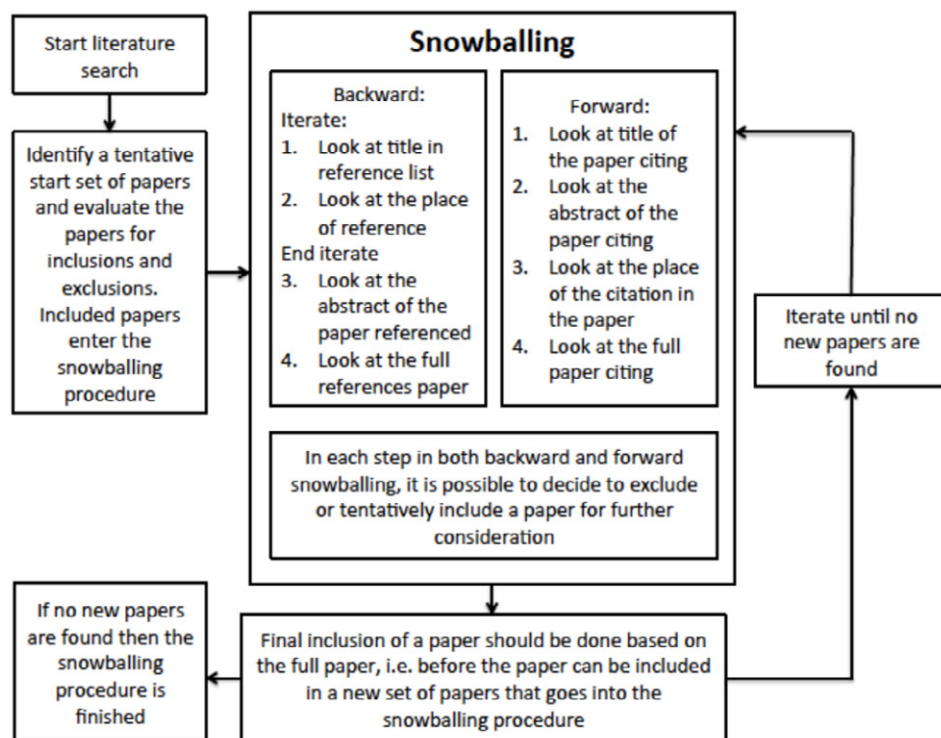


Figure 1. Snowballing procedure.

Search strategy
 Search strategy formulated from keywords (identified in research questions) and synonyms of terms used e.g., “food waste” AND “social media” AND “behaviour change”

Search #1	(Broad: Food + waste + reduction + social media + campaign) (campaign* OR marketing OR intervention*) AND (“social media” OR “social network*” OR Twitter OR Facebook OR Instagram OR “social marketing” OR transmedia OR “digital media” OR “digital platform*”) AND (behavi* NEAR/15 chang*) AND (food* NEAR/20 wast*)
Search #2	(Narrow: Food waste + social media) (“food waste” AND “social media”) AND noft(“social media” OR “social network*” OR Twitter OR Facebook OR Instagram OR “social marketing”) AND noft(“digital platform*” OR “digital media”)
Search #3	(Focused: Food waste + social/digital media + behaviour change + intervention + influence) “food waste” AND noft(“social media” OR “social network*” OR “digital media” OR “digital campaign*” OR “public communic*”) AND noft(“behaviour* change*” OR “behavior* change*” AND intervention* AND influence OR affect)

Data management

Literature	Endnote for database software management
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Data collection

Study selection	Phase 1: Relevant abstracts identified through database searching filed to Endnote library + manual screening of title, abstract, and key words for relevance Phase 2: Download to Endnote the full text of the remaining articles as identified as relevant and applicable to the research interest + removing duplicates + manual application of inclusion/exclusion criteria to selected studies
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Data extraction	Information extracted from full text articles to an Excel spreadsheet (title, authors, journal, and publication detail + empirical context of study, social media platform, method, intervention (characteristic/component/function), theories or models underlying intervention, key outcomes/results + review author’s own notes/remarks)
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Data analysis

Qualitative analysis	Develop a codebook (in Excel spreadsheet) to analyse each individual article following an interpretive, inductive process (emergent – Grounded Theory approach) based on the above data extraction specifics
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Critical appraisal & thematic synthesis	<ul style="list-style-type: none"> • Review and synthesise the empirical context, method, metrics, process of behavioural change and its determinants, and central results of the research • Assess quality of study, methods/models applied, theoretical underpinning, rigor • Identify overarching themes and subthemes that emerged from the synthesis
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Discussion

Summary of evidence	<ul style="list-style-type: none"> • Summarise main findings/strength of evidence to support outcomes/ relevance to research • Note limitation at the study and outcome level • Conclude to provide general interpretation of results and present implications for future research/ways forward
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Funding

Support	Describe all sources of funding/support for the systematic review and role of funders for the systematic review
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Appendix 3:

Useful resource links

Social media guideline, toolkit used by U.S. CDC in health campaigns:

Centers for Disease Control and Prevention guidelines and tools for use of social media in health campaigns:

- www.cdc.gov/socialmedia/tools/guidelines/index.html
- www.cdc.gov/socialmedia/tools/
- www.cdc.gov/socialmedia/tools/guidelines/pdf/socialmediatoolkit_bm.pdf
- www.cdc.gov/eval/logicmodels/

Digital invention campaign – Reduce your juice

<https://research.qut.edu.au/best/projects/reduce-your-juice-assisting-low-income-households-to-better-manage-their-energy-use/>

(Note: On this page are various articles, multimedia outputs, and the project report)

Social media logic model

<https://jmgrants.com/social-media-logic-model/feed>

Purpose-built website for ‘Waste Watchers’ program:

<https://sustainability.asu.edu/waste-watchers/>

‘Reduce Food Waste, Save Money’ purpose-built website

www.foodwaste.ca

Emergent social media platforms – Clubhouse:

<https://www.joinclubhouse.com/>



**FIGHT
FOOD
WASTE**
it's easy as